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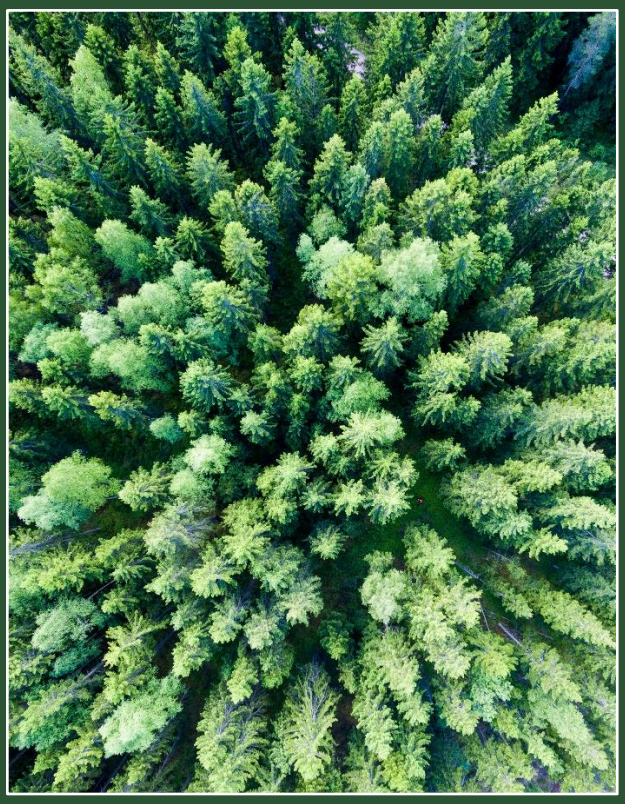

From Forest Research to Forestry Practice -

Approaches in Leveraging Forest Research in Northern and Central European Countries

Risto Päivinen and Liisa Käär (editors)

From Forest Research to Forestry Practice -
Approaches in Leveraging Forest Research in Northern and Central European Countries

PROCEEDINGS
of
SNS-EFINORD network meeting and international workshop
Tools for improving science-practice interaction in forestry
Faculty of Forestry, Warsaw University of Life Sciences-SGGW
Warsaw, Poland - 11th May 2017

Edited by
Risto Päivinen and Liisa Käär

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EUROPEAN FOREST INSTITUTE
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Foreword

In the European countries, forest research results contribute to the development of practical forest management through various kinds of processes and organizational arrangements. The importance of streamlining processes that bring science to practice is increasing. However, international cooperation and awareness of approaches in neighboring countries in this field has so far been limited.

The SNS-EFINORD Network aims at speeding up the process of turning research results into effective practical forestry applications by:

1. Creating a Northern European network for exchanging experiences on, and developing instruments for, bringing research results to practical forestry
2. Organizing an international workshop to carry out benchmarking
3. Developing applications for further Nordic and European projects that can identify best practices for transferring forest science to practical applications

In these proceedings, presentations of the SNS-EFINORD Network international workshop "Tools for improving science-practice interaction in forestry", in Warsaw on May 11, 2017 are gathered. Country reports on interaction between forest research and forest practice include Denmark, Estonia, Finland, France, Germany, Iceland, Norway, Poland and Sweden.

During the general discussion at the end of the workshop, the following aspects in forest-practice interaction were highlighted:

- Multiple platforms, networks and channels should be built for different audiences – one size does not fit all.
- Feedback from practice to research is not always working well, and it should be better organized.
- Questions related to economics and policy often missing from the national-level discussion which is dominated largely by conservation and silviculture-related topics. Policy questions are gaining importance.
- Quality of communication is a priority as it is connected to the impact of communication. Modern communication tools need to be fully employed. Learning to be a good communicator needs to be an integral part of research training.
- International cooperation and a common European platform for bringing forest science to practical forestry is necessary.

The SNS-EFINORD Network also recommended to take further steps for consolidating the Northern European cooperation platform and expanding it geographically and thematically to the field of science-practice-policy interaction.

We would like to thank SNS, EFINORD and the Finnish Ministry of Agriculture and Forestry for making resources available for this network, all participants of the workshop as well as all the authors of the proceedings for their valuable contributions. Special thanks to the Faculty of Forestry, Warsaw University of Life Sciences-SGGW, for providing facilities and staff for organizing the workshop.

Risto Päivinen Liisa Käär

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Warsaw, Poland, May 11, 2017

Towards an intensified science-practice-policy interaction

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Abstract

It has been widely recognized in national and international forest-related policy processes that decisions must be based on best available scientific knowledge. In order to generate added value for people and society, science must be utilized in designing and implementing decisions by policy makers and forest practitioners at all levels.

The mechanisms established so far have increased dialogue between researchers, policy makers and practitioners. They aim at boosting the effectiveness of research investments by accelerating the process between research and implementing the results. The levers include analyzing the often scattered research results and synthetizing them in to sets of policy options and recommendations. Furthermore, the analysis of available information also reveals the need for further research. Communication tools include brief documents with clear recommendations, panels discussions as well fora and conferences of various types and sizes.

In any science-practice-policy interaction, relevance, credibility and legitimacy are the key characteristics.

Keywords: Science-policy-practice interaction, scientific communication, communication channels, impact of research

Introduction

In Europe's main international forest policy process, the Ministerial Conference on the Protection of Forests in Europe (MCPFE), the first resolutions of the Strasbourg conference, 1990, underlined the importance of research.

The Warsaw declaration in 2007 also highlighted the importance of communication between policy makers and researchers by: "taking effective measures to improve understanding between policy makers, practitioners and the scientific community in order to better use scientific knowledge and research results relevant to forests and the forest sector as a sound basis for decision making." (Forest Europe, 2015)

The EU forest strategy include the following orientations: "The Commission will also assist Member States and stakeholders in transferring technological and scientific knowledge to forest practice and the market. The Commission and the Member States will set up the Forest Information System of

Europe by collecting harmonized Europe-wide information on the multifunctional role of forests." (European Commission, 2013)

At the national level, both the National Forest Strategy for Finland (Ministry of Agriculture and Forestry, 2015) and the Bioeconomy Strategy for Finland (Ministry of Employment and Economy, 2014) address the need to boost the socio-economic impact of forest research by developing decision support and utilizing the new information and knowledge to create novel products and services. The former suggests a new research strategy for the forest sector to stress the research fields and roles of organizations to develop the bioeconomy. The latter aims at developing the competence base and paying attention to opportunities for business development in the bioeconomy in addition to the research, development and innovation activities.

It can be concluded that there are several initiatives both at the European and national levels in the fields of governance of forests and the environment, signaling the need to further improve the science-policy-practice interface. This paper is largerly based on report by Päivinen and Toivonen (2015).

Scope for improving the science-policy-practice interface

The science-policy interface includes "many ways in which scientists, policy makers and others link up to communicate, exchange ideas and jointly develop knowledge for enriching policy, decision-making processes and research. The aim is to do things differently as a result of the learning" (Hove et. al., 2014). A similar process also takes place between science and practice. The concept has often been expanded to the science-policy-practice interface (Weichselgartner and Kasperson 2010, Stewart et.al., 2014).

In order to increase the usability of the research results in policy making and practice, research donors have, for a long time, required the involvement of 'clients' of research in one form or another in the research projects, through steering committees or other forms of engagements. In addition, today's research reports more often include policy recommendations or suggestions for the practical use of the results.

However, often the policy questions are broad and complex, and cannot be solved using the knowledge gained within a single research project or program. Young et al. (2014), express the view that transforming scientific evidence into a usable knowledge "is neither automatic or straightforward". Moreover, Vogel et. al. (2007) conclude that the scientific output is often not what practitioners or policy makers need or its timing and format is not suitable for their use. There may also be communication problems between the producers and users of the results.

A very common case is that researchers feel obliged to report all reservations and preconditions for implementing their results. Practitioners are then confused to see too many 'buts' and have difficulties to understand how to utilize the research findings. Researchers may also be concerned that too close collaboration with practitioners decrease their credibility as scientists, if not otherwise, at least by limiting the time available for their main products – peer reviewed publications. Consequently, stakeholders may consider that their legitimate concerns are not addressed in the research (Vogel et. al., 2007).

In the modern discourse on science-practice-policy interaction the concept of "evidence-based decision making" is often referred to. This approach has been used particularly in the health care sector. "Evidence-based forestry" (Cifor, 2017) is characterized by a holistic approach to form a synthesis using systematic review of the research on the identified problem area.

In the report on the state of Finnish forest research, Seppälä (2014) argues that the main problem in national research is the slow and low implementation of the results. Many of the problems related to

the low impact of the research results can be traced to the so-called 'linear' model of communication, in which the scientific facts are transmitted to policy makers to be used in solving policy problems. In several reports, there are demands for a shift from a puzzle-solving linear model towards a more integrated non-linear approach of science for policy (Koetz et. al., 2011, Young et.al., 2014).

