Forest soil and biodiversity monitoring in the EU

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# Table of contents

- **Background on the BioSoil project** 5
- **Executive summary** 7
- **Did you know that…?** 10
- **Conference programme** 11
- **Soil session: summary of presentations** 13
- **Conclusions from the soil session** 18
- **Biodiversity session: summary of presentations** 19
- **Conclusions from the Biodiversity session** 25
Background on the BioSoil project

The BioSoil project is a demonstration project co-financed under the Regulation (EC) No 2152/2003 concerning the monitoring of forest and environmental interactions in the Community (Forest Focus). It aimed at getting data and information on forest soils and forest biodiversity broadening the scope of the previous forest monitoring activities.

The project was divided into two modules: soil and biodiversity.

**The soil module**

The soil module based on a forest soil survey, aimed to assess basic information on the chemical and physical soil status and on properties of the soil which determine its sensitivity to atmospheric deposition. The project aimed as well to demonstrate the feasibility of systematic forest soil monitoring at European scale through the performing of a second survey on all level I sites and some level II sites\(^1\). A first soil survey was performed in 1994/95 on more than 5000 Level I plots in 31 countries. The repetition of the survey for most of these plots will thus enable detecting changes in the chemical soil condition.

This information, together with the results of the Level I crown condition assessments, aim to determine whether forest damage observed throughout Europe is related to soil condition, particularly accelerated by chemically induced soil degradation.

The analyses were performed at national level by national laboratories which followed the same procedures for comparability of data, as well as the same inter-calibration tests. In addition to those analyses, 10-15% of the samples both from the new survey and archived samples were sent to the central laboratory managed by the French National Institute for Agricultural Research (INRA). The results were compared with the reported data of the individual countries as a data quality check.

Data storage and compilation on plot observations, samples analyses and descriptions of soil profile horizons started in November 2006. The work was coordinated by the European Commission’s Joint Research Centre (JRC) and performed by INRA and the French National Forest Inventory (NFI).

Validated soil data provided to the JRC are integrated into the Soil Profile Analytical Data Base of Europe, which is part of the European Soil Data Centre.

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\(^1\) Forest condition monitoring in the EU as established in the Regulation (EC) No 2152/2003 concerning the monitoring of forest and environmental interactions in the Community (Forest Focus) was set up in a systematic 16x16 km grid overall Europe (Level I) and on an intensive network of selected plots (Level II).
The biodiversity module

The main objective of the biodiversity module was to make an inventory of components of forest biodiversity such as forest structure and species diversity using 3379 plots on the Level I systematic network in the 19 participating EU Member States.

The project intended to provide information on the status of forest biodiversity by:

- Collecting harmonized information relevant to forest biodiversity at the European level and demonstrate the use of the Level I network in this context.
- Presenting a European forest type classification of the Level I plots and provide a first attempt to habitat classification of the European forests.
- Testing selected and internationally recognized indicators of forest biodiversity on a large scale survey thereby to develop a practical methodology as a manual.
- Establishing an improved common baseline framework to integrate other information and ongoing projects on forest biodiversity to achieve maximum added value.
- Designing a multi-scale hierarchical approach to quantify European forest biodiversity and monitor changes over time and space.

The sampled variables have been:

- Tree species and diameter at breast height
- Canopy characteristics
- Forest deadwood
- Ground vegetation: vascular species
- Forest type classification (using the European Environment Agency classification)²

The “Biosoil conference” has been the first occasion for presenting information and results from all the data gathered on EU forests under this demonstration study. Biosoil aims at finding answers to questions on the soil status and on biodiversity indicators. The feasibility of both monitoring exercises should now be examined in order to obtain relevant forest information.

Executive summary

The conference on the BioSoil study – soil and biodiversity monitoring in the EU took place in Brussels on 9 November 2009. It was organised by the Directorate-General "Environment" of the European Commission with the aim of spreading the results of the BioSoil study performed under the Forest Focus Regulation.

Approximately 50 participants attended the conference, mainly the scientists involved in the project and policy makers from the European Commission. The conference was opened by Mr Michael Hamell as Acting Director of the “Nature” Directorate within the Directorate-General “Environment”. Mr Hamell welcomed the audience and introduced the study on forest soils and biodiversity. These two topics were chosen when the Forest Focus Regulation was set up in 2003 and stressed their relevance to current environmental momentum. Soil Directive will be presented in the next Spanish presidency and biodiversity will be as well a hot topic in the international arena as 2010 will be the biodiversity year. Mr Ernst Schulte as Head of the Forest Sector in DG Environment thanked the Joint Research Centre the coordination and foundations of the forest monitoring and in particular of the C-studies where the BioSoil project is part.

The conference was structured in two sessions based on the two modules that formed part of the whole project; a first session on soil and a second session on forest biodiversity.

