United Nations Economic Commission for Europe (UNECE)

Convention on Long-range Transboundary Air Pollution (CLRTAP)

International Co-operative Programme on Assessment and Monitoring of Air Pollution Effects on Forests (ICP Forests)

MANUAL

on

methods and criteria for harmonized sampling, assessment, monitoring and analysis of the effects of air pollution on forests

Part I

Objectives, Strategy and Implementation of ICP Forests

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Prepared by:

Kai Schwärzel, Walter Seidling, Karin Hansen, Sigrid Strich, Martin Lorenz

on behalf of the Programme Co-ordinating Centre (PCC) and the Task Force of ICP Forests

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Application for such permission should be addressed to:

Programme Co-ordinating Centre of ICP Forests
Thünen Institute of Forest Ecosystems
Alfred-Möller-Strasse 1, Haus 41/42
16225 Eberswalde
Germany

pcc-icpforests@thuenen.de

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1 Introduction

In response to widespread air pollution and concerns about damages to human health and ecosystems, the Convention on Long-range Transboundary Air Pollution (CLRTAP, Air Convention) was signed in 1979. The Convention entered into force in 1983. The backbone of the scientific work under the Convention are the International Co-operative Programmes, the ICPs. The ICP on Assessment and Monitoring of Air Pollution Effects on Forests (ICP Forests) was established in 1985, in order to conduct monitoring and research of the effects of air pollution on forests. In 1986 the European Union (EU) adopted the scheme on the protection of forests against atmospheric pollution and with Regulation (EEC) No. 3528/86 the legal basis for co-financing of relevant assessments was provided. This was replaced by Regulation (EC) No 2152/2003 (Forest Focus) adopted by the European Parliament and the Council for 2003 to 2006. From 2009 to 2011 the EU supported the forest monitoring at European scale on a project basis (Further Development and Implementation of an EU-level Forest Monitoring System, FutMon) under the LIFE+ Regulation.

Besides its original purpose the monitoring system and the monitoring data can also be used for international processes of environmental policies other than the Air Convention. This applies in particular to the FAO Global Forest Resources Assessment (FRA) and the future Global Forest Survey (GFS), to the Forest Europe process (formerly: Ministerial Conference for Protection of Forests in Europe (MCPFE)), the Convention on Biological Diversity (CBD), to the Framework Convention on Climate Change (UNFCCC), and the European Commission. The monitoring is in accordance with the MCPFE resolutions S1 “Monitoring of forest ecosystems” (Strasbourg 1990), H1 “Sustainable Forest management” (Helsinki 1993), and L2 “Pan European indicators and criteria for sustainable management” (Lisbon 1998). It also contributes to the discussion on global forest policy, such as the Intergovernmental Forum on Forests leading to the United Nations Forest Forum (UNFF). The latest example of the use of ICP Forests monitoring data for environmental policy processes at the European level is the National Emission Ceilings (NEC) Directive (2016/2284/EU). Article 9 of the NEC Directive requires EU Member States to monitor the negative impacts of air pollution on ecosystems (including forests). Therefore, many parties to the convention use ICP Forests data to fulfil their reporting obligations for the EU. Finally, the monitoring and research infrastructure built over more than three decades can also contribute to terrestrial research infrastructures within new international consortia such as the long-term ecological research (LTER) network.

At present, 42 European countries as well as the United States of America and Canada are participating in the Programme, which includes assessments according to harmonized and standardized methods following this ICP Forests Manual. Results of ICP Forests provide the scientific basis for political decisions on air pollution control and thus contribute to the elaboration and review of protocols of the Air Convention. Moreover, ICP Forests’ monitoring activities can contribute to other aspects of relevance for forest policy, such as effects of climate change on forests, forests’ contribution to climate change mitigation, sustainable forest management, and biodiversity in forests.

2 Structures and Objectives of ICP Forests

2.1 Background

The objectives of ICP Forests are based on both the long-term strategy of the Air Convention (ECE/EB.AIR/133/Add.1) and the revised long-term strategy of the effects-oriented activities (ECE/EB.AIR/2009/17/Rev.1). The long-term aims to which all Task Forces, respectively

International Co-operative Programmes (ICPs), under the WGE (see Figure 1) are expected to contribute are:

(a) Provision of quantitative policy-relevant information on monitored and modelled air pollution effects;

(b) Derivation of exposure-response functions for chemical and biological effects of air pollutants, inter alia for effects of nutrient nitrogen, ozone and acidifying pollutants and ecosystems' functioning and biodiversity, in combination with other stresses such as land management and climate change;

(c) Gathering information on policy-relevant user-friendly indicators to evaluate pollution effects on the environment and health;

(d) Monitoring and assessment of effects on the environment and health as well as their trends;

(e) Investigate the relevance of short-lived climate forces from the viewpoint of human and ecosystem health as well as detrimental effects on materials.

(f) Further development of modelling and mapping procedures, in particular for effects of nitrogen and ozone on the environment, ozone and particulate matter on health, multi pollutant effects on environment and materials, and of dynamic processes of damage and recovery due to eutrophication, acidification and heavy metal accumulation, including biological effects;

(g) Further studies of the uncertainties, robustness and validation of models, as well as data assumptions and uncertainties;

(h) Gathering information on possible risks from POPs and heavy metals not regulated in global agreements;

(i) Evaluation of environmental benefits of air pollution control policies, as well as contribution to economic assessment of damages.

Two-year's workplan items and in the future mandates laid down as Annex to the Memorandum of Understanding between the UNECE CLRTAP Secretariat and the Thünen Institute (see Chapter 3.1.5) further specify the effects-oriented activities.

In order to meet the information needs of WGE, ICP Forests pursues the following four main objectives:

(i) Provide a continued overview of forest health, vitality, forest soil condition, and biodiversity in relation to air pollution and its combination with biotic (e.g. pests, diseases) and abiotic (e.g. climate extremes) stressors, and climate change.

(ii) Contribute to a better understanding of cause-effect relationships between anthropogenic as well as non-anthropogenic stressors and forest ecosystems' conditions and processes.