Figure 1. The cycle of the science-policy(-practice) interface

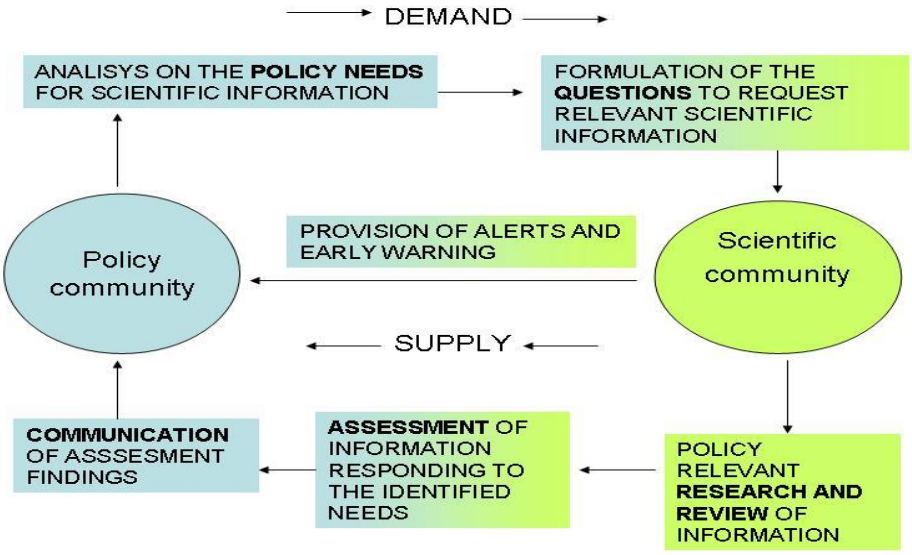

Figure 1 describes the policy-science interface where policy and science communities interact and meet to discuss three main issues: the formulation of the research questions, the provision of alerts, and the assessment of the information responding to the policy needs (IUCN 2010). It can be noted that similar approach can also be implemented in science-practice interaction. In this approach, the linear, one-way communication is replaced by an interactive system with feedback from the policy (and practice) side.

The most important attributes of effective science-policy-practice interaction kcited in the literature are as follows (Cash et. al. 2003, IUCN 2010):
1. Relevance, reflecting the ability to link the issues on which decision makers and practicioners focus.
2. Credibility, reflecting the believability of knowledge to a user of scientific results and facts, models, scenarios and options behind them.
3. Legitimacy, referring to political acceptability, transparency and trust of the process in the science-policy-practice interaction.

Examples of science-policy-practice interfaces

Probably the most well known initiative on the science-policy interface is the International Panel on Climate Change (IPCC), which was established in 1988 under the United Nations. It aims at synthetizing scientific information on climate change and presenting it to decision makers in a digestible format. The IPCC has been visible in the environmental policy discussion, especially at the global level.

In the Forest Europe process, the scientific community has been one of the participants in the Multi-stakeholder Dialogue (Mayer & Rametsteiner 2004) and in the work of Expert Level Meetings (ELM). However, Mayer (2015) concludes that in Forest Europe, "there is no science mechanism for systematic knowledge input," and recommends that one should be established.

The Forest Based Technology Platform, which is an industry driven EU initiative, has taken the role of identifying the most relevant research topics contributing to the EU political goals towards a sustainable and competitive forest sector in Europe. In doing so, it attempts to combine the broad political goals and more specified business goals to a research agenda serving both policy and practice.

Discussion and conclusions

There are several issues to be considered in developing a national science-policy-practice forum.

The experts involved must be interdisciplinary on the science side and cross-sectoral on the side of policy making and practice, in order to be able to handle complex issues related to climate change, protection of biodiversity, forest products trade and trade-offs between various aspects of sustainability, among others. (Young et. al. 2014).

The scientists, policy makers and practitioners participating in various roles on the panels should be aware of processes in fields other than their own. Scientists should be willing to engage themselves to a policy arena and bear the associated risks (Guldin 2003). Policy makers and practitioners should bring questions relevant for their work to the process, but at the same time understand what types of questions can be answered by a scientific approach.

In order to protect the credibility of any science-policy-practice interface, scientific independence cannot be compromised in any way. However, the ways of communication should be not dictated only by scientific traditions, they should also be complemented by the needs of the users of science. For this reason, it is necessary to find incentives for scientists to devote time for activities that do not directly support the writing of peer-reviewed publications (Sarkki et. al. 2014).

Nordin (2014) suggests issues that need to be considered in interaction processes are the following:
• Actors must engage in defining the questions that needs to be answered;
• Interaction must be formalized – to some extent - to assure transparency;
• Interface processes may be owned by interface organizations if these can be seen as trustworthy by all actors.

New ways should be explored to design interactive processes, ones that are not too heavy and time consuming yet are rewarding for all participants. The process must be legitimate itself by being fair and transparent while bringing added value to the individuals and organizations participating in it.

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Can we use the evidence base more effectively in forestry?

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Abstract

As society's demands for goods and services from forests increase, there is a corresponding increase in demand for high quality science which can help shape forestry policies for the sustainable management of natural resources. Forestry and related research is now undertaken in a very diverse range of institutions. The increased outputs from researchers in domains other than traditional forestry schools have not been matched by systematic methods of utilising new or existing information for policy and practice or to identify future research needs that reflect the priorities of people in forestry's extended networks. The benefits of adopting gold-standard systematic reviews, introduced almost 25 years ago in medicine and public health, are clear for forestry in the 21st century. Systematic reviews and systematic maps are robust tools, driven by transparent methods that link science and policy in flexible collaborative frameworks, developed for each new question under consideration. In the aftermath of society's concerns about possible manipulation of science by experts (in the climate science arena), and with more recent concerns over the role of expertise and science itself in supporting policy formulation, it would be folly for the forestry sector to ignore the benefits that would accrue from adopting genuinely evidence-based procedures for matters of national and global significance.

Introduction

In 1979 Archie Cochrane, a British epidemiologist critical of the haphazard use of research and clinical data, issued a challenge:

"It is surely a great criticism of our profession that we have not organised a critical summary, by speciality or subspeciality, adapted periodically of all relevant randomised controlled trials" (Cochrane *et al.* 1979).

This led ultimately to the establishment in 1983 of the Cochrane Collaboration (now called Cochrane) established with a mission to *"promote evidence-informed health decision-making by producing high-quality, relevant, accessible systematic reviews and other synthesized research evidence"*[1]. Other disciplines followed suit, notably the Campbell Collaboration[2] in 2000 for

[1] Cochrane http://www.cochrane.org/

[2] Campbell Collaboration https://www.campbellcollaboration.org/

systematic reviews of social policies, and the Collaboration for Environmental Evidence (CEE)[3] in 2006. Forestry entered the field with a UK Department for International Development (DFID)-funded initiative in 2013[4], which drew on research in Oxford (Petrokofsky *et al.* 2011, Petrokofsky & Mills 2009) that responded to a broad challenge by the President of the Royal Statistical Society a decade earlier:

"But what is so special about medicine? We are through the media, as ordinary citizens, confronted daily with controversy and debate across a whole spectrum, of public policy issues. But typically, we have no access to any form of systematic 'evidence-base – and therefore no means of participating in the debate in a mature and informed manner…perhaps there is an opportunity…directed at developing analogues to the Cochrane Collaboration, to provide suitable evidence bases in other areas besides medicine" (Smith 1996)

In fact, there had been a suggestion in 2005 that forest science should *"embrace standards of evidence established for other scientific fields",* and the authors had included in their paper a brief section titled "*a case for evidence based forest science*", using the term 'forest science' to mean decision-making in forestry (Binkley & Menyailo 2005). However, this valuable suggestion lay dormant until the Evidence-Based Forestry initiative was undertaken.

There is no one single reason why good science does not lead directly to better-informed policy or better-directed action (explanations include the "leaky evidence pipeline" (Wallace 2013) and the "17-year odyssey" from basic research to practice (Olswang & Prelock 2015), but, leaving aside the question of whether a 'linear' model of science-to-policy-to-practice is even desirable, the sheer volume of science, which grows exponentially, and the cost and difficulty of reading through it to gain understanding of complex, often conflicting, messages are daunting for policy-makers and practitioners.

. It is hardly surprising if cherry-picking science becomes routine in decision-making:

> *"The scientific enterprise is diverse enough to offer information that can be used to support a diversity of perspectives on just about any subject…deciding a course of action and then finding information to support it is common across the political spectrum"* (Pielke 2007)

It is not just the policy community who are guilty of drawing on information that supports a particular position. Latour (1987) illustrates how technical papers attract 'friends' and 'dissenters', particularly where there are scientific controversies, and how the patterns of citations amongst these two groups influences the arguments proposed in the original paper, but there are less malign reasons, that are less overtly personal or political, that explain why some scientific pronouncements may be favoured over others, including volume and cost of high quality information.

The general public, landowners and policy makers do not know about, or have access to, the full spectrum of scientific advice that is available; however, it is altogether more worrying that forestry professionals and academics are often also aware of only a fraction of the evidence base underpinning practice, and are therefore not well placed to assess the likely shortcomings in the evidence base. Systematic tools and techniques used in other disciplines to increase the power of the evidence base, minimise bias, and ensure that selective use of the evidence is reduced when planning research or constructing policy and practice advice (Pullin *et al.* 2016) were almost universally

[3] Collaboration for Environmental Evidence http://www.environmentalevidence.org/

[4] Evidence Based Forestry initiative http://www1.cifor.org/ebf/home.html &

https://oxlel.zoo.ox.ac.uk/people/dr-gillian-petrokofsky

unknown in the forestry sector until relatively recently with the establishment of CEE and then the EBF initiative, which utilised Cochrane and CEE guidelines for best practice in evidence synthesis.

The heart of this initiative was raising awareness of the benefits of systematic reviews and conducting a range of systematic reviews and systematic maps across the research interests of the partner organisations who represent 'forestry' in its broadest sense:

"Forestry - the profession embracing the science, art, and practice of creating, managing, using, and conserving forests and associated resources for human benefit and in a sustainable manner to meet desired goals, needs and values" (Helms 1998, updating Ford-Robertson 1971).

Systematic reviews

Systematic reviews have been described as 'critical links in the great chain of evidence' which are not satisfied with finding part of the truth, but look for 'the whole truth' (Mulrow 1994). They are tools used to summarise, appraise and communicate the results and implications of a large quantity of research and information. They aim to overcome problems inherent in single studies, randomly selected from a huge body of literature, by looking at a large body of literature which is selected and analysed according to strict, transparent protocols and methods and they synthesise results of studies that examine the same question but which may have conflicting findings. The purpose of a systematic review is to provide the best available evidence on the likely outcomes of various actions and, if the evidence is unavailable, to highlight evidence gaps - areas where further original research is required. They support decision-making by providing independent, unbiased and objective assessments of evidence; they do not directly tell the user-community what decisions to take.