The Soil Session chaired by Mr Eckelmann started with Mr Montanarella giving a general overview on the soil survey and stressing the fact that it consisted in a demonstration project aiming at demonstrate the feasibility of large scale soil monitoring. The previous survey on soil conducted 10 years before the BioSoil survey will offer the possibility to assess changes of soil parameters such as soil organic carbon stock. It will also contribute to the Land Use/Cover Area frame Statistical Survey, LUCAS, soil survey from Eurostat and the final results could be set in a wider frame of forest data.

Three soil case studies were presented showing the first assessments in UK, Finland and France. In the UK the BioSoil project constitutes the baseline for forest monitoring, crucial to evaluate changes on eutrophication, soil quality, carbon stock evolution, nitrogen, etc. and the impact that forest management can have on soil carbon. First results have shown that C ranged in forest soils from 130 to 450 tn/ha and N from 5 – 20 t/ha.

Finnish assessment showed that 90 % of soil C is in peat-lands and made an assessment of the 700 sample plots comparing the results South-North. As an example above ground vegetation varies from 4 kg of C/m² to 3 kg/m² and soil C varies S-N between 6-5 kg/m². There will be soon an internet application that will permit access to the soil and stand photo of each of the measured plots. This is combined with data mining methods to find out information on structures of the ground vegetation to combine this with the analysis performed.
The first results of BioSoil in France focused on the overall quality of the BioSoil campaign on level I plots, showing more species and spatial variability than in the previous campaign from 1993-1994. Soil analyses show a huge variability in the evolution of the concentrations and a global positive shift for all the elements and all the layers but temporal and spatial trends can not be clearly identified for the moment.

Mr Hiederer closed the first session with the conclusions on the feasibility of the systematic forest soil monitoring at European scale.

In total 22 countries, meaning 31 national focal centres and 4035 plots have been analysed. Preliminary results show that there are different approaches used then separating organic layer from mineral soils that should be harmonised. Completeness of data varies between parameters and the manual could be improved when defining soil horizons. In conclusion soil surveying at EU level is feasible but can still be improved.

The Biodiversity Session was chaired by Mr Pat Neville who introduced Ms Annemarie Bastrup-Birk who made a general overview of the biodiversity part of the BioSoil project.

With a budget of over 800,000€ 3.379 plots were surveyed and 19 Member States participated covering around 93 % of the intensive monitoring plots on the 16 x 16 km systematic grid. For the first time we have a forest biodiversity baseline with information on forest classification, deadwood, tree species, state of the canopy, ground vegetation and a general description of the geo-referred plot including previous land use and forest management.

Ms Mayte Minaya explained in depth the measured indicators and proposed a few optional indicators for future biodiversity monitoring such as lichens, naturalness, invertebrates or birds. In Sweden indicators of forest biodiversity are measured within the NFI. North-Swedish forests are dominated by Scots pine (50%) and followed by Norway spruce (30 %) the contrary happens in Southern-Sweden followed in both cases by birch species. Standing volume has increased since 1920 by 80% and the area of old forests has increased despite it accounts for a 4% in the South. Deadwood assessment show an average in Sweden of 8.1 m³/ha varying a lot depending on the region surveyed. Results from Poland revealed that 63 % of the monitored plots are planted, 80% were managed within the last 10 years, the average number of plant species is 27, 27% of the plots are 40-60 year old, only 2,5% of the forests are untouched, deadwood was found in 95% of the plots varying from 0 to 298m³/ha with an average of 9,6 m³/ha.
The session was closed by Mr Jesús San-Miguel and Ms Tracy Durrant Houston from the Joint Research Centre, who discussed the feasibility of a systematic forest monitoring in the EU. The data produced in the BioSoil project are part of the BioSoil database and will be part of the broader European Forest Data Centre. As the data have already passed all the validation checks, the analysis will start now and will present results along 2010. A first assessment has already provided some results; over 750 of the scores show an age class between 40-60 year old and for the first time the EEA forest type classification has been applied at EU level. The majority of the scores showed a species richness between 1 to 2 species and very few over 10 species. First recommendations on how to proceed in the future were already raised to the audience: simplification of deadwood classification is needed, clarification of species identification, non homogeneous plots have been found, etc.

The main conclusions taken from the conference is that it is feasible to have forests soil and biodiversity monitoring at EU level despite the improvements on the procedures and on the manuals that remain to be done. The first assessments on the data produced are still very preliminary but will contribute to the EU debate on the soil condition and on the status of biodiversity therefore are crucial for environmental policy makers and scientists.

Presentations available at:

http://ec.europa.eu/environment/forests/ffocus_noticeboard.htm
Did you know that . . . ?