(iii) Maintain and provide high quality, harmonized, accessible data managed in one central database.

(iv) Develop and maintain the ICP Forests Level I and Level II monitoring networks, including highly equipped forest measurement stations, as the basis for harmonized forest monitoring and forest ecosystem research across Europe.

Consistent with WGE's long-term priorities, these goals imply providing a basis for calculating critical loads and levels and assessing their exceedance. In addition, through the use of models, the response of forest ecosystems to deposition scenarios expected in the future can be studied and evaluated. Additional insight is gained by compiling available studies from the National Focal Centres (NFCs) and from related programmes inside and outside the Air

Convention. In this respect close cooperation is sought with the other relevant ICPs under WGE.

To better address the above objectives, strategies of ICP Forests have been periodically developed since 1998. The most recent strategy, adopted by the Task Force in Luxembourg in May 2016, covers the period from 2016 to 2023 and is included as Annex 1 to this Part I of the ICP Forests Manual.

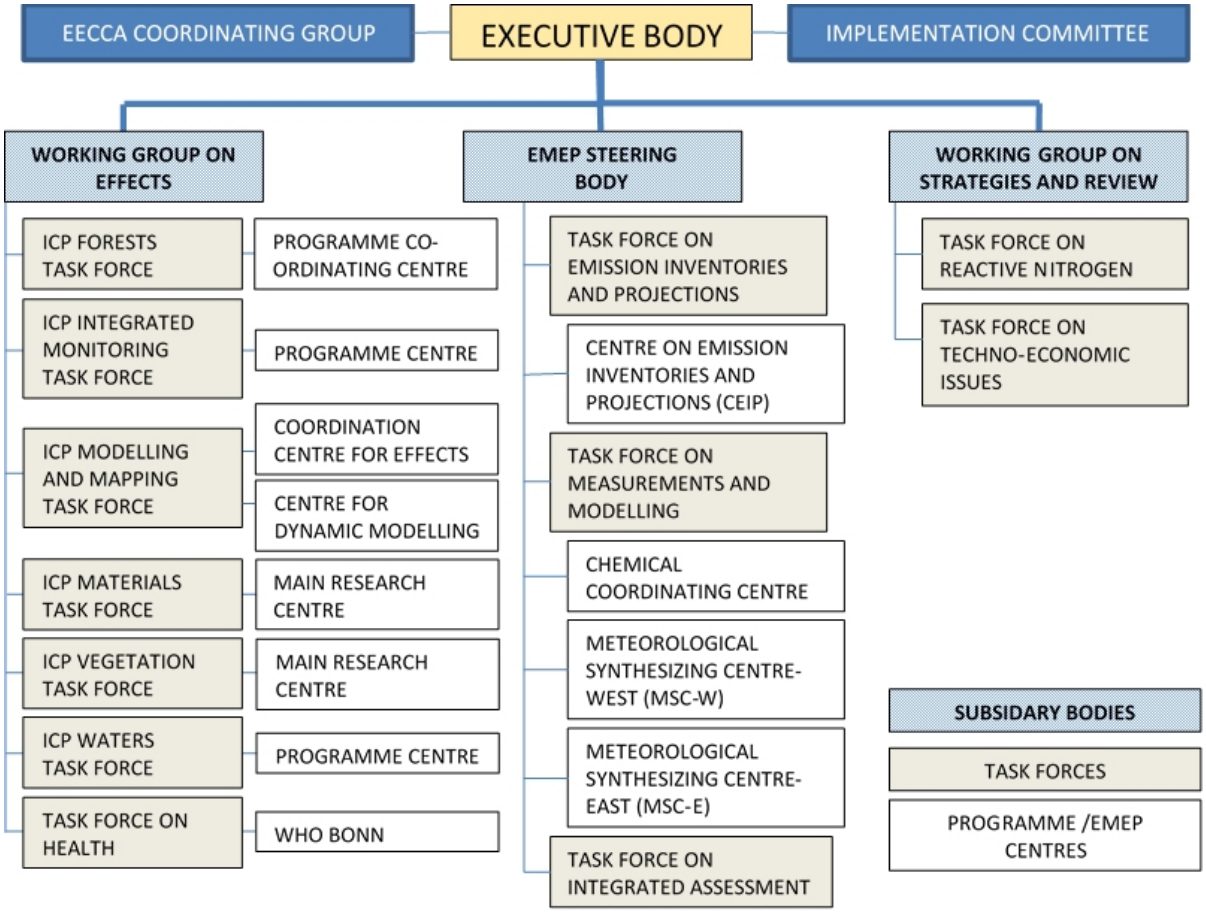

Figure 1: Organisational chart of the Air Convention. ICP Forests is one of seven ICPs, respectively Task Forces.

2.2 General features of ICP Forests

2.2.1 Monitoring activities

In order to meet its reporting obligations, ICP Forests employs data collection at two levels.

- The systematic large-scale monitoring (Level I) provides periodic overviews of the spatial and temporal variation of forest condition, forests health and vitality, and forest soil condition. Level I plots, national forest inventory (NFI) plots, and other related inventory plots may be combined when appropriate, feasible and necessary, according to defined and agreed procedures.
- The intensive monitoring (Level II) is carried out on permanent, highly equipped forest monitoring plots to foster integrative studies on cause-effect relationships based on consistent and harmonized long-term data series. These plots are dedicated to in-depth

investigation of the interactive effects of anthropogenic and non-anthropogenic stressors on the condition of forest ecosystems.

Details of the ICP Forests monitoring design can be found in Manual Part II on Basic Design Principles for the ICP Forests Monitoring Networks (http://icp-forests.net/page/icp-forests-manual).