They are invariably conducted collaboratively, with as much effort going into setting the question and agreeing the search criteria as analysing the studies and drawing the conclusions. These features make them eminently suited as tools in the effort to bring rigour and order to the large bodies of research and practice knowledge which exists for forestry and landscape management.

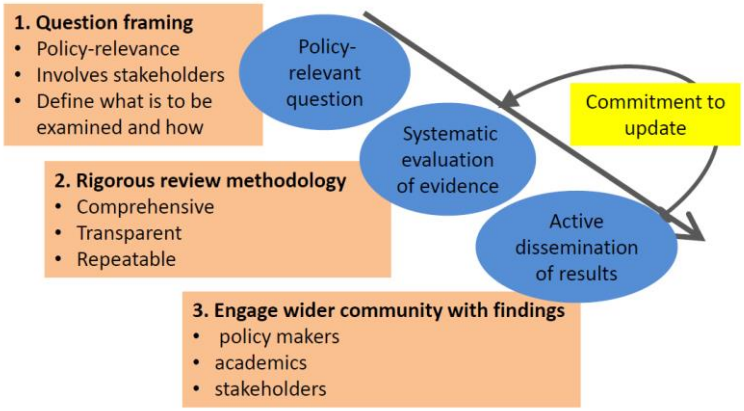
They are not simply bigger, more comprehensive, literature reviews, utilizing a wider set of bibliographic databases; they may even be smaller than traditional literature reviews because of the strict criteria used to select studies for review (Petticrew 2001). Whereas systematic reviews use a highly formal approach, traditional 'narrative' reviews use an informal approach which is mostly far from transparent to the reader, and almost invariably not possible to replicate and therefore fundamentally unscientific. Table 1 summarises the key differences between the two types of review.

Table 1 Difference between narrative and systematic reviews (adapted from Nutley *et al*. 2007)

Feature	Systematic review	Narrative review
Question	Often a focused question	Often broad in scope
Sources and search	Comprehensive sources and explicit search strategy	Not usually specified, *potentially biased*
Selection	Criterion-based selection, uniformly applied	Not usually specified, *potentially biased*
Appraisal	Rigorous critical appraisal	Variable
Synthesis	Quantitative summary (may be a meta-analysis if it includes a statistical synthesis)	Often a qualitative summary

The process for conducting a systematic review (or systematic map) involves a series of stages which are designed to ensure a rigorous, transparent and repeatable approach that reduces bias as much as possible. They are collaborative exercises, with authors and who are familiar with the relevant research areas and, ideally stakeholders and advisory members reflecting a wide experience of policy and practice. Figure 1 and Table 3 show the process and main stages of a review.

Figure 1 the systematic review process (Petrokofsky *et al.* 2011)



Systematic maps

Systematic maps describe the evidence base available for broader questions and can help identify knowledge gaps in the literature. They employ the same rigorous and transparent processes as systematic reviews (Figure 1) and are equally dedicated to reducing biases.

Evidence is usually presented in the form of a searchable database, with 'meta-data' that describe the nature and quantity of research for a given topic. For example, the number of articles published in journals, books, conferences; the number of publications per year; the number of studies from each country of origin; the type and number of interventions; type and number of different study designs. Systematic maps rarely include synthesis of results of primary studies. Some key differences between systematic reviews and systematic maps are listed in Table 2.

Table 2 Differences between a systematic map and systematic review (James *et al.* 2016)

Stage in 'evidence synthesis'	Systematic review	Systematic map
Objective	Aims to answer questions with a quantitative or qualitative answer	Describes the state of knowledge for a question or topic
Question formulation	Question is usually closed-framed	Question can be open-framed or closed-framed. Topic can be broad or narrow
Search strategy	Evidence is limited to primary qualitative or quantitative research. For example comparative, prevalence or occurrence type studies	No limitation on research evidence that can be included (e.g. primary and secondary research)

Article screening	Article full text is usually required to extract relevant data	Articles not obtainable at full text (where the full document is not available) or studies with limited data may be included
Data extraction	Information describing the study and its methods and studies' qualitative and or quantitative results extracted	Information describing the study and its methods are extracted. Study results may not be extracted
Critical appraisal	All included studies critically appraised for study internal and external validity	Critical appraisal optional
Synthesis	Qualitative or quantitative synthesis of study results where possible using appropriate methodology (e.g. meta-analysis). Knowledge gaps identified	Trends in the literature, knowledge gaps and clusters identified but no 'synthesis of study results' carried out
Report	Narrative and qualitative or quantitative synthesis study results (e.g. meta-analysis) to answer the question (where feasible). Implications for policy and practice, and identification of knowledge gaps for future research	Describes and catalogues available evidence relating to a topic of interest, identifying knowledge gaps and knowledge clusters. Implications for policy, practice and research made

Components of systematic review & map questions

Questions suitable for systematic review are structured to contain a number of key elements, which are clearly described components that specify the aspects of a primary research study to be able to answer the review question. The most common question type relates to the effects of an intervention (or exposure) and generally has 4 key elements that need to be specified: population (P), intervention (I) (or exposure (E)), comparator (C) and outcome (O) commonly referred to the PICO or PECO elements (CEE 2013). The following three examples illustrate these elements:

Example 1

Review question: What is the effect of prescribed burning in temperate and boreal forest on biodiversity, beyond tree regeneration, pyrophilous and saproxylic species? A systematic review protocol (Eales *et al.* 2016)

Components of the question:

Population: Boreal and temperate forests.

Intervention: Prescribed burning.

Comparator: Non-intervention or alternative levels of intervention.

Outcomes: Biodiversity measures, including diversity, richness, abundance and composition of species (excluding pyrophilous and saproxylic species).

Example 2

Review question: What is the evidence that gender affects access to and use of forest assets for food security? A systematic map protocol (Chiwona-Karltun *et al.* 2017)

Components of the question:

Population: Forest resources and assets in low and middle income countries (as defined by the World Bank, 2014)

Exposure: Women or female headed households who access and use forest resources and assets Changes in food security, defined by a range of indicators

Comparator: Men or male-headed households who access and use forest resources and assets

Outcomes: Changes in food security, defined by a range of indicators

A more complex set of PECOs is shown in example 3

Example 3

Review question: The environmental, socioeconomic, and health impacts of woodfuel value chains in Sub-Saharan Africa: a systematic map (Phosiso *et al.* 2017)

Components of the question:

Populations: Forests, woodlands, and shrublands (natural or planted), or farmlands, agroforests or landscapes consisting of the mixtures of those that supply firewood and charcoal in Sub-Saharan Africa (SSA); Wood energy value chain participants (as specific economic groups): collectors, producers, traders, intermediate and final consumers in SSA

Exposure: Production, collecting, harvesting, processing, trading and consumption of woodfuel (note: Production practices can include managed coppice systems, plantation forestry, assisted natural regeneration, and agroforestry)

Comparators: Before or without woodfuel production, collection, harvesting, processing, trading or consumption activities; Before or without substitute or alternative technologies (kilns and cookstoves) that affect demand/supply of woodfuel

Outcomes: Environmental impacts, including deforestation, forest degradation, forest regeneration, and other changes in tree cover; Secondary impacts on greenhouse gas emissions, carbon sequestration/carbon stocks, and non-carbon ecosystem services, water flow, erosion/sedimentation, biodiversity; Socio-economic impacts on woodfuel value chain participants and such as changes in employment, assets, income; Health impacts on woodfuel value chain participants such as pollution and illness

Impact evaluation and future prospects

Though widely acknowledged that Cochrane groups have been producing high-quality systematic reviews for almost 25 years, there is a lack of information about the impacts of Cochrane reviews. A systematic review of the efficacy of systematic reviews highlighted the difficulty of defining and assessing impact. Impacts on knowledge production and clinical guidance were easier to identify and substantiate than those on clinical practice. The clearest impacts were on policy with a total of 483 systematic reviews (of 1502 investigated) cited in 247 sets of guidance (62 international, 175 national and 10 local) (Bunn *et al.* 2014). No similar impact assessments have been conducted in conservation and it is too early to assess impact of the systematic reviews and maps that have emerged (or are still emerging) from the EBF initiative, but this is a future need.

Pullin (2015) reported that despite considerable effort on a range of systematic reviews looking at evidence of effectiveness and impact of some of these types of intervention, sufficient evidence to inform future decisions is lacking. Examples of relevance to forestry cited were from a review of the effectiveness of community forest management, which concluded that the evidence base was poor and evidence of effectiveness equivocal and from two related systematic reviews on the effects of

decentralised forest management and payment for ecosystem services, which reported limited evidence as the major outcome, particularly in relation to human wellbeing indicators.

It is clear that trade-offs need to be considered before commissioning a systematic review - the cost can be high and the time longer than for a more traditional narrative review. However, it is reasonable to argue that the scientific approach to literature reviewing embodied in the systematic review method is one that should be encouraged for assessing the state of the evidence base for questions in forestry and related fields and before producing practice guidelines and policy recommendations. The alternative 'haphazard' habit of selecting only a tiny subset of studies to review, or, worse, cherry-picking studies that confirm existing biases are indefensible. Moreover, the collaborative nature of systematic evidence synthesis that encourages multi-disciplinary groups to frame questions of high priority, and seek out evidence from many different domains of relevance to the question help make a strong case for using systematic tools to use the evidence base in forestry more effectively.