**SOILS**

- The highest levels of organic carbon in forest soils can reach more than 500 g/kg in Northern Finland and Scotland?
- The forest soil organic layer is thinner in Mediterranean forests with less than 2 cm but can be wider, up to 30 cm in some forests such as punctual findings in Lithuania, France, UK or Sweden?
- 67% of the assessed plots contain less than 20tn/ha of organic carbon in the organic layer but it can be up to 4 times higher in some Swedish, Estonian, French or Slovenian forests?
- Organic carbon in the first 20 centimetres of the forest soils varies from 10 to over 100 tones per hectare? And that is seems that lower carbon content is characteristic for higher latitude forests?
- From 1996 until 2006 some forest soils faced a decrease in the organic content of the organic layer up to 250g/kg meanwhile in other forest soils it increased in 250 g/kg?
- And that in that same period in the first 20 centimetres there were variations on the organic carbon content varying from -100g/kg to +75g/kg?

**BIODIVERSITY**

- 65% of the forests are forested for more than 100 years? Only 4% were forested in the past 25 years?
- Natural regeneration is used in more than half of the surveyed plots? Planting is used in 30% of the cases.
- Depending on the type of management, some MS remove deadwood from their forests at the same time that other MS leave stems and branches lying on the forest.
- The amount of deadwood that can be found varies from 0 to 298 m³/ha?
- There is a great variety of forest management: high forest (even aged stands) is the most common but there are also high forests uneven aged, young or medium forests and coppices?
Conference programme

9.00 Welcome
*Michael Hamell, Acting Director of Dir. “Nature”, DG Environment, European Commission*

9.05 Introduction
*Ernst Schulte, Head of Forest Sector, DG Environment, European Commission*

**First session: Soil survey Chair: Wolf Eckelmann, DE**

9.15 BioSoil project: soil survey: what, how, where?
*Luca Montanarella, Joint Research Centre, European Commission*

*Elena Vanguelova, UK*

10.15 BioSoil case study: North-European results.
*Hannu Ilvesniemi, FI*

10.45 Coffee break

11.15 First results of BioSoil in France.
*Vincent Badeau, FR*

11.45 Feasibility of systematic forest soil monitoring at European scale. Results of the BioSoil- soil survey. Forest soil information: European Soil Data Centre.
*Roland Hiederer, Joint Research Centre, European Commission*

12.15 Conclusions and open discussion.
*Chair*

**Second session: Forest Biodiversity Chair: Pat Neville, IE**

13.30 BioSoil biodiversity survey: what, how, where?
*Annamarie Bastrup-Birk, DK*

14.00 Forest biodiversity indicators from the BioSoil study.
*Mayte Minaya, ES*
14.30 Forest biodiversity in Sweden.
Sören Wulf, SE

15.00 BioSoil results in Poland.
Janusz Czerepko, PL

15.30 Feasibility of systematic forest biodiversity monitoring at European scale. The results of the BioSoil, biodiversity survey. Forest information: European Forest Data Centre.
Tracy Durrant Houston, Jesús San-Miguel, Joint Research Centre, European Commission

16.00 Conclusions and open discussion.
Chair

17.00 Closing remarks
Michael Hamell, Acting Director of Dir. “Nature”, DG Environment, European Commission
The BioSoil project: soil survey: what, how, where?
Mr Luca Montanarella, Joint Research Center, European Commission

The BioSoil project aims at demonstrating the feasibility of long-term soil monitoring at continental scale. As the first repetition after 10-years of the forest soil level I survey it may allow to gain insight into temporal changes of some of the parameters monitored during the exercise. Even so not all participating countries of the first survey are participating in BioSoil, there are large expectations that the final results will be able to give an answer to the various questions that were put on the table at the beginning of the project for its justification:

- Will a second survey detect any changes in selected soil parameters?
- Will these changes be significant in statistical terms?
- Are changes explicable by cause-effect relationships within the Driving force-Pressure-State-Impact-Response, DPSIR, framework?
- Is the adopted manual of procedures applicable at EU scale?
- Are methods reproducible?
- Can results be compared across EU Member States?
- Are results relevant in the EU context?
- Can results be integrated into a wider European Soil Information System?

Given the well known spatial and temporal variability of soil parameters as well as the high inter-laboratory variation in actual measurements, it is to be expected that these questions will be only answered partially. Great expectations have been raised concerning the new approach involving a central laboratory for the re-analysis of 10% of the original national samples as well as of the corresponding archived soil samples of the previous survey. It is to be expected that having eliminated the large inter-laboratory errors, there could be a more realistic opportunity of actually comparing measurements over time (between the two surveys) as well as over space (between national soil data). Eventually BioSoil, if successful, and other similar initiatives, like LUCAS-Soil, could pave the way towards systematic operational soil monitoring in Europe.