2.2.2 Quality assurance and control

All monitoring activities are largely harmonized and standardised within ICP Forests among the participating countries and are laid down in this Manual. This ensures a standard approach for data collection and evaluation and can be further developed towards a future common European or even global forest monitoring programme. A consistent quality assurance (QA) approach is applied within the programme covering the setup, methods, data collection, submission and investigation as well as reporting. The elements of the Quality Assurance programme and the available QA/QC procedures are described in Manual Part III on Quality Assurance within the ICP Forests Monitoring Programme. Details about specific QA/QC procedures are described in each of the individual parts of the Manual and compiled in Manual Part XVI on Quality Assurance and Control in Laboratories for all surveys depending on analyses in laboratories (http://icp-forests.net/page/icp-forests-manual).

2.2.3 Data evaluation

A range of monitoring variables is required to meet the information requirements of the Air Convention and other international institutions. The Programme Co-ordinating Centre (PCC), the Programme Co-ordinating Group (PCG) and the Expert Panels (EPs) are responsible for a data evaluation and reporting approach based on the general mandate given to the PCC of ICP Forests and on the current 2-years' workplans, negotiated at WGE level and approved by the Executive body of the UNECE CLRTAP. If appropriate, international and national data from other programmes and institutions should be included in combined analyses. The main topics for data analyses are:

- Forest condition
- Effects on forest ecosystems from acidity, nitrogen, and ozone

as well as contributions in the fields of

- Climate change
- Biodiversity.

The integrative monitoring approach of ICP Forests using the Level I and Level II networks provides robust data on the condition including health aspects and stability of forests. This facilitates an understanding of the effects of deposition on the role and functioning of forest ecosystems in protecting soils and water. Furthermore, the programme surveys can contribute to the understanding and forecast of climate change effects on forests and can be used to supply information on the sequestration of carbon and on forest biodiversity.

Trends in deposition and effects on the adaptation and vulnerability of forest ecosystems are evaluated. This includes spatial and temporal changes and cause-effect relationships with special emphasis on the exceedances of critical limits. Dynamic models and transfer functions derived from suitably selected intensive monitoring plots are used to investigate the effects of air pollution and climate including climate extremes on forest ecosystems in space and time. Resulting model values are validated against measured data collected at the plots.

2.2.4 Deliverables

Results are published via reports and scientific publications available under: http://icp-forests.net/page/publications (see Chapter 3.4).

Relevant results from ICP Forests important for WGE and other CLRTAP bodies are summarized by PCC and the chairperson of ICP Forests and presented at the Joint Session of the EMEP Steering Body and Working Group on Effects. The most recent versions of such summaries are available under the official documents of the respective Joint Session: https://unece.org/info/events/unece-meetings-and-events/environmental-policy/air-pollution.

3 Programme Implementation

3.1 Organization of ICP Forests

3.1.1 Overview

The organisational structure of ICP Forests is shown in Figure 2. The programme is steered by its Task Force where all participating countries are represented by their ministries and National Focal Centres (NFCs). The Programme Co-ordinating Centre (PCC) and the Programme Co-ordinating Group (PCG) including a Quality Assurance and a Scientific Committee care for the full implementation of the programme. The Forest Soil Co-ordinating Centre (FSCC) assists in preparing and evaluating soil data while the foliar data are treated and evaluated by the Forest Foliar Co-ordinating Centre (FFCC). In response to the demand for harmonized and standardised monitoring at both Level I and Level II, Expert Panels (EPs) were established. In appointing the chairs and vice-chairs of the committees, expert panels, and working groups listed below, ICP Forests strives for a high degree of diversity in terms of age, gender, origin, nationality and race.

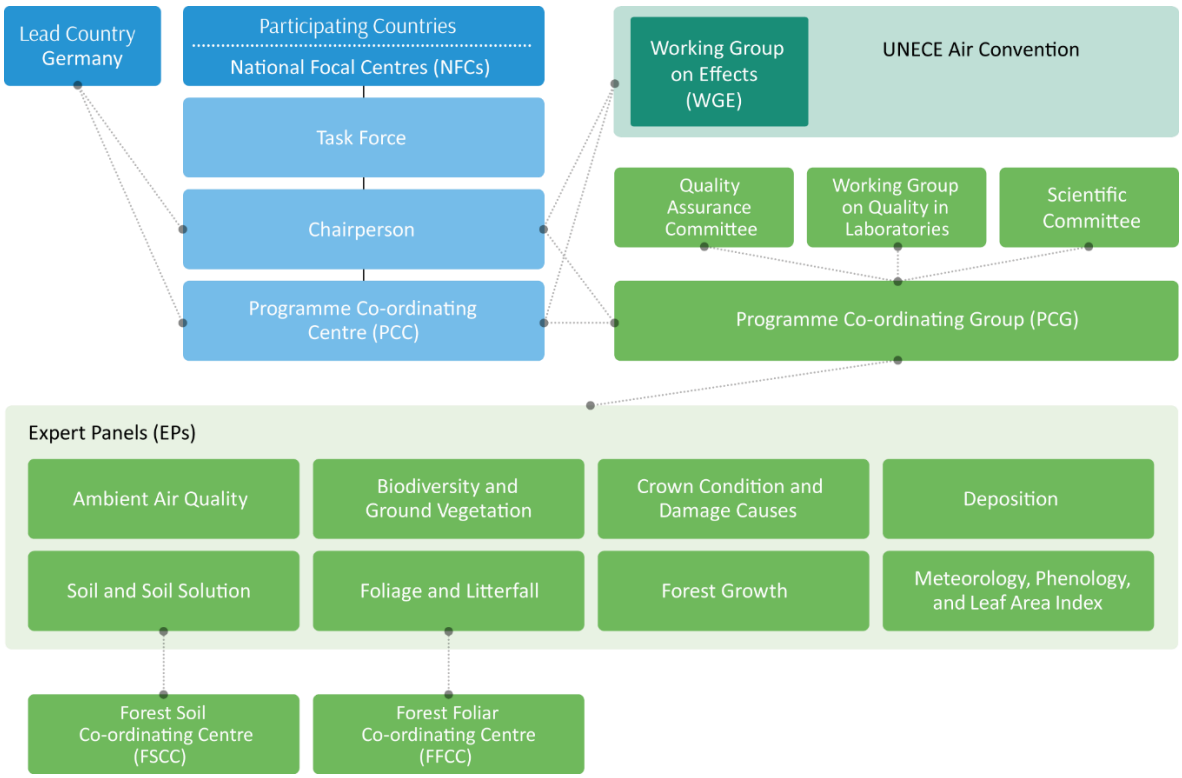

Figure 2: Structure (organogram) of ICP Forests.