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SNS-EFINORD network meeting and international workshop
Tools for improving science-practice interaction in forestry
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Country report - Denmark

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1. Science-practice interaction in policy documents

a) legislation,

In Denmark there is an aspiration that management and political decisions should be evidence based in the sense of scientific results. Most of these scientific results come from scientific-based advising made by the universities and other knowledge institutes. Most universities, such University of Copenhagen (Faculty of Science) have similar goals expressed in their foundational policies: "Interaction with society is a key activity at SCIENCE. The knowledge produced at the Faculty must be transferred to society and the business community and, thus, contribute to solving global challenges … We want to be the preferred partner when enterprises, consultants, authorities and organisations involved in science-related activities seek knowledge and cooperation at the highest level" (http://www.science.ku.dk/english/external-relations/).

The figure below illustrates how different ministries use different universities for securing this knowledge on a daily and continuous basis through so-called framework agreements. The forestry sector is represented in the first column (University of Copenhagen) and third row (Ministry of the Environment).

Bilag C. Eksisterende aftaler om forskningsbaseret myndighedsbetjening

	Københavns Universitet	Aarhus Universitet	Syddansk Universitet	Aalborg Universitet	Danmarks Tekniske Universitet
Fødevareministerium	Fødevareøkonomi § 19.22.01	Jordbrugsforhold § 24.33.03			Fiskeriforhold § 24.33.17 Fødevare og veterinærforhold § 24.33.25
Klima og Energi-ministerium	Understøttelse af Kyoto-konvention, via DMU/AU	Understøttelse af Kyoto-konvention § 23.31.01			
Miljøministerium	Skov- og landskabsopgaver § 19.22.01 og § 23.51.05	Miljøundersøgelser § 23.31.01			Toksikologiske forhold § 23.21.01
Statsministerium		Understøttelse af Grønlands hjemmestyre § 23.31.01			
Sundhedsministerium			Folkesundhedsforhold § 16.33.01		
Transportministerium					Transportforhold § 28.11.12
Udenrigsministerium	Skovfrøcenter og Frøpatologisk Institut og DBL § 19.22.01 Udviklings-forskning § 19.22.01				
Videnskabsministerium	Center for sprogteknologi (CSI) § 19.55.09				Risø (Dansk Dekommissionering) § 19.51 Institut for Rumforskning og Teknologi (geodæsi) (tidl. Danmarks Rumcenter) § 19.55.01
Økonomiministerium				Byggeforhold § 08.37.15	

20

(http://dkuni.dk/Politik/~/media/Files/Publikationer/Hvidbog.ashx)

b. national forest programmes or strategies,

Specifically, University of Copenhagen has a number of obligations to provide scientific based assistance to public authorities (http://mfvm.dk/kontakt/kontakt-til-klagecenteret/ministeriet/samarbejdemeduniversiteter/aftaler-med-ku/).

The core of public sector services relevant to forestry is funded through a long term contract between the University of Copenhagen and the Ministry of Ministry of Environment and Food.

The aim of having contracts is to deliver science based independent advice and consultancy. Science based means that the University has to secure a reasonable level of science within the fields (i.e. they cannot have only consultants within a certain field). To secure independence, projects are initiated by a project description where expectations are made clear. Reports are not written together with members from the ministry, but as independent reports. All results are publicly available, and the ministry is not allowed to ask for it not to be published or published with a delay if it is unpleasant results. All communication is subject to public access request and can at any time be followed.

The contract for environmental economics work with an annual work programme in which the Ministry presents tasks they want investigated, and the university expresses interests and realism in what can be made within the given project. Based on this an annual work plan is decided and followed up upon regularly. A part of the budget is set aside for competence building and can be used freely by the university. This is e.g. used to secure research within areas where other funding is difficult to obtain, or to train new researchers (PhD students) within the field.

Apart from this, the university takes on ad hoc projects, when the Ministry has questions they want answered that are not in the work programme. Sometimes the ministry participates in research projects, e.g. as stakeholders in EU projects. Again, there is a strong focus on securing independence between research results and the public sector.

Whenever the University has results believed to be of relevance for the public sector, they are presented to them in workshops, as articles in sector journals or by other means.

2. Research capacities in relevant fields

There are two departments at the University of Copenhagen under the Faculty of Science which provides knowledge transfer to the forestry sector: Department of Geosciences and Natural Resource Management (IGN) and Department of Food and Resource Economics (IFRO).

IFRO, a part of Faculty of Science at University of Copenhagen (UCPH), has its origins in the traditions and methodology developed in the Danish agriculture, forestry and food production sectors, in which the close consultative relationships developed between the private sector, public authorities and research institutions contributed significantly to positive outcomes.[5] The strategy of

[5] The Department of Food and Resource Economics (IFRO) in its current form was established in 2012. It has its roots in the former Royal Veterinary and Agricultural University (KVL), and in two research institutes,

IFRO can be found here: https://intranet.ku.dk/ifro/om-ifro/Sider/default.aspx. A specific service agreement under that contract concerns the obligations of and resources available for IFRO, within "Resource and welfare economics".

The research of the Section for Environment and Natural Resources at The Department of Food and Resource Economics (IFRO) addresses fundamental questions and challenges as well as applied policy relevant aspects of human kinds use and protection of the environment and natural resources in a wide sense, including how people interact, e.g. in forms of conflict over natural resources, such as forests, or in the relation to provision of public goods. The section addresses these questions from a social science perspective covering in particular disciplines like economics and sociology, and as a general rule typically engage in interdisciplinary research projects with national or international colleagues from natural sciences. Approaches cover theory formation and theoretical analysis as well as numerical modelling and simulation, experimental approaches and large scale empirical analyses based on surveys or long-term databases of economic and environmental issues.

The applied work includes issues like the optimal regulation and use of natural resources like forests, and game, environmental valuation and regulation of externalities, cost-effective protection of biodiversity, groundwater and water bodies and the economics and policies of climate mitigation and adaptation. Other issues include the ethical issues in and possible conflicts over environmental protection hunting or natural resource use, such as forestry.

IGN has strong traditions for cooperating on all levels from informal knowledge exchange for counselling, advisory services and joint research projects. IGN also works towards facilitating contact between students and private and public companies for mutual benefit. The overall aim is that IGN's knowledge will contribute to the managing societal challenges within the fields of research through collaboration projects; consultancy for professionals; public-sector services; and bachelor internship projects. The Section for Forest, Nature and Biomass at IGN has experimental research efforts in a large variety of fields within forests and ecosystems in the entire range from ecosystem via management to products. The section has experimental research efforts in a large variety of fields within forests and ecosystems in the entire range from ecosystem via management to products. It consists of seven research groups: Biogeochemistry, Biomass Science and Technology, Ecology and Nature Management, Forest Genetics and Diversity, Forest Resource Assessment and Bioenergy, Trees and Forest, and Tropical Trees and Landscapes. The Forest and Landscape College is also a part of IGN, and offers educational programmes, courses, consultancy and development within the field of forest and nature.

Both departments are united in a so-called centre without walls, "Forest & Landscape Denmark". Forest & Landscape Denmark is a national centre for research, education, consultancy and outreach within forestry, urbanism, landscape architecture and planning. Forest & Landscape Denmark has a close collaboration with the Ministry of the Environment and the municipalities. This involves on-going close dialogue at multiple levels with the Ministry and municipalities and inspiration for research projects with direct application to questions and problems within this area.

which in 2004 was merged into KVL. In 2007, KVL was merged with University of Copenhagen. In 2012,

University of Copenhagen merged the Faculty of Life Sciences with the Faculty of Natural Sciences.

Science field	UCPH	IGN	Total
Ecology and silviculture	0	16	16
Forest technology	0	2	2
Economy, statistics, society and policy	10	4	14
Researchers, total	**10**	**22**	**32**

Other relevant research organizations carrying out forest-related research in Denmark include Aarhus University, Department of Bioscience doing research in ecology, zoophysiology, biodiversity and conservation biology.

3. How the interaction is arranged in the country

The Department of Food and Resource Economics (IFRO) conducts research-based consultancy assignments for the public sector concerning (mainly) economic issues with regard to forestry. The agreement with the public sector (ministries) can be found here: https://intranet.ku.dk/ifro/myndighed-erhverv/Sider/default.aspx.

The main users of those services include the Ministry of Environment and Food of Denmark and other ministries and institutions. The consultancy reports are used for the ministries' preparations for international negotiations and the preparing and evaluating of law propositions, action plans, etc.

The written outputs of the different consultancy assignments are published in the series IFRO Udredning (IFRO Commissioned Work). Usually, they are written in Danish.

IFRO's public sector service related to economic and policy issues within e.g. forestry are research based, and for IFRO it is important that the resulting outputs are produced at "arms-length" from any political or economic interests, ensuring independence and the legitimacy of the work, as this may often form a foundation for the preparation of new legislation, regulation, international negotiations or provide evaluations of existing regulations and legislation. To secure this, IFRO has a strict code of conduct that is fully respected in current standard contracts with authorities. Moreover, a prerequisite for providing relevant public sector services are good relationships with different stakeholders, e.g. public agencies, NGOs and other research institutes, and the department engages in dissemination of the work both in traditional research channels and at public seminars and media.

IFRO has an Advisory Panel involving 20 representatives of the private sector, the public sector and other stakeholders with interests in the research, educations and other activities at IFRO. The purpose with this panel is to enhance the network and collaboration between researchers and the private and public sector and to gather and give inspiration around research, advisory work and education. Part of this panel has relation to forestry.

It should be remembered that quality integration between research and Public Sector Services requires continuous attention as the needs for knowledge within e.g. the forest sector does not automatically correspond with the search for fields of interest in research calls and journals.