Evaluation of the quality and changes in UK forest soils
Ms Elena Vanguelova, Forest Research (UK)

Soil quality is of significant importance for: (1) the productivity and sustainability of forest systems, (2) the conservation of soil and water resources, (3) the accumulation of persistent toxic substances, and (4) the contribution forested systems make to the global carbon cycle. The concept of ‘soil quality indicator’ has been put forward in the EU and in the UK as an appropriate means to establish a baseline of soil quality and / or functional ability, and from which changes can be
observed as a result of pressures exerted on the soil.

Forest soils experience a range of pressures, some due to forestry operations and the growth of trees themselves, others outside the control of the forest manager. Spatial and temporal monitoring of soil function and dynamics is vital in improving our understanding of the response of forest soil to changes in climate, pollution and forest management practices. Increasingly, climate change and pollution policies have required an effects-based approach to proposing solutions for environmental problems and implementing the mitigation and acclimatisation policies and strategies to aid forest carbon sequestration and emissions reductions in a targeted and cost-effective way. The European extensive and intensive forest monitoring networks (ICP Level I, Level II and BioSoil) include detailed forest soil temporal and spatial monitoring in addition to environmental factors and tree health conditions. In the UK, forest soils are monitored in 67 Level I plots, 9 Level II plots and 167 BioSoil plots.

Level I, Level II and BioSoil forest monitoring networks were used to evaluate:

1) The conditions of forest soils in the UK by using well established soil quality indicators;
2) The response of forest soils to changes in climate and pollution;
3) The carbon and nutrient stocks and changes in forest soils.

**BioSoil case study: Finland**
Mr Hannu Ilvesniemi, Finnish Research Institute (FI)

In my presentation I will first shortly describe which kind of effort it is to carry out a process named ‘BioSoil’ with nearly 700 sample plots distributed evenly over a land area of 300 000 km². I show the importance of phases starting from the planning, field work, sample pre-treatment, laboratory analysis, data storage and data management on producing correct and reliable, a really representative soil data. I show also some technical challenges like the estimation of the amount of stones in cases where data is expressed in the units of g m⁻² or the definitions of WRB soil classification systems and their suitability to young soils of Finland. I also shortly touch the fact that the projects like BioSoil often end before the data analysis has been thoroughly done. I include some information of the additional measurements, like the biomass of ground vegetation and the photographic measurement of canopy closure that we have made at the same sites as an example how suitable BioSoil sites are as a platform for other measurements.

In our case all measurements were done on exactly the same locations than in surveys in 10 and/or 20 years earlier. This allows us to make some attempts on determining the changes of measured properties in time. The sites are also permanent sample plots of the 8th National Forest Inventory, NFI, and this connection to the NFI with more than 60 000 plots of measured stand properties, gives a good possibility for generalization of the BioSoil data.
Based on the earlier measurements on the sites we have produced the first estimate of the amount of carbon accumulated in the Finish upland forest soils. At the moment we are analyzing the BioSoil soil carbon data in order to make comparisons with the earlier measurements. This information is also used as a background in the national greenhouse gas reporting.

From the measured soil chemical properties we have produced national averages divided in different site class types. At the moment we are preparing an internet version of some of the most visual parts of the results under a slightly provoking working title ‘A deeper insight into Finland’. In the interface the user can click any of the more than 600 dots on the map of Finland representing all sites measured in BioSoil and find a photograph of the soil profile and a general picture of the stand and canopy cover. Also some information of the measured soil properties and ground vegetation will be included. We are expecting that e.g. teachers in grammar and high schools could use this link to visualize their teaching.

We are using some novel data analysis methods like data mining and self organizing maps to find out some general structures of the ground vegetation species at the sites and combine this information with the similar analysis done for the measured soil properties. In addition to BioSoil we have also ground vegetation measurements available from 1950’s, 80’s, 90’s and we are analyzing whether some changes in ground vegetation related to the changes in climate could be found. We have also planned to use material representing a larger geographical area than Finland for the data mining, but this process is slow due to the strict data ownership in BioSoil database.
Changes in the chemical and/or physical forest soil condition. First results of BioSoil in France

Mr Vincent Badeau, French National Institute for Agriculture Research, INRA (FR)

In 2007, the BioSoil project allowed a soil re-sampling on 10 of 102 plots of the French network RENECOFOR (level II plots) and the soil and vegetation re-sampling of the 600 plots of the European Systematic Network (level I plots).

For the level II plots, the sampling and the analyses were realized according to the protocol of the first campaign (1993-1995): 25 replicates per layer assembled in 5 composite samples were analyzed by INRA-Arras (European reference laboratory). The 5 replicates allowed a statistical comparison of the chemical parameters for each site and between the two campaigns.