3.1.2 The Task Force

The programme is steered by the Task Force, in which 42 participating countries are represented by their responsible ministries and their NFCs. The European Commission (EC) might be represented as well. The Task Force is the official and highest body of ICP Forests. All relevant programme issues have to be presented to the Task Force. The Chairperson - supported by the Lead Country and the PCC - prepares, convenes and chairs annual Task Force meetings.

3.1.3 The National Focal Centres (NFCs)

The NFCs are nominated and financed by the participating countries. They are responsible for the collection, validation, evaluation and storage of their monitoring data and aggregation of national data in accordance with the ICP Forests Manual. The NFCs and their responsible agencies have to ensure that the data is collected according to the methods described in the Manual and that the quality assurance programme has been applied. The NFCs evaluate and interpret their national data. In the last years an enormous potential for evaluation and advancement of knowledge of forest ecosystems has been gained at national level. Increasing attention also at national level is paid to integrative data evaluations.

The NFCs have the task to submit the Level I and Level II data and accompanying information to the PCC in accordance with the agreed deadlines and format. The NFCs are invited to participate in the evaluation and interpretation of the data at European level. In case that part of the national responsibilities is delegated to sub-national agencies, PCC needs to be informed accordingly.

Within the procedures under the Intellectual Property and Publication Policy of ICP Forests, NFCs inform PCC on contact details of experts that are interested to participate in specific evaluations.

3.1.4 The Lead Country

The Lead Country of ICP Forests is Germany represented by the Federal Ministry of Food and Agriculture (BMEL). The Lead Country installs the Chairperson and maintains the Programme Co-ordinating Centre (PCC) of ICP Forests, supports the Chairperson and the PCC to prepare, convene and chair the annual meetings of the Task Force. The Lead Country also convenes and chairs meetings of the PCG, fosters co-operations with the EC, and supports the contact with other monitoring programmes within and outside the Air Convention.

3.1.5 The Chairperson

The Chairperson of ICP Forests is appointed by the Lead Country or by a Co-lead Country. This(these) country(ies) is(are) responsible for funds to enable adequate scope for action. The chairperson represents ICP Forests externally and plays a central role internally. The chairperson connects the different entities of ICP Forests and fosters its coherency, leads the Task Force and – in accordance with the Lead Country – the PCG meetings. He or she supports the contact with other monitoring programmes within and outside the Air Convention as well as the co-operation with the European Commission. Together with the head of the PCC of ICP Forests, the chairperson represents ICP Forests within the WGE and is part of its Extended Bureaux.

3.1.6 The Programme Co-ordinating Centre (PCC)

The PCC is hosted by the Johann Heinrich von Thünen Institute, Federal Research Institute for Rural Areas, Forestry and Fisheries and located at the Institute of Forest Ecosystems in Eberswalde, Germany. Together with the chairperson, the head of the PCC of ICP Forests represents ICP Forests within the WGE and is part of its Extended Bureaux. The PCC coordinates the implementation of the programme and its further development on behalf of

BMEL in close consultation with the ICP Forests chairperson and the ICP Forests Programme Co-ordinating Group (PCG). Specifically, this includes the following:

- Assistance to the Chairperson, the Task Force and the PCG in the continuous review, further development, and implementation of the programme
- Contact point for the Ministries and National Focal Centres (NFC) of the member countries as well as for the Expert Panels (EP)
- Development and maintenance of the ICP Forests Website
- Data management including
    - Establishment, maintenance and further development of the ICP Forests data portal and the ICP Forests database
    - Supporting NFCs with annual data submissions to the ICP Forests database
    - Data management and validation
    - Coordinate data sharing with third parties in accordance with ICP Forests' Intellectual Property and Publication Policy
    - Technical implementation of manual changes in the data model of the central ICP Forests database
- Preparation, implementation and follow-up of the following annual steering meetings: Task Force Meeting (TFM), Programme Co-ordinating Group Meeting (PCGM) and the ICP Forests Scientific Conference (FORECOMON).
- Support in the planning and implementation of the Combined Expert Panel Meetings and Head of the Lab Meetings
- Coordinate periodic revisions of the ICP Forests Manual, including editorship and technical implementation of manual changes approved by the Task Force.
- Management of the ICP Forests budget and fundraising.
- Initiation and implementation of data analyses
- Initiation and development of scientific publications
- Development and publication of the annual ICP Forests Technical Report.
- Representation of ICP Forests including reporting at international meetings, conferences, workshops, forums, etc.
- Annual reporting to the Task Force, UNECE, Working Group on Effects and the following sister ICPs: ICP Integrated Monitoring, ICP Vegetation, ICP Waters, ICP Modelling and Mapping

3.1.7 The Programme Co-ordinating Group (PCG)

The PCG has the task to continuously review and further develop the monitoring and to support the Chairperson and PCC in all issues of relevance for the future of the programme. Recommendations of the PCG are directed to the Task Force of ICP Forests. Members of the PCG are the Chairperson, the Lead Country, the PCC, the chairpersons of the Expert Panels, the Scientific Committee, the Quality Assurance Committee, the Working Group on Quality in Laboratories and occasionally a representative of the European Commission and the WGE. In order to meet these tasks, the PCG needs to convene regularly. A participation of representatives of NFCs in PCG meetings as well as representatives of the UNECE secretariat may be considered.

3.1.8 The Scientific Committee

The Scientific Committee promotes and fosters scientifically sound evaluations and publications within the programme and explores links between ICP Forests and international scientific communities at various levels in close cooperation with PCC, PCG and the EPs. This includes the organisation of the annual scientific conference of ICP Forests FORECOMON (Forest Ecosystem Monitoring Conference) in regards to content.