Example: Forest biodiversity management
One example of forest-policy and research interface is represented by a recent study on conservation of biodiversity in Denmark where IFRO participated (Petersen et al. 2012, 2016) which turned out (unexpectedly) to influence forest and nature policy in Denmark. The main focus of conservation policies in the EU has for years been addressing the regulation of farmers. The European Common

Agricultural Policy has since the early 1990s supported agri-environmental schemes and promoted conservation objectives (Davies 2004). The study by Petersen et al. (2012) found that large gains in protection effectiveness and cost-efficiency could be achieved from allocating more of the conservation investments to the protection of valuable forest habitats. The EU environmental schemes have mainly promoted the protection of open land natural areas and buffer zones in agricultural areas.

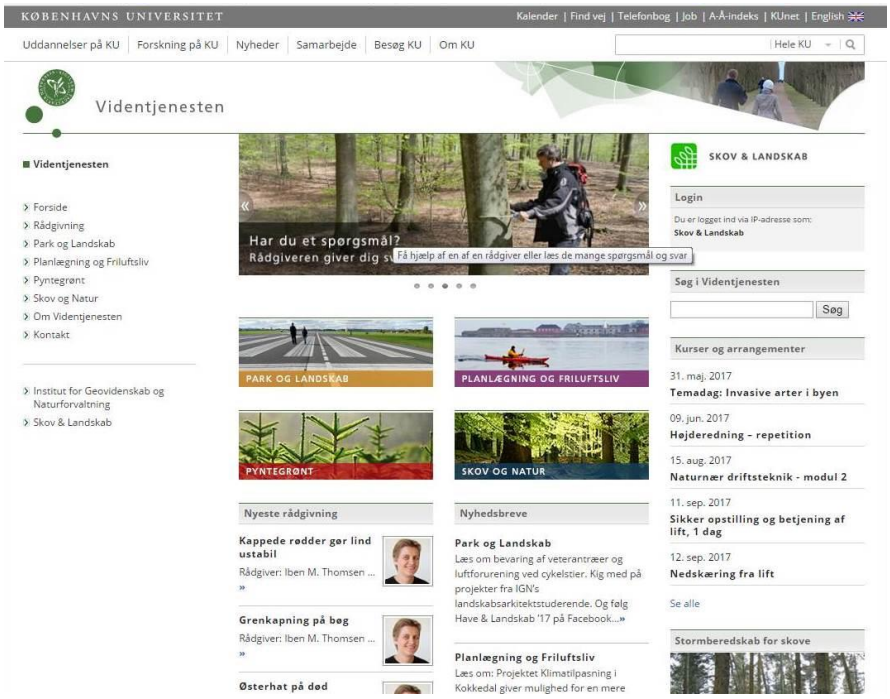
The results of the study were discussed with stakeholders from the agricultural and forestry sectors, the World Wildlife Foundation and other environmental non-governmental organizations, and members of the Danish Parliament at national workshops. This topic turned out to be highly controversial – as the forestry sector disputed the claim that forests should be a more important habitat for protection of biodiversity than farmland and open land natural areas. When confronting the forestry sector with the logical steps and assumptions behind the analysis they opposed against it as they feared it would lead to the close-down of the forestry sector in Denmark. In terms of economic size and political power the Danish forestry sector is much less important than the agricultural sector. The report was integrated in the work of the Danish Nature and Agricultural Committe (2013), and partly advocated by the Danish Liberal Party (Venstre, 2015) during the national elections in 2015, and presented at a national assembly in the Danish Parliament in 2016. The government decided subsequently that the Danish Nature Agency is expected to designate 13,000 ha of state owned forest as biodiversity forests (without forest management) in 2017.

Example: Sustainable forest management: forest development types

Another prominent example of forest research causing a significant impact on forest policy and practice was the development of guideline for sustainable forest management in Denmark. The research was led by professor Larsen from the early 1990s promoting the conversion of Danish forests to mixed species and age structures, which were believed to be more robust and in line with ecological, economic and social goals of society. The majority of Danish forests were managed as mono-species/-age forests. Economic challenges in the forest sector, risks of severe storm events, and the state forests' request for meeting public demands influenced the Danish National Forest Programme launched in 2002). It included the suggestion of adopting the guidelines of sustainable forest management developed by Professor J. Bo Larsen at IGN.

Altogether, like IFRO IGN solves explicit assignments for companies, municipalities, government agency, and government department based on our research-based knowledge. IGN's employees have strong professional competencies, and their knowledge is wide-ranging. This enables IGN to solve problems that need special competencies or equipment, including analyses, inquiries, or risk assessments, e.g. measurement of mould fungus in wood chips. Consultancy is usually delivered in a report and often leads to a changed practice that saves resources for the company.

Furthermore, IGN consults in smaller individual cases – for example the handling of pests. This provides the possibility of solving concrete problems, to which help is needed immediately. Consultancy is often verbal and delivered for example through the extension branch called "Videntjenesten" (meaning knowledge service in Danish) for forest and landscape – see the homepage in Figure 2. The company itself contributes to planning the assignment, and it usually has the right to the results, but the researches can also publish the results. The company fully finances the assignment.



At IGN researchers also communicate their results through many channels: Academic publications and reports (presenting research results or evaluating projects); Conferences and seminars; Software; and as a part of education, consultancy, and research, IGN preserves three arboreta, two in Hørsholm, Denmark and one in Greenland (http://ign.ku.dk/english/advisory-services/)

4. How the impacts of scientific results are being assessed

The main way is quantitative assessment of research in terms of output (scientific, consulting, dissemination – or changed e.g. economic output of, say, a company) but clear more qualitative assessment methods also (co-)exist in terms of e.g. implementation into forest management programmes (like the close-to-nature silviculture) or forest policy or legislation (like the biodiversity set a side plan). At the moment, there is a process going on in terms of making a new advisory board (http://ifro.ku.dk/udredning/aftale_fvm/) for IFRO, which partly includes aspects of interest for forestry.

5. Needs and plans for development

As stated previously in this report, the relationship between the Ministry of the Environment and Food and the universities that make government services to the Ministry has been largely run through framework agreements and contracts. Some of these have been renegotiated during the winter of 2016-17, and a case about the effect of application of liquid manure on the groundwater had a significant influence on these negotiations. For example, universities were working to remove the various silence clauses in the standard contracts between the ministry and a university to ensure that they did not have to end in a situation where university researchers could not participate in public debate about their own results and did not even have to say why they could not participate. Similarly, the universities wanted to change the sections of the contracts, which allowed the ministry to delay publication of the reports universities deliver to the ministry.

It is a specific requirement that the Public Sector Services and research is integrated both at the strategic and operational level, and also relies on the same requirements in terms of independence, quality and quality assurance. Moreover, the Public Sector Services are formally regulated by a department based code of conduct, and outputs from the public sectors services must be published as quickly as possible after having being submitted to the client.

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Forest research and practice interactions in Estonia

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1. Estonian forests and forestry in brief

Forestland accounts for almost 2.3 million ha in Estonia, of which private ownership accounts for 48% (Environmental Agency, 2016). The Ministry of Environment is mainly responsible for forestry issues. However, the Ministry of Agriculture plays an important role as it implements the Rural Development Policy. This includes also some subsidies that are paid to the owners of private forestlands. Policy implementation for private forestry is the task of the Private Forest Centre (PFC), a foundation that acts under the Ministry of Environment.

The state forests are managed by the State Forest Management Centre. It includes 930 000 ha of forestland. Private forests cover some 1.1 million ha with approximately 100 000 forest owners managing them. Most of these forest owners (95%) are private individuals (700 000 ha of forest) while the rest (5%) are legal owners (companies, firms etc.). The felling intensity has mostly increased year-by-year since the beginning of 1990-ies, mostly due to the land reform process. However compared to private forests the state forest management has been more stable. This means a more stable annual harvesting, tending, maintenance and planting compared to private forests (Environmental Agency, 2016).

Table 1: Gross fellings (in 1000 m^3) based on the National Forest Inventory (NFI) between 2009 and 2013 (Statistics Estonia, 2016)

Felling type	2009	2010	2011	2012	2013
Regeneration felling	5043	6822	6069	5978	5836
Maintenance felling	1334	1331	1752	1123	1630
Other felling	222	338	332	310	125
Total felling	6599	8491	8153	7410	7591

Agriculture, forest management and fishing employs approximately 25 000 persons (4%), but the manufacturing industry to which also forest management contributes with the resource, employs 120 000 persons. Therefore, while forest management is as a primary sector, it gives valuable input to the whole chain of production. Even more, in 2014-2015 the biggest contributors to the rise of GDP was given by the rise of added value in this primary sector of agriculture, forest management and fishing (15%). In 2015, agriculture, forest management and fishing contributed 620 million € (4%) at

current prices to the GDP. In addition, it is important to highlight the significance of the manufacturing sector and the further processing of roundwood as forest and timber product exports is the most important balancer of overall foreign trade (Statistics Estonia, 2016).

2. Science-practice interaction in policy documents

Within forest-related national legislation, there are no specific or direct links to scientific results. Nevertheless, in the policy formulation processes often forest scientists are somewhat involved. The Forest Act (2006) itself has no direct references to science-based paragraphs. However, there are some aspects or points of the legislation which are influenced by research results. For example, the Forest Act (2006) insists that in case of clear-cuts retention trees should be left on the area (minimum of 5 m^3ha^{-1}). In the past, there has been research within this field (e.g. Lõhmus *et al*. 2006). There are also points in the legislation (e.g. specific rotation ages) where research (e.g. Korjus *et al.* 2011) questions the necessity of the regulations. It seems that it is mostly a political question which research results have been used as suitable or applicable in policy.