For the level I plots, the analysis protocol of the second campaign (2007) was the same that above but the field operations strongly evolved since the first campaign (1994-1995 completed in 1999). For the first campaign, the field operations were led by five private offices (what led to a strong heterogeneity of the results) and the soil layers were sampled without replication (only one pit and only one sample by mandatory layer) (no statistical comparison was possible). For the second campaign, the field operations were led by our National Forest Inventory on the whole territory and a composite sample of five replicates was prepared for each soil layer.

For the 10 level II plots (RENECOFOR), and by taking into account the measurement uncertainties, we observed few significant differences between the two campaigns. Chemistry of calcaric soils had not changed at all and, and despite the large decrease of acid deposition, acidic soils showed no significant change for pH or saturation rate, even though their magnesium and potassium contents seem to have been increasing. However for one andic soil in Massif Central Mountains (EPC 63 plot) the saturation rate had surprisingly and significantly decreased, what might be explained by the loss of nutrients inherited from an agricultural past. Soil re-sampling is in process for the 92 other plots of the network. The results are expected at the end of 2012 for a complete trend analysis by soil context.

The analysis of the 600 level I plots was performed by Renaud Rabastens (Master Degree – Nancy University - 2009). His work principally concerned the potential shifts of the ground vegetation but some first results were available for the soils chemistry. We observed a light acidification and an increase of the nitrogen concentrations. This result suits to the vegetation shift (significant increase of the Ellenberg indicator for nitrogen and significant decrease of the Gégout indicator C/N). However we found an increase for all the elements! So we supposed that the quality of the samples of the first campaign was too poor and that the tendencies are very uncertain.

In conclusion, the level I dataset is always the most important ever obtained in France with respect to forest soils but the lack of replicates for each site leads to uncertain tendencies. For the level II plots, the sampling methods allow a statistical comparison between the two campaigns but the number of re-sampled sites is still too weak and we didn’t noticed a global shift of the soil’s chemistry. We must wait the end of the re-sampling campaign of the level II plots (2012) to bring to light the potential tendencies.
Feasibility of the systematic forest soil monitoring at European scale. Results of the BioSoil survey

Mr Roland Hiederer, Joint Research Center, European Commission

The overall purpose of the Soil Module of the BioSoil demonstration project is to evaluate the feasibility of systematic forest soil monitoring at European scale.

The practical aspects of soil sampling and laboratory analysis are assessed by investigating the amendments to the survey guide, which specifies the methods for in-field observations and laboratory analyses, are reviewed based on the feedback received from the participants in the project and the experience with the previous Level I soil data. The merits and inconveniences of sampling soil data at fixed layer depths or by pedological horizons are compared.

Comparability of the data sampled by 32 National Focal Centres across 22 European states is assessed by evaluating the deviations in measurements to the results obtained by the central laboratory, at which 10% of the samples surveyed were re-analyzed following unified procedures. Temporal consistency of the measurements is evaluated by comparing results from plots with co-location with the previous Level I or Level II surveys for parameters, which should not change or vary little over time.

An appraisal of the minimum detectable difference of a parameter, in particular organic carbon, is performed based on an analysis of in-site and between-site variability of data and under consideration of results obtained from the central laboratory. Temporal changes in soil organic carbon are estimated on the basis of the re-analysis of samples from the Level I survey and a comparison of the BioSoil data with data from the previous Level I soil condition survey. By combining the results from the change analysis with the findings from analyzing data in the reference laboratory the possibility of observing changes in organic carbon in European forests over a period of 10 years are evaluated.
Conclusions from the soil session
Session Chair: Mr Wolf Eckelmann, Bundesanstalt für Geowissenschaften und Rohstoffe, Hannover (DE)

1. One of the basic requirements is a proper geo-referencing of all sample plots. It should be discussed, if during plot installation a plot can be moved slightly away from the grid position, if this would allow putting a grid plot into a more or less representative area with respect to soil or land use.

2. The change of the respective numbers of sample plots per sampling campaign and/or the move of sample plots between different campaigns even to a nearby neighborhood makes it more or less impossible to properly compare results of different campaigns on a plot by plot basis.

3. Different sampling designs at sample plots hamper proper comparisons of results.

4. Soil profile descriptions should properly meet the decided taxonomy system, in the case of BioSoil the WRB. Regional variations of soil profile description constrain a European-wide presentation of results.

5. Sampling following soil horizons or depth layers can lead to different results in soil analysis. It is therefore necessary to properly clarify the pros and cons of both sampling strategies.

6. It is not sufficient only to compare contents of horizons or layers between campaigns. Humic or even peaty horizons may have lost their thickness which implicates huge losses of organic C in the meantime. Changes in bulk density implicate as well the need to regard horizons, not only depth layers.