3.1.9 The Quality Assurance Committee

The Quality Assurance (QA) Committee has the task to identify and support the implementation of a consistent QA approach valid throughout the various investigations carried out within the ICP Forests. Members of the Quality Assurance Committee include the chairpersons of the Expert Panels and possibly one more person involved in QA issues per EP, the chairpersons of the Working Group on Quality in Laboratories and of the Scientific Committee, the PCC, delegates from data managers, and when necessary the Chairperson of ICP Forests.

3.1.10 The Working Group on Quality in Laboratories

This working group is mainly concerned with the analysis of samples from different media in the forest ecosystem. This includes the setup of specifications for the safe transport of the samples to the laboratory, the optimal and complete sample preparation (e.g. grinding, digestion) up to the need of a correct analysis of the samples. The group also deals with method harmonization, quality assurance and quality improvement measures in the laboratories, including the performance of regular and mandatory ring tests. Members of the Working Group on Quality in Laboratories are national experts or heads of the national laboratories of ICP Forests participating countries and possibly experienced scientists. A close cooperation and coordination with the chairpersons of the involved expert panels (EP on Soil & Soil Solution, EP on Foliage & Litterfall and EP on Deposition) concerned is needed and necessary.

3.1.11 The Expert Panels (EPs)

The EPs further develop the harmonized methods as laid down in this manual. This includes the development of methods and standards including data quality assurance, as well as supporting and actively working towards integrative data evaluations and scientific publications. Members of the Expert Panels are national experts of ICP Forests participating countries. For specific purposes and for a limited period of time, additional ad hoc working groups may be established consisting of representatives from different EPs. The EPs hold EP and joint-EP meetings.

3.2 Monitoring activities and ICP Forests Manual

The methods and standards of the monitoring activities are laid down in the various parts of this manual. Part II describes the monitoring design at the two intensity levels (Level I and Level II) including plot selection and plot design and general information on monitoring plots and stands. Also described are the data submission procedures and data validation. Part III describes the elements of the Quality Assurance programme and the QA/QC procedures that EPs and Working Groups should develop and implement within their own field of application. From Part IV onwards, data quality assurance and the methods and standards of individual surveys are described in detail.

Investigation methods, variables to be measured and QA/QC procedures are under continuous screening by the EPs (see Part III). This continuous process provides the basis

for two kinds of amendments, the Manual update and the more comprehensive Manual revision (see Part III).

In short, the Manual update consists of minor changes and need to be discussed among the respective EPs/WGs and the PCC. Manual revisions by contrast are a more comprehensive process and are carried out on a 5-year basis. Manual revisions must be formally approved by the Task Force (see Part III).

3.3 Data analyses

Analyses of the monitoring data pursue the objectives of ICP Forests laid down in Chapter 2.1. Both the Level I and in particular the Level II approaches call for an integration of the data from various monitoring surveys. The possibility for integrating data from different investigations into a cohesive evaluation system is the most important aspect related to the Level II plots. The integration can be achieved at different levels according to data availability in space and time. Forest over-all condition (health) in terms of growth, tree condition, plant diversity and soil condition can be impacted by biotic (pests and diseases) and abiotic (e.g. climate, air pollution) factors, the effects and importance of which depends on inherent site properties (e.g. site history and management, topography, soil condition) according to complex and often mutual relationships. These relationships can be fully investigated only if data from all investigations are available. Another option can be to consider modelled data from available and suited models, provided model outputs can be applied with confidence to the situation of the plot being considered. In this respect, the wealth of data collected on Level II sites can be used to establish deterministic relationships that can be useful for deriving estimates of unmeasured variables at given sites.

3.4 Publishing and reporting

The WGE asks in its long-term strategy to “further develop forms and methods for efficient, comprehensive and timely communication of scientific results with the Convention and to policymakers, the scientific community and the general public”. To comply with these demands ICP Forests has developed a multi-level publication and reporting system. Research, review and methodological papers regarding air pollution and other impacts on forest ecosystems published in reviewed scientific journals are targeted at the scientific community. The initiative for these publications is to be taken up by all members of ICP Forests, however initiatives are expected especially from members of the EPs, the Committees, and the PCC.

In order to provide general overviews on monitoring results and their interpretation with respect to relevant results of forest damage research as well as on special topics for a broad public, ranging from politicians across NGOs and environmentalists to forest owners and the general public currently ICP Forests briefs are issued. The scientific and technical basis of the monitoring is provided by annually published ICP Forests Technical Reports along with evaluations and reviews to be carried out by the EPs, the PCC, and the NFCs. Other suitable contributions can be included as well. The target group of the Technical Reports are mainly experts involved in the work as well as the ministries of the participating countries. The responsibility for the briefs and the Technical Reports lies with the PCC.

3.5 Data release and acknowledgement

ICP Forests data is available for use by the wider scientific community. Experts and data providers of the monitoring programme are available to support external data users. Data is

made available upon request. All data users need to agree to and need to acknowledge the intellectual property policy of ICP Forests (see Annex 2).

3.6 Citation of ICP Forests reports and manuals

ICP Forests reports and publications should be cited as follows:

Author(s or editor), year: title. (In: **Editor** [e.g. UNECE ICP Forests Programme Co-ordinating Centre (ed.)]: title of omnibus volume [e.g. Technical Report...]), **publisher** [e.g. Thünen Institute of Forest Ecosystems], place, pages or n of pages. [optional: DOI], [optional: available from: IP address].

The recommended form of citation should be included in all scientific ICP Forests publications on the back cover or on a colophon page. The DOI and IP address of the respective ICP Forests website should additionally be given in square brackets.

The ICP Forests Manual as a whole is suggested to be cited as follows:

UNECE ICP Forests Programme Co-ordinating Centre (ed.), 2022: Manual on methods and criteria for harmonized sampling, assessment, monitoring and analysis of the effects of air pollution on forests. Thünen Institute of Forest Ecosystems, Eberswalde [available from: http://icp-forests.net/page/icp-forests-manual].