In the National Forestry Development Programme (NFDP) until 2020 (2010) the matter of science-practice relations gain more momentum. The research and development (R&D) system has undergone many changes since early 1990-ies. Research groups have concentrated mainly to universities as there aren´t any other research institutions in forestry. Public R&D funding has been decided on the basis of scientific quality criteria. In order to promote forestry, the NDFP, there is a wider need for organizations that deal with research, development and training for forest management and policy (NFDP until 2020 2010). The NFDP foresees certain activities to promote and favor R&D in order to increase the competitiveness of forestry (table 1).

Table 2: Measures taken to advance R&D in order to increase the competitiveness of forestry by ensuring knowledge-based decisions (NFDP until 2020 2010)

Activities	Immediate result	Target
The application of Forestry Sector Technology Platform strategic research agenda	Focused research system	Continuous
The construction, re-organizing and based on necessity re-measuring forestry-related research and testing sites	Data flow from research plots	Continuous
The development of sample plot data in cooperation with forest-related institutions, Forest register and the Nordic forest database NOLTFOX	A dataset on research plots	Continuous
Continuing research in achieving forest management, silviculture and environment-related objectives	Surveys and analysis	Continuous
Support for issuing scientific journals Baltic Forestry and Forestry Studies	Publishing of research journals	Continuous
The modernization of forest management standards and models	Models and standards	Continuous
The development of forest-related applied research	Research program	2013

For the years 2008-2013 there has even compiled a research and development strategy for the Estonian forestry sector in the frame of Forest-Technology Platform (FTP) initiative (Estonian University of Life Sciences 2009). Its main idea was to give input to the NFDP until 2020 on behalf of the private and R&D sectors.

Regards the implementation of the NFDP until 2020 there is an interim report for 2011-2015 (2016) available which indicates that during the observer period different applied research projects got approximately 230 000 € direct funding from either state forest management organization or the Foundation Private Forest Centre. In addition, the responsible Ministry of Environment sent forestry-related issues to the Ministry of Education and Research (Implementation report… 2016). The interim report also reports on the successful development of a forest-related applied research program. Further information about these issues is not provided in the report.

3. Research capacities in relevant fields

In the Estonian University of Life Sciences in 2009, 77 employees dealt with forestry or forestry related issues. Among them 25 scientists. At the same time in Tallinn University of Technology there were 17 persons dealing with either wood processing or technology (Estonian University of Life Sciences 2009). Today, the approximate number of lectures and researchers in the forestry-related fields is around 70-80 (table 2), however not all are engaged in these activities full time (or forestry is their focus partially). At the same time, there might be other fields of research (plant physiology, economics, land use planning) which might cover some aspects of forestry as well. Thus, it is difficult to assess the capacity of forest research in full. If to search from the Estonian Research Information System (2017) within the field of forest sciences there is a result of 101 persons. However, this result includes also PhD students and many already retired or not active (left the field for another position) persons.

Table 3: Research capacities (number of persons) in 3 main Universities dealing with forestry (-related) issues (Estonian Research Information System 2017a)

	Estonian University of Life Sciences	University of Tartu	Tallinn University of Technology	Tartu Observatory	Total
Ecology and silviculture	31	9		4	44
Forest technology	9		7		16
Economy, statistics, society and policy	14				14
Total	**54**	**9**	**7**	**4**	**74**

The core of (classical) forestry research is conducted in the Estonian University of Life Sciences where all the subtopics (dendrology, protection, silviculture) are being coordinated. This is also reflected in the financing of research (table 3). Forest research however, has developed towards more interdisciplinary approaches (Jõgiste 2007). Modernization of science and technology has gained momentum also in this field, regardless of its long history and slight conservatism. Nevertheless, Ukrainski and Varblane (2005) conclude from a cluster analysis, that compared to Finland, Estonian forest industry cluster has weaker linkages to innovations. Furthermore, they identified that universities and research institutes are the weakest part in the knowledge flows of that cluster. Regards industry, the most important innovation sources were the suppliers (Ukrainski and Varblane 2005). The research and development strategy for the Estonian forestry sector 2008-2013 was used in the development of the NFDP its importance and influence remains unclear as Strykowski (2011) shows that there was only mild interest towards the FTP National Support Groups who were responsible for making the strategy.

Table 4: Forest research financing (thousand €) in the period 2010-2017 by institutions and financing sources (Estonian Research Information System 2017b)

	Estonian University of Life Sciences	University of Tartu	Tallinn University of Technology	Tartu Observatory	Total
Direct projects (Estonian Research Council)	2602	1570	0	376	4549 (37%)
National public sector	2665	201	0	0	2867 (24%)
Public-private	1542	77	20	20	1658 (14%)
International finances	640	2357	0	61	3057 (25%)
Total	**7449 (61%)**	**4205 (35%)**	**20 (0%)**	**457 (4%)**	**12131 (100%)**

The financing of forest science has been based mostly on direct funding or public sector financing. Table 3 is a general overview about the recent situation, however the funding there also includes investment funds for science infrastructure (laboratories, equipment) and publishing costs (scientific journals like *Forestry Studies* and textbooks). In recent years, the proportion (and amount) of public sector financing has decreased as external budgetary pressures have resulted in some cuts also in financing forest science projects (i.e. State Forest Management Centre, Foundation Environmental Investment Centre). In general, financing of forest research (annually approx. 1.5 million €) is not on sustainable and sufficient level in Estonia.

4. Arrangements for science-policy-practice interactions

Research communication is somewhat missing – most of the "communication" is done *via* scientific journals (an Estonian journal *Forestry Studies | Metsanduslikud Uurimused*) or by participating in particular events or conferences. The first is an open-access peer-review journal, which is published twice a year and among others, is indexed by *Scopus*. It should be one of the main, locally important, science-policy-practice interaction facilitator (Metsanduslikud Uurimused 2017). Some communication occurs through the institutions themselves (universities) however; it is not frequent or based on some communication plan. It is mostly related to either some events (PhD defense) or daily political issues. Most of these universities have their own department for communication.

The State (acting under the Ministry of Environment) Forest Council should work as the main basis for science-policy interaction. The Council includes different representatives from the public (public administration, Parliament, ministries) and private sector (industry, nature protection, forest owners). In addition, representatives from universities are present. Currently the Council involves one ecologist from the University of Tartu and one administrative person (lecturing on forest economics) from the Estonian University of Life Sciences. The Council meets on an irregular basis; however, considering that a new NFDP period is approaching debates over the content of the new NFDP will start soon. This means also a wider participation of different stakeholders and scientists also in the different working groups (e.g. currently the working group on strict protection) under the Council (Ministry of Environment 2017).

The main facilitators of science-practice interactions should be the Research Council of the State Forest Management Centre and the Foundation Private Forest Centre. The first is a governing body for the financing of applied science projects. Between 2008-2016, about 2 million € worth of support has gone to different projects which have been evaluated by the members of this council. Members of this council include scientist from the University of Tartu and Estonian University of Life Sciences but also senior staff members of the State Forest Organization (Research at RMK 2017). The latter – Foundation Private Forest Centre – has also financed (through public funds) applied science projects for private forestry and in an informal set-up between 2009 and 2014 there was also a group of consultants who helped the Foundation in prioritizing the topics (Aun 2017). One of the contributions of the Private Forest Centre is also being the mediator between science and practice. They´ve published numerous leaflets and information booklets to private forest owners about sustainable forest management in its practical sense. However, the cuts in the environmental financing sphere (Environmental Investment Centre decreased budget) have also meant that such applied research funding has run out.

Scientific results are mostly being assessed through the number of publications. The most high-ranking or influential in this respect are the papers published by journals with the *Thomson Reuters Web of Science*^{TM} indexation. However, the influence or importance of scientific results to practice or policy has not been assessed as such.

5. Challenges and development needs

A small country such as Estonia definitely needs international cooperation. In addition, the individual scientists could be more active themselves to inform their institutions communication specialists about their recent activities or scientific findings. In order to facilitate science-practice relationships further there are several possibilities. For example, public sector administrators could have regular science-based (additional) training courses within the universities. The same could also be provided to private sector (forest owners' organizations consultants or forest managers). Joint and regular events (seminars, meetings) between scientists and practitioners could also be one way. A good example of this kind of cooperation is the regular State Forest Management Organization scientific conference where the funded projects give a state-of-the-art overview about their findings to the senior staff of the organization.

The way to promote more science-policy integration could be the larger involvement of scientists to the work of different ministerial councils. For example, currently there are only two persons as members of the State Forest Council. From whom one is an ecologist (environmental biology) and the other a vice-rector. In addition, in the preparation process of the new Rural Development Plan (RDP) until 2020, agricultural scientists were involved, but forest scientists were not included to the process despite there are numerous forestry-related measures in the RDP.

A slight imbalance might be also present in the Research Council of the State Forest Management Centre. There are scientists from the fields of environmental biology, forest biology, silviculture, landscape planning (nature protection), and ecophysiology and landscape ecology. However, there aren´t any members whose focus would be forest industry, forest policy and economics or forest management planning. Despite the highlight that the selection of applied research projects concentrates on a versatile and sustainable forestry (Research at RMK 2017), there aren´t virtually any funded projects that would concentrate on economic or social aspects of forestry.