7. Because of high stone content, it will be sometimes impossible to gain volumetric representative soil samples. It is therefore necessary to define a strategy for solving those problems.

8. First evaluations of BioSoil analysis very often show a wide range of spreading but no significant results and possibilities to interpret the data. It seems to be necessary to look for the reasons e.g. coming from sampling strategy, sampling method, and preparation of the sample or the measurement.

9. Some parameters seem to show changes in content comparing different years, but this must not be a change in the long term matrix content: It can be caused e.g. by different biotic conditions in the respective sampling periods of the years.

10. It makes a difference if the result of a measurement is definitive “0” or the zero shall replace the term e.g. of “no measurement”. It is necessary to clearly indicate a given result or even not.
Ms Annemarie Bastrup-Birk, University of Copenhagen, Forest & Landscape (DK)

Many initiatives are currently taken to estimate the loss of biodiversity in Europe. Efforts to develop guidelines for assessing forest biodiversity have been under way for many years. Several processes like the MCPFE process (Vienna, 2003), the Convention on Biological Diversity, the SEBI 2010, are presenting lists of indicators relevant to forest biodiversity. However, there is still no large scale monitoring system of forest biodiversity in Europe. The idea of launching such large scale, harmonised inventory of forest biodiversity and soil was initiated at a meeting at the European Environmental Agency in 2004.

The BioSoil study was launched in 2006 as a study under the Forest Focus Regulation (EC) No 2152/2003 to broaden the scope of the monitoring scheme from the protection of forests against atmospheric pollution and forest fires towards other environmental issues such as soils and forest biodiversity. Article 6 of the basic act allows the Commission as well as the Member States to carry out studies and demonstration projects for this purpose. The BioSoil study aimed to carry out an inventory of both soil chemical characteristics and forest biodiversity at the Level 1 plots. This part describes only the forest biodiversity component of BioSoil.

The existing Level 1 survey of the monitoring programme represented an option for such a large scale monitoring system. The Level 1 survey is a systematic network based on a 16km x 16km trans-national grid of sample plots and as such represents a statistically unbiased sampling tool for European forests. It should also be stressed that the Level 1 survey does not aim and has not been designed to be a comprehensive forest biodiversity survey, but represents a unique opportunity to examine selected parameters of biological interest in forests at the European level. 21 countries agreed to participate in the demonstration study corresponding to app. 5000 plots.

The approach adopted was devised following meetings of biodiversity experts from the Member States combined with field testing of the approach and in co-operation with the Joint Research Centre of the European Commission. The approach is known as the stand structure approach, which assumes an increased potential for biological diversity with increasing complexity of the forest stand. This approach is complimented with the addition of biological data such as information on the ground vegetation community. The sampling approach of the biodiversity component of BioSoil included furthermore a new plot design for sampling, a geo-referencing of the plot using a common projection and an application and a verification of actual forest type according to the European forest category nomenclature (EEA).
In summary the BioSoil biodiversity was proposed as a demonstration study under the Forest Focus Regulation. There was no mandatory participation but the participating Member States were requested to adopt a harmonised practical approach. The BioSoil biodiversity study demonstrated how a large-scale European study can use already existing networks following a harmonised approach to provide European data that contribute to international and national policies on forest biodiversity. The BioSoil study is still one of the few initiatives to select and test simple and suitable indicators to measure and describe forest biodiversity at stand as well as at European level.

**Forest Biodiversity indicators in the BioSoil Project**

Ms Mayte Minaya, INIA-CIFOR (ES)

Given the upcoming year 2010, when progress towards the 2010 Biodiversity targets has to be assessed, relevant and credible indicators of European biodiversity are of utmost importance. However the indicators suggested by the European Environment Agency (EEA) fail to provide the needed information about several important topics of the European forest biodiversity.

**Biodiversity Goals of BioSoil**

- The overall objectives of the BioSoil biodiversity component are to build an inventory of forest biodiversity components such as forest structure and species diversity based in the Level I systematic network.
- The BioSoil project provides data to support policy on forest biodiversity at international and national level, by:
  - Conducting a demonstration study to collect harmonised information relevant to forest biodiversity at the European level using the Level I European network in this context;
  - Applying an European forest type classification in the Level I plots and providing a first attempt of habitat classification for the European forests;
  - Testing selected, internationally recognised, robust and practical indicators of forest biodiversity on a large scale survey thereby to develop a practical methodology as a manual;
  - Establishing an improved common baseline framework to integrate other information and ongoing projects (including the soil initiative of BioSoil) on forest biodiversity to achieve maximum added value;
  - Designing a multi-scale hierarchical approach to quantify European forest biodiversity and monitor changes over time and space;

**Selection of indicators**

The selection of indicators to use in any particular assessment will depend on the precise objectives of the assessment (which must be clearly defined) and on the framework for the development of the indicator that has been adopted. In addition, the relationship between selected indicators and endpoints should be analyzed using appropriate statistical approaches (Hyman and Leibowitz, 2001). Many indicators of forest biodiversity have been poorly tested and require rigorous validation in order to be interpreted with confidence (Noss, 1999).
In a recent report from the EEA (Anon. 2007), several sets of indicators are presented for European biodiversity aiming to evaluate the 2010-target. Concerning forest biodiversity three indicators are suggested:

- Ecosystem coverage,
- Forest growing stocks
- Dead wood.