Individual parts of the ICP Forests Manual should be cited as follows:

Authors, year: [Title of relevant manual part]. [version number]. In: UNECE ICP Forests Programme Co-ordinating Centre (ed.): Manual on methods and criteria for harmonized sampling, assessment, monitoring and analysis of the effects of air pollution on forests. Thünen Institute of Forest Ecosystems, Eberswalde, [n of pages], [available from: http://icp-forests.net/page/icp-forests-manual].

Annex I - Strategy of ICP Forests 2016–2023

I ICP FORESTS IN SHORT

The 'International Co-operative Programme on Assessment and Monitoring of Air Pollution Effects on Forests' (ICP Forests) is a work programme within the 'Working Group on Effects' (WGE) of the 'Convention on Long-range Transboundary Air Pollution' (CLRTAP) under the United Nations Economic Commission for Europe (UNECE). ICP Forests is led by a Chairperson and administered by its Programme Co-ordinating Centre (PCC). The Programme Co-ordinating Group (PCG), its Committees (Scientific Committee (SC); Quality Assurance Committee (QAC)), the Expert Panels (EPs) and the National Focal Centres contribute to the Programme.

II MISSION STATEMENT

The mission of ICP Forests is to carry out multifunctional long-term monitoring of forests within the UNECE region and beyond and provide scientific knowledge on the effects of air pollution, climate change and other stressors on forest ecosystems.

III AIMS

ICP Forests pursues the following aims:

- *Forest Condition.* Provide a continuing overview on forest health, vitality, forest soil condition and biodiversity status in relation to anthropogenic (air pollution, atmospheric deposition) and natural stressors.
- *Cause-effect relationships.* Contribute to a better understanding of cause-effect relationships between anthropogenic as well as natural stressors and forest condition and processes.
- *High quality data.* Provide high quality and open access data managed in one central database for risk assessment for forests across Europe, large-scale and long-term trend analyses as well as model validation and calibration, serving also as a reference for global assessments.
- *Infrastructure*. Develop and maintain highly equipped forest measurement stations as central data hubs and standardized forest monitoring and research infrastructures across Europe.

IV FEATURES OF THE CURRENT PROGRAMME

ICP Forests works at two levels:

- The systematic large-scale monitoring (Level I) provides periodic overviews of the spatial and temporal variation in forest health, vitality and forest soil condition.

- The intensive monitoring (Level II) is carried out on permanent, highly equipped forest monitoring plots to foster integrative studies on cause-effect relationships based on consistent and harmonized long-term data series.

All monitoring activities are described in the “Manual on methods and criteria for harmonised sampling, assessment, monitoring and analysis of the effects of air pollution on forests”. This ensures reliable and consistent information and quality assurance by a standardised approach for data collection and evaluation.

Quality assurance and control
A consistent quality assurance is guaranteed for the set-up of methods, data collection, submission, validation, as well as reporting and publishing. This includes field checks, inter-calibration and cross-comparison courses, inter-laboratory ring tests, data validation procedures and internal reviewing.

Data and database
A large range of data is provided. All data are kept in a central database and managed according to agreed guidelines as laid down in the Manual. Data are open for internal and external use upon request.

Evaluation, reporting and publishing
ICP Forests

- publishes annual *technical reports* on main scientific topics including long-term effects from e.g. acidification, eutrophication, ozone and other relevant impacts on forest ecosystems;
- publishes syntheses, highlights, and extracts of results compiled in annual *executive reports* addressing public and political stakeholders;
- publishes *scientific papers* in peer-reviewed scientific journals addressing the scientific community;
- organizes scientific conferences and publishes *proceedings* to foster the exchange among scientists, stakeholders and policy makers;
- encourages participating countries to publish *national forest reports*, which complement and support the ICP Forests dissemination efforts.

V VISION FOR THE FUTURE

Our vision is for a European-wide forest monitoring infrastructure, integrating multiple levels and providing high quality, transparent, robust and open access data i) on the status and trends of forest health, vitality, productivity and biodiversity; ii) on risks of forests being exposed to anthropogenic and natural stressors (separately and combined), and iii) on progress in achieving relevant policy goals to diminish risks.

VI OBJECTIVES AND ACTIONS

We focus on new challenges for forest health, vitality and diversity in relation to the impact of transboundary air pollution and climate change to further develop the ICP Forests programme in the next period (2016–2023). To support work to realise the future vision ICP Forests states its commitment to:

- **intensify co-ordination** of the national monitoring activities by offering standardized infrastructure and facilities to potential users, such as forest authorities, environmental agencies, and research institutions, for additional research activities complementing the central purpose and data, thereby deriving improvements and/or extensions such as long-term experimental monitoring sites to the programme.

- **broaden the scope of monitoring activities** for the unique long-term data series of traits and processes in forest ecosystems by considering topics such as climate change effects, ecosystem services, biodiversity, and large-scale scientific investigations.

- **follow-up on relevant international policy issues** and offer collaborations by supplying the scientific background for forest related policies and providing advice to national and European policy makers.

- **strive for long-term financing** of activities, particularly including the maintenance of existing infrastructure and required staff as well as exploring more mechanisms for sustainable funding.

- **increase the visibility** of the programme to improve the acknowledgement as well as the funding opportunities, by organizing scientific conferences and workshops (partly in co-operation with other ICPs and forestry organizations), by publishing peer-reviewed scientific articles in highly ranked journals, policy briefs, fact sheets, information bulletins, and in social media (internet blogs, ResearchGate, Facebook, etc.). The current publication strategy is renewed.

- **foster a high quality and transparent database** and work towards open access to researchers and stakeholders.

- **strive towards maintaining used field measurement methods** at the latest state of the art to guarantee for high-quality data. A review of the Manual every five years and Expert Panel meetings continuously promote the awareness and discussions on the latest methodologies and instrumentation. The concept of core plots with more in-depth investigations will be further explored.

- **explore new tools and technologies** (e.g. satellites, remote sensors, proximal sensing, new analytical instruments, modelling tools, information technology) and strive for incorporating them into the programme.