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SNS-EFINORD network meeting and international workshop
Tools for improving science-practice interaction in forestry
Warsaw, Poland, May 11, 2017

Research and practice interaction in Finland

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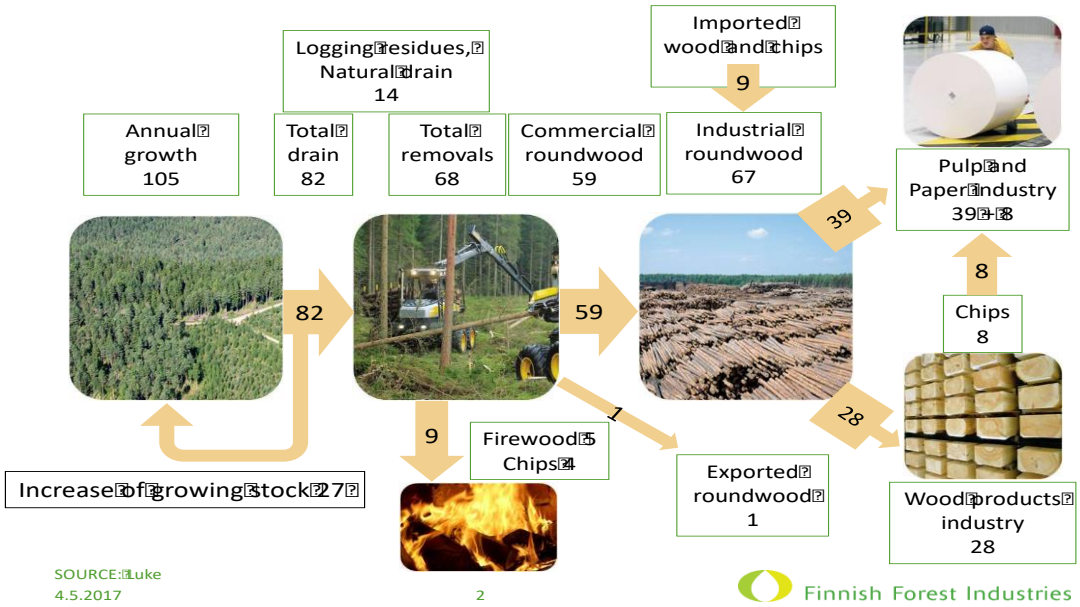
1. Finnish forests and forestry in brief

Finland is Europe's most heavily forested country, with over 3/4 of the land area under forest cover, representing 23 million hectares. Furthermore, an additional 3 million hectares is sparsely wooded areas, open mires and rocky forest lands.

Private individuals and families own 60 percent of forests in Finland. There are some 630 000 individual family forest owners in Finland, including those who own forest jointly and forest holdings larger than two hectares. Nearly 14 percent of Finns are forest owners. Shares of state and industrial ownerships are 25 and 8 %, respectively.

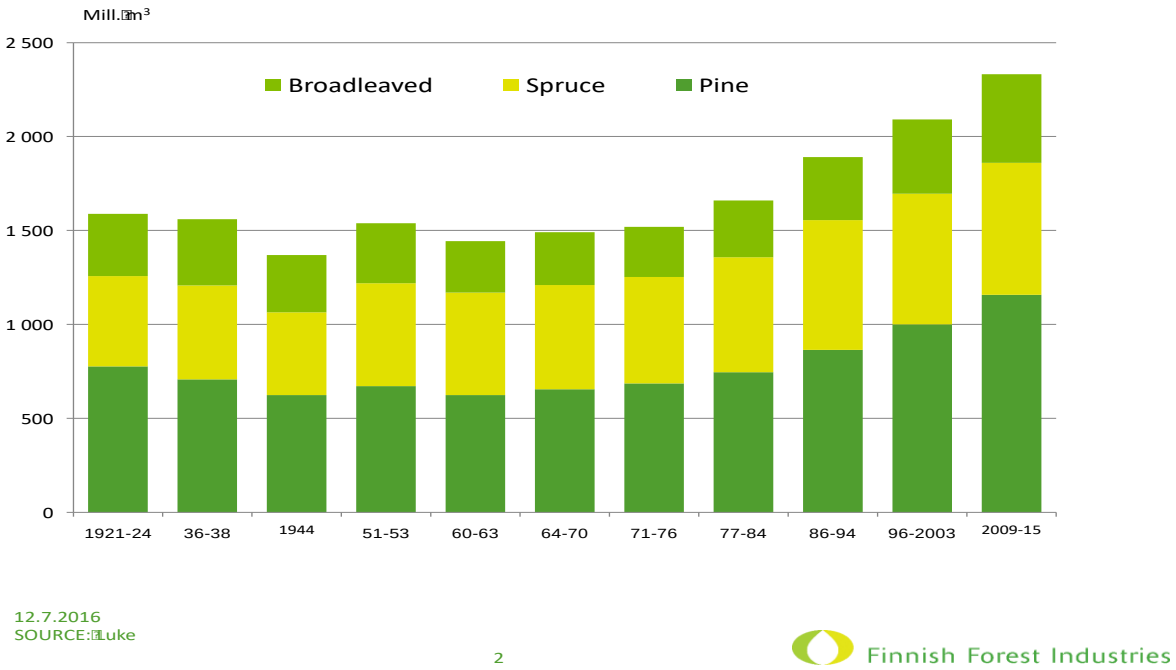
Todays's annual growth has reached more than 100 mill m3/a and it has typically been 25-30 mill m3 higher than the total drain of the forests (see Fig.1).As the growth has exceeded the harvest for more than 50 years, the growing stock has increased to the present level of 2,5 billion m3 (2014-2016 inventory period) (Fig.2.).

Fig. 1. Wood flows in Finland in 2016 (Million m3/a)



The forest sector is one of key supporters of Finland's economy. One fifth of Finland's export revenue comes from forest industries. In 2011 the forest industry employed directly some 70,000 people in Finland, which was 2.8 percent of all employees. More than 60 percent of the value added generated by the forest industries came from pulp and paper manufacturig and the rest from wood products sector in 2011 (See Fig.1.)

Fig. 2. Development of Forest resources in Finland



2. Science policy interaction in policy documents

As stated in the Government Report on Forest Policy 2050 (2014), the overarching document for Finnish forest strategies and programmes is the Finnish bioeconomy strategy (2014). The strategy expresses the relationship of research and practice in enhancing bioeconomy as follows:

- Bioeconomy should be prioritised through cooperation between public finance providers for research and innovation, and allocating public research and innovation funding to the bioeconomy
- Harnessing the competence of government sectoral research institutes and testing environments to the planning and implementation of pilot and demonstration projects.

Competitive bioeconomy requires the creation of centres of expertise of an international standard and reform of the priorities and operating models of research. New knowledge and expertise are continuously being created in the world. Finland must secure of its ability to utilise and apply this knowledge fast and efficiently in order to create bioeconomy solutions.

Measures suggested:

- Making an effort to incorporate the bioeconomy theme to the process where decisions are made on the themes and priorities of the Strategic Research Council to be set up in connection with the Academy of Finland.

- Intensifying research cooperation that crosses sectoral boundaries and accelerating the imple,emtation of research results by means of a reformed strategic research concept.
- Improving our ability to utilize international research in Finland by influencing the contents of the EU Framework Programme for Research and Innovation, by encouraging Finnish actors to take part in international research networks and by promoting the international mobility of scientists and students.

The National Forest Strategy of Finland (2015) allocates the task of identifying the research needs of the bioeconomy strategy to the ”Research strategy of the forest sector ” (Metsäalan … 2015). Special attention in forest research should be addressed to the productivity of forest management and silvicultural activities and to the development of forest related services and entrepreneurship.

This research strategy of the forest sector addresses the improvement of impact of research with following statements:

- There is a gap between researchers and users of research leading to imperfect utilisation of research results -> need to intensify collaboration
- Research should better address commercial and industrial processes and their development needs
- Research communication needs to be developed into a strength (in today’s world every morning reveals a new truth in social media)
- Researchers should have multiple skills in foresight to guarantee that information would be available at the right time and at the right places; as in policy-making information needs may appear fast.
- Networks should consist of universities, research institutes, business enterprises and consultants. Roles should be clear in order to utilise know-how of others efficiently.

3. Research capacities in relevant fields

In the following table, research capacities of main forest research organisations is described (as full academic person years in 2014).

Table 1. Research capacities in 4 main forest research organisations in Finland by fields of science

Field of science	University of Helsinki	University of Eastern Finland	Luke*	Metsäteho	Total
Ecology and silviculture	111	38	192		**341**
Forest technology	7	5	23	10	**45**
Economics, statistics, society and policy	37	14	114	2	**167**
Researchers, total	**155**	**57**	**329**	**12**	**553**

* Luke - Natural Resources Institute Finland

Other relevant research organisations publishing forest related research results.

- Finnish Environment Institute (SYKE)
- PTT Pellervo Economic Research
- The Finnish Meteorological Institute (FMI)

- TTS institute
- Technical Research Centre of Finland VTT
- Other universities incl. universities of applied sciences (Oulu, Jyväskylä. Lappeenranta etc.)

4. How the interaction is arranged

4.1 Background

The two-way interaction between research and practical forestry is depicted in Fig. 1. Research results are channelled through publications and media, but also the intermediate organisations and experts have an important role, especially in synthetizing the scattered results to practical guidelines to be used in forestry by forest owners, contractors and professionals.

When it comes to feedback from practice to science, personal contacts between researchers and practical foresters play an important role. Additionally, participation of practitioners in governance structures of research institutions or steering committees of research projects, is a common practice in many organisations. The industrial organisations and larger companies have also specialized staff members to link with and follow up the development in research.