Only the last two have relevance for the biodiversity trends in European forests.

- Ecosystem coverage of 13 different ecosystem types is suggested, any kind of tree covered area is included in one of these indicators. The claim is that this indicator “has a high relevance for biodiversity because it indicates the area of available habitats and ecosystems across Europe”. This is simply not true. We have seen major ecosystem shifts within European forests through the logging of old-growth natural forests, use of exotic tree species, fertilization, drainage and various types of pollution. A simple measure of tree covered areas masks all these factors having profound negative effects on forest biodiversity.

- For indicator “Forest growing stock” is stated that “Growing stock is an important and well accepted proxy for biodiversity”. The increase in growing stock detected in several European countries has come as a consequence of intensive forest management including, clear-cutting, thinning, exotic tree species, fertilization, drainage and plant breeding. These activities all have negative consequences for forest biodiversity as they cause loss of natural forest habitats and genetic variation. In this context “growing stock” doesn’t serve as a valid “proxy for biodiversity”.

The clear failure to identify relevant indicators of European forest biodiversity is surprising and raises a question behind this failure. We assume that the intentions have been the very best, but something in the process has gone wrong. With due respect to the individual experts taking part in the process, we do note that with a few exceptions the experts are officials from various organizations, authorities and ministries. The limited involvement of scientist is obvious. We cannot evaluate if this is a deliberate choice of the EEA or a lack of interest from the scientific community to participate. For whatever reason, the result is that the SEBI 2010 lack relevant and credible indicators on forest biodiversity and hence should not be used to evaluate the 2010-target.

BioSoil indicators

Biodiversity indicators that are appropriate for implementation at the BioSoil level can be divided into three general groups and the plot design:

- Plot design: BioSoil sampling plot design
- Forest type classification
- Structural forest diversity
- Compositional forest diversity
The sampling plot design affects the variability and the representatively of the network. One approach is to deal with that problem in a large-scale inventory, by taking a number of samples and mixing them together in a combined sample that can be analysed. The most frequently asked questions are how many samples should be taken and how high should be. Uncertainties may appear on different scales and at different components. Especially, systematic errors have to be avoided. Analytical data which are systematically too high or too low have to be avoided too.

Some indicators, such as area of different forest types and protected forest area, are common to all of the criteria and indicator processes and international reporting obligations.

Most processes also include indicators relating to forest composition, principally in terms of species richness and the presence of species of particular conservation concern (threatened or endemic species). These indicators clearly require data from forest inventory and other survey types to generate species lists, which can be cross referenced to national and international assessments of species status.

Structural characteristics of forest stands are relatively easy to assess and are of fundamental importance for biodiversity. Forest stands tend to be structurally heterogeneous, both vertically and horizontally; structural complexity may determine habitat availability and may thus influence diversity of plant, animal and microbial communities. Measures of forest structure that can contribute to indicators include canopy cover, vertical structure of the canopy, and size or age distribution of trees.

**BioSoil optional indicators**

As possible examples:

Lichens: Lichen assessment is relevant to describe and monitor part of forest biodiversity development over time in space and to evaluate effects of changing air quality over time in space. Only macro lichens can be assessed on a representative sample of plots for Europe. The effects of the surrounding landscape on species richness on the plot (e.g. area of forests / fragmentation) can be assessed, at landscape level.

Naturalness / Environmental quality: Considering the proposed forest naturalness assessment at all levels is rather a quality parameter/concept, it has been proposed replacing the expression “Naturalness” with the new one “Environmental quality”.

Invertebrates: To address the main priorities at European level (climate change, loss of biodiversity/SEBI2010, synergies with the Nature2000 network, ecosystem functioning) is recommended to apply the method “window traps”.

Birds: This would allow information on bird species densities and frequency of occurrence to be evaluated against already existing data on forest structure and ground vegetation communities for the first time.
**Forest Biodiversity in Sweden**
Mr Sören Wulff, Swedish University of Agricultural Sciences (SE)

Indicators of forest biodiversity, such as forest structure, tree species composition, stand and tree age, big trees, conks, and dead wood are measured within the Swedish National Forest Inventory (NFI). The assessment of biodiversity in the BioSoil program was carried out on a selected part of the NFI plots. In Sweden, the majority of the forests are within the Boreal zone (57 %), however, in southern Sweden hemi-boreal and nemoral forests dominate but also areas of beach and oak forests are found. The forest area has during the past 80 years has remained relatively constant, however, timber volume has increased by 80 % during this period. The increase is not only seen in younger forest created by modern forestry but also in older forests.