- **use monitoring data for** testing cause-effect relationships, long-term trend analyses, modelling (calibration, parameterization, and validation) and evaluating effects of forest management and environmental policy strategies.

- **enhance co-operation with other ICPs** to promote integrated and cross-sectorial evaluations and reporting as well as unified measurement protocols through e.g. mutual funding and scientific conferences.

- **stress the global importance of air pollution monitoring** and increase the motivation to common activities by closer collaboration with monitoring networks outside of Europe, such as NADP (USA) and EANET (East Asia) and by inviting members from SEE and EECCA countries into the ICP Forests network.

- **encourage and increase future collaborations** with other research activities and monitoring platforms by joint use of research infrastructures, open data access, data harmonization, federated databases and large-scale scientific evaluations and hereby attain possibilities for an even more comprehensive terrestrial monitoring research programme.

- **feed information into other bodies and programmes** such as the FAO Forest Resources Assessment (FRA 2015 and its long-term strategy), the Ministerial Conference for Protection of Forests in Europe (*Forest Europe*), the UN Convention on Biological Diversity (CBD), the Framework Convention on Climate Change (UNFCCC), and other appropriate bodies, e.g. of the European Commission.

VII ADOPTION

This strategy of ICP Forests is fully in line with the long-term strategy of the Convention (2010–2019, ECE/EB.AIR/2008/6 and ECE/EB.AIR/106/Add.1, Annex), the revised long-term strategy of the WGE (2010–2020 and beyond, ECE/EB.AIR/2009/17/Rev.1) and the most recent work plan (ECE/EB.AIR/122/Add.2) for the effects-oriented activities of the WGE.

This document was adopted at the 32nd Meeting of the Programme Task Force of ICP Forests in Luxembourg, 13 May 2016. By the end of 2016, ICP Forests develops a plan for how and when to work towards implementation of each of the actions. In the year 2020, a mid-term review of this strategy will take place.

APPENDIX: AREA OF IMPLEMENTATION AND MEMBER STATES

The ICP Forests Strategy 2016–2023 is targeted at all 51 Parties (as of November 2013) of the UNECE Convention on Long-range Transboundary Air Pollution (CLRTAP): Albania[1], Armenia[2], Austria, Azerbaijan[2], Belarus[2], Belgium, Bosnia and Herzegovina[1], Bulgaria[1], Canada, Croatia[1], Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Georgia[2], Germany, Greece[1], Hungary, Iceland, Ireland, Italy, Kazakhstan[2], Kyrgyzstan[2], Latvia, Liechtenstein, Lithuania, Luxembourg, Malta, Monaco, Montenegro, Netherlands, Norway, Poland, Portugal, Republic of Moldova[1], Romania[1], Russian Federation[2], Serbia[1], Slovakia, Slovenia[1], Spain, Sweden, Switzerland, The former Yugoslav Republic of Macedonia[1], Turkey[1], Ukraine[2], United Kingdom, United States of America, and the European Union.

ICP Forests has 42 members (as of January 2016): Albania, Andorra, Austria, Belarus, Belgium, Bulgaria, Canada, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland,

France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Liechtenstein, Lithuania, Luxembourg, Montenegro, Netherlands, Norway, Poland, Portugal, Republic of Moldova, Romania, Russian Federation, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, The former Yugoslav Republic of Macedonia, Turkey, Ukraine, United Kingdom, and the United States of America.

[1]) South East Europe (SEE) Programme of the EU and [2]) Eastern Europe, Caucasus, and Central Asia (EECCA) region of the OECD

Annex II - Intellectual Property and Publication Policy

The Intellectual Property and Publication Policy (IPPP) covers rules, rights and obligations to be applied for data supply, request, and use from the official ICP Forests PCC Collaborative Database (ICP Forests DB).

The aims of this Intellectual Property and Publication Policy (IPPP) is to

- stimulate cooperative scientific studies among internal and between internal and external partners of the ICP Forests Network;
- protect the rights of owner- and authorship;
- ensure proper co-authorship and acknowledgement.

Rights and Obligations of the Applicant

Data Application

1. In order to receive access to data from the ICP Forests DB, the applicant has to submit this application form to the PCC. The applicant is declaring the intended use of the data requested specifying the scientific purpose of the study, the duration, the methodological approach and the sub-contractors foreseen to also work with the data.
2. The data application is first evaluated by the PCC due to formal correctness. Hereafter, the PCC sends it to all relevant NFCs for evaluation.
3. A response by the NFCs containing the decision over the submitted proposal may be expected from the PCC within 4 weeks. [1]
4. Following the rules under the LRTAP Convention data access by applicants can only be denied or restricted by the contributors if appropriate reasons are provided. [2]
5. Information provided with the application will be made public on the ICP Forests website. [3]

Use of Data

1. In case of a positive evaluation the applicant is allowed to use the requested data for the scientific purpose described in the proposal and to publish the results.
2. It constitutes a breach of the agreement if data is submitted to other parties or used for purposes other than declared in the proposal.
3. The applicant is free to provide requested data to peer-reviewed journals for validation purposes on demand if the peer-reviewed journal does not request to publish this data.
4. The applicant is not allowed to include the explicit coordinates of ICP Forests monitoring plots in any publication.
5. The applicant is allowed to include plot coordinates accurate to geographic minutes in published results.

Distribution of Results

1. Any publication based on data from the ICP Forests DB has to be provided to the PCC for publication on the ICP Forests website. [4]

2. The applicant informs the PCC if a publication can be shared on the ICP Forests website according to the publisher's rules.
3. If any rules and regulations stand against an open publication, only metadata on the article such as author, co-authors, title and journal will be published.
4. The applicant agrees to report on the progress of the data evaluation using a standardized report form which will be distributed by the PCC annually.

Scientific Collaboration – Co-Authorship

1. The applicant is obliged to offer a scientific collaboration to interested members of the ICP Forests Network to gain the requirements for a co-authorship.
2. According to the Vancouver Protocol [5], which is used as an international standard for ethics of publication, all following criteria have to be fulfilled to be named as a co-author:
   - Conception and design, or analysis and interpretation of data
   - Drafting the article or revising it critically for important intellectual content
   - Final approval of the version to be published.

Acknowledgements

1. The applicant is obliged to properly acknowledge the origin of used data with following acknowledgement text in any publication: "The evaluation was based on data that was collected by partners of the official UNECE ICP Forests Network (http://icp-forests.net/contributors). Part of the data was co-financed by the European Commission (Data achieved at *"download date"*)."
2. For any form of graphical presentation of results (e.g. maps, tables, presentations) the following short label should be used including the hyperlink to the official ICP Forests website: "Based on ICP Forests data" (http://icp-forests.net)

Rights and Obligations of the ICP Forests Network

1. A two-year exclusive right for data evaluation is granted to the ICP Forests Network for Internal Evaluations. Data evaluation by the ICP Forests Network is regarded as the final step of validation and is thus essential to ensure appropriate data quality.
2. Internal Evaluations can be initialized by the Chairperson of ICP Forests, the PCC, the Expert Panel Chairs and/or other bodies under the LRTAP Convention [6]
3. For any Internal Evaluation the official application form is to be submitted to the PCC by the person(s) initializing the evaluation.
4. The NFCs will be informed by the PCC about any Internal Evaluation using the provided application form.
5. Internal Evaluations do not need the permission of concerned contributors.
6. Any member of the ICP Forests Network has the right to be included in any Internal Evaluation.
7. The requirements for a co-authorship remain according to the criteria of the Vancouver Protocol.

Processed Datasets

Based on the measurement data collected during the monitoring activities several processed datasets have been created by members of the ICP Forests Network. Those datasets can only be requested for Internal Evaluations.

Precision and Quality of Data

1. In order to respect national property rights, plot coordinates of some countries will be provided at the accuracy of geographic minutes only for External Evaluations.
2. A list of those countries is included in the data approval by the PCC.
3. The measurement data is not interpolated to those generalized coordinates. So data from listed countries cannot be used for spatially explicit pinpoint analyses.
4. Neither the PCC nor the contributor is fully responsible for data quality. Only the close collaboration between the applicant and the concerning members of the ICP Forests Network can guarantee for a full understanding of the data, their relevant background information (metadata), and overall quality, including accuracy and applicability. A list of (national) experts of the ICP Forests network is available under: http://icp-forests.net/page/expertlist

Annex

Application and Publication Process

In the following, the individual steps of the required application process are described for both, Internal and External Evaluations. Recommended response times are given in parentheses.

1. The applicant completes this official data application form and submits it to the PCC, hereby accepting and agreeing to the conditions of this IPPP.
2. The PCC informs the NFCs about the application and the proposed purpose for the provision of data (2 weeks).
3. The NFCs consider the application and respond within the following categories (2 weeks). In case other parties than the NFC are responsible for the data contribution the NFC might further distribute the request to concerned parties and coordinate the final decision delivered to the PCC:
    - Rejection: the contributor is not convinced that the data will be fairly used and duly acknowledged or there is a significant conflict of interest. Following the data rules under the LRTAP Convention, the contributor is obliged to provide specific reasons for rejecting the release of data.
    - Permission: the contributor is satisfied with the proposal and agrees that the respective data is provided to the applicant. The contributor may name contact details of relevant experts of the ICP Forests Network for scientific collaboration.

An Internal Evaluation cannot be rejected by the contributors. There is no formal reply of the contributors to the applicant. Instead, the contributors that are interested in a direct involvement of the proposed analyses may contact the applicant directly.
In case, the contributor does not participate in the application approval process within a predefined period (4 weeks), the final decision over the application is up to the PCC.

4. The PCC compiles the NFCs' responses and informs the applicant about the final decision on the approval of the submitted application (2 weeks), including:
    - any information needed to get access to the data;
    - the list of experts to be contacted for collaborations.

5. The applicant shares any publication based on ICP Forests data with the PCC as pdf-file. The applicant informs the PCC if the publication can be shared on the ICP Forests website according to the publisher's rules. If any rules and regulations stand against an open publication, only metadata will be published on the website.

Explanation of Used Terms

- ICP Forests DB: the official ICP Forests PCC Collaborative Database
- Contributor: representatives of NFCs and any other institution delivering data to the ICP Forests DB listed under http://icp-forests.net/contributors
- Applicant: a third party, individual, or institution that applies for data access
- NFC: National Focal Centre
- PCC: Programme Coordinating Centre of ICP Forests [7]
- ICP Forests Network: Contributors, Expert Panels (EPs) and the PCC
- Internal Evaluations: Evaluations initialized by the Chairperson of ICP Forests, the PCC, the Expert Panel Chairs and/or other bodies under the LRTAP Convention [6]
- External Evaluations: Evaluations initialized by Applicants other than bodies under the LRTAP Convention [6]

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[1] In case that data is contributed by different contributors of one country (e.g. representative institutions of federal states) the corresponding NFC organizes the national work and information flow.

[2] Report of the Executive Body on its twenty-fourth session held in Geneva from 11 to 14 December 2007 – Addendum – Part Two: Decisions adopted by the Executive Body – Decision 2006/1

[3] http://icp-forests.net/page/project-list

[4] http://icp-forests.net/page/scientific-publications

[5] Anonymus (2008): Uniform Requirements for Manuscripts Submitted to Biomedical Journals: Writing and Editing for Biomedical Publication. Updated October 2008. International Committee of Medical Journal Editors. http://www.icmje.org

[6] Convention on Long-range Transboundary Air Pollution (CLRTAP)

[7] The PCC is responsible for the application approval process and the protection of the rights of both parties, the Contributors and the Applicants, according to this IPPP.

Annex III: Minor changes after 2022

Date	Minor change to latest published version in 2022	Affected sections of this document
06/2022	To specify tasks, the following sentence was added: *This includes the organisation of the annual scientific conference of ICP Forests FORECOMON (Forest Ecosystem Monitoring Conference) in regards to content*.	3.1.8 Scientific Committee
	Addition of Annex III as missing	Annex III