Larger volumes in older forest create conditions for an increased biodiversity as in these stands trees and snags are left behind to a larger extent. The volume of big trees has also increased which is most obvious in the southern part of Sweden. The area of old forest has also increased although the area still is quite small in southern Sweden (4.2 % of the forest area). The largest continuous areas of old forest is found in the northwestern mountain areas of the country (in the north old forest is defined as >140 yrs) but scattered areas of old forest are also found elsewhere, particularly in the eastern parts of the country.

The volume of dead wood is on average 8.1 m³sk (2004-2008 data). The highest volume of dead wood is found in the northwestern mountain areas. Higher volumes are also found in the middle part of Sweden and in the western part of southern Sweden. In forest land within protected areas (National park and nature reserves) the volume of deadwood is three times higher. Standing hard wood of conifers has been measured for a long time. The quantity of this kind of dead wood has increased. The increase is most distinct during the last years.


**BioSoil Results in Poland**
Mr Janusz Czerepko, Forest Research Institute (PL)

The purpose of this presentation is to present synthetic analysis of forest biodiversity in Poland based on Level I monitoring plots ICP Forest (16x16 km), where, in accordance with the Forest Focus Regulation, in the years 2006-2008 there was conducted a demonstration project, namely the BioSoil Forest Biodiversity. Realization of the project resulted in a first, wide-scale, unbiased, timely and methodologically coherent and reliable work on biodiversity in Europe.

In Poland, the studies of BioSoil Forest Biodiversity project were conducted on 438 plots during the growing season of 2007. Within the scope of these works there were included, among others, determination of previous way of use of the observed area, origin of the stand, way of the forest management, types of forests in accordance with European Forest Type Classification, relevés, and measurement of stands and deadwood structure.
What gets out of the database analysis done for the purposes of these studies is the fact that the average number of plant species in Polish forests is 27. Nearly half of the stands are two-storey stands, 13% of which are from natural regeneration. Only 2.5% of forests were found untouched and ¼ of forests has already existed on the observed plots for 25 up to 100 years. The most anthropogenic forests are beech forest and acidophilus oak-wood, whilst the most natural ones are alder carrs and floodplain forests. On one hectare of a forest were average four trees larger than 50cm DBH. The deadwood occurs on 95% of the observed plots and characterizes their very range volume: from 0 to 298 m³/ha. The average volume of deadwood in Polish forest is extensive and reaches 9.6 m³/ha, where coarse woody debris volume is 4.2 m³/ha. Deadwood does not occur in only 5% of the explored plots.

Conclusively, it is worth emphasizing that the aforementioned information may essentially influence the forestry policy in Poland and whole European Union. Taking specificity and uniqueness of the given data as well as their high utility into consideration, realization of the BioSoil Forest Biodiversity programme should be continued.

Feasibility of systematic forest biodiversity monitoring at European scale: Results of the BioSoil-Biodiversity survey; Forest Information: European Forest Data Centre

Ms Tracy Houston, Mr Jesús San-Miguel, Joint Research Center, European Commission

Forest biodiversity data have been collected throughout Europe using the systematic 16x6km grid otherwise known as “Level I”. The objectives were to make an inventory of components of forest biodiversity such as forest structure and species diversity. 19 countries (comprising 27 competent bodies) collected data from 3379 plots between 2006 and 2008. The resulting database includes information about stand structure, deadwood and ground vegetation from 14 broad forest types ranging from boreal to Mediterranean. Preliminary results are presented, along with recommendations for the design of future similar studies.
Conclusions from the Biodiversity session
Chaired by Mr Pat Neville, COILLTE (IE)

Conclusions and outlook

The successful implementation of the BioSoil biodiversity project means that a large scale standardised inventory of forest biodiversity indicators is now feasible at European level. A field manual of standardised methods is available and has been tested and validated in the field. Baseline biodiversity data from more than 3,379 forest plots across Europe now exists in a validated form and represents a stable platform upon which future studies of forest biodiversity may be built upon.

In addition what has also become clear is that the capability exists to build a framework for European forest biodiversity monitoring and a capacity has been formed to provide clear and relevant information to policy makers. Entering the European year of biodiversity in 2010, the BioSoil project offers unique baseline data on biodiversity for the forests of Europe and can become a stable platform for other studies to be built upon to understand changes in forest biodiversity across Europe.
European Commission

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