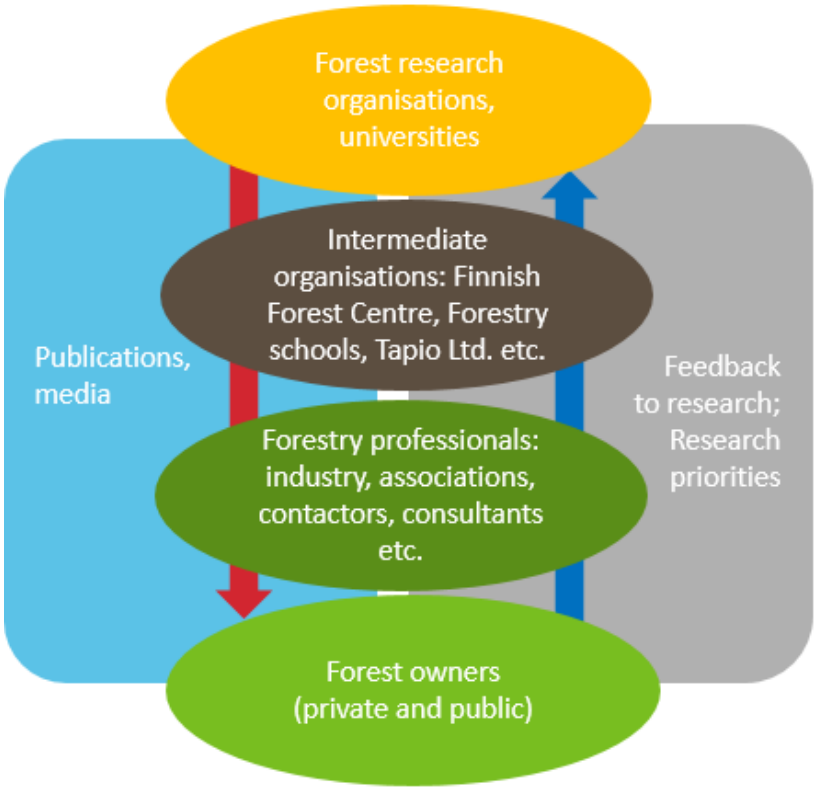


Fig. 1. Interaction between forest science and practice.

4.2 Universities and research organisations

Luke - Natural Resources Institute Finland. Luke's researchers and experts provide new solutions towards the sustainable development of the Finnish bioeconomy and the promotion of new biobased businesses. Luke's strengths are the following in terms research implementation and results:

• Comprehensive multidisciplinary know-how of bioeconomy industries and production chains - from biology to end product (circular economy, forestry, agriculture, water and fisheries)
• High-quality experimental research environments and extensive data resources
• Close partnerships and interaction networks for efficient use
• Anticipating support needs for decision-making - continuous development of knowledge
• Multiple locations - present and near regionally in Finland
• Utilizing social media in real-time communication

The results of forest research are carried out into practice through the following channels:

• Expert statements for lawmaking and the sustainable use of natural resources policy
• Participation of experts from different fields in the working groups of various organisations
• Seminars, workshops and training opportunities for companies and practical organisations
• Publications and instructions in collaboration with partners

However, all results of forest research could be utilized, do not reach forest owners at the practical level e.g. in terms of forest regeneration, management and biodiversity. In order to improve the interaction between research and practice more advanced models for building new partnerships and understanding should be developed:

- Public - Private - Partnerships projects in which forest owners should be represented
- Real and practical exchange of views and understanding for the common future
- Courageous launches for pilot projects
- Making use of communication and social media in everyday life

Universities carry out cooperation in the field of sectoral research institutes, businesses and other partners with continuous dialogue: joint research, third party participation in project steering groups, evaluation of the effectiveness of research projects, seminars and tours on social network. Universities of Helsinki and Eastern Finland offer academic degrees in forestry.

One of the main channels in contributing to the practical forestry is education. University staff will bring research expertise to working groups, development projects, governments, etc., the work in which they are participating.

Joensuu, at the University of Eastern Finland forest bio-economy operators have set an open innovation expert community GreenHUB, the aim of which is to enhance the effectiveness of RDI bioeconomy innovation ecosystems nationwide.

Metsäteho Oy is a limited company owned by the leading forest industry organisations and companies of Finland and is specialised on research and development (R&D) work and projects. It supports the development of its shareholders' wood procurement and wood production operations and improves the operating preconditions for wood supply.

The primary areas of activity include R&D projects, consultancy services, seminars and other communication activities. Research and development work is based on active networking as well as skills and knowledge of Metsäteho employees.

Technical Research Centre of Finland (VTT) creates technology for business – for the benefit of society. VTT's multidisciplinary experts work together to help the customers and partners create new products, production processes, methods, and services. VTT also strives to broaden dialogue with all stakeholders (industry, public sector, academy).

Finnish Environment Institute (SYKE) researchers analyse and predict changes in the environment, and they explore various avenues to find solutions our society can apply to

environmental problems. Inter-organizational and interdisciplinary research and competence provide means of addressing the most complex and challenging issues.

SYKE's specialists offer professional support to administrative bodies, alongside a wide range of services to businesses, other organizations, and citizens. SYKE provides specialist input into the preparation of environmental policies at all levels: in negotiations on international conventions, at European Union level, in Finland's government administration, and in regional and municipal organizations.

4.3 Intermediate organisations

Tapio Ltd.

Tapio has had a role as intermediate organization since beginning of the 20th century. The development of *The Best Practice Guidelines for Sustainable Forest Management* in Finland has been carried out by Tapio for several decades. The primary target of these Guidelines is to support management decisions among the small private forest owners – who own 60% of the Finnish forest land and generate some 82% of the annual roundwood removals. The Guidelines are continuously updated in order to reflect the most recent scientific knowledge and societal values among the key stakeholders as well as the main targets set by the Finnish national forest policy. The development work related to the Guidelines is financed by the Ministry of Agriculture and Forestry.

Even if the Finnish forest legislation allows a wide range of regimes to be applied to different forest management goals, the challenge to a forest owner is the plethora of options available. This is where the Guidelines come to help decision making. The Guidelines also serve the needs of different forestry professionals and entrepreneurs by providing a tool and support for forest management planning and related extension services and they are often referred to in various agreements between the actors in forest sector.

The Guidelines are developed in a multi-stakeholder process where the actors represent forest, environment and energy sectors and the issues discussed are selected based on their relevance and the availability of new research data. The work is overseen by a high-level management group and steered by a group representing the different interests broadly – some 30 different organizations, e.g. forest owners, industry, entrepreneurs, environmental NGOs, research and the government, are all involved in the process. Much of the work is done in expert panels where the role of the participating specialists is critical as they provide as inputs the latest scientific research information and the most up to date practical applications from the field. The outcome of the process is a unique synthesis of research results, practical knowledge and stakeholder values.

The Guidelines aim to demonstrate the ways and means how to manage and use forests in a sustainable way – taking into account all aspects of sustainability, economic, ecological and social – the latter including also cultural sustainability. Economic impacts, biodiversity impacts as well as impacts on landscape level are all described in the Guidelines. They are in general more extensive and include more detailed information than the certification standards PEFC and FSC. However, the Guidelines and forest certification are not in conflict but rather support each other.

The most recent update of the main Guidelines document was published in 2014. The more detailed guidelines for Peatland Management, Maintenance of Forest Roads, Profitable Timber Production, Energy Wood Harvesting and Nature Management in Commercial Forests were published in 2015–16. In addition to the printed format, the publications are also available in the internet and for mobile applications: http://www.metsänhoitosuositukset.fi/suositukset/.

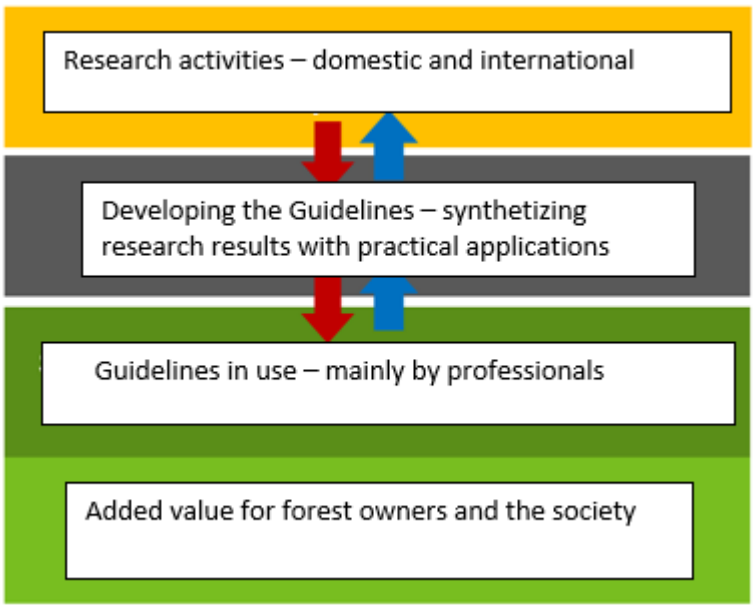


Fig. 2. Developing the Best Practice Guidelines for Sustainable Forest Management in Finland, organized by Tapio Ltd.

Finnish Forest Centre

The Finnish Forest Centre is a state-funded organisation covering the whole country. It promotes forestry and related livelihoods, advises landowners on how to care for and benefit from their forests and the ecosystems therein. It cooperates with e.g. The Natural Resources Institute Finland and Tapio.

The Forest Centre collects and shares data related to Finland's forests and enforces forestry legislation. The Metsään.fi-eServices of the Forest Centre offer the latest information directly to forest owners regarding their own properties.

Forestry schools

There are 26 vocational schools and training institutes in Finland, which provide training for forest workers and/or forest machine drivers. Several of these institutes educate forest owners and offer wide-ranging further professional training, too. Tapios *Best Practise Guidelines for Sustainable Forest Management* form a core element within the educational material.

Finnish Society of Forest Science

The Finnish Society of Forest Science was established in 1909 to promote research in forest and wood science in Finland. The Society is a network of researchers that strives to stimulate scientific discussion and cooperation within the forest research community, to enhance communication between researchers and practical foresters, and to promote public interest in forest research.

The Society organizes seminars, workshops and excursions. Annually, the Society organizes the Forest Science Day in Finland, in which currently interesting topics in forest research are presented and discussed. The interaction between science and practice is especially taken care by five thematic ‘clubs’, including forest biology, silviculture, mensuration, economics and technology.

4.4 Forest Certification

Certification standards **PEFC** and **FSC** cover some 95 % and 10 %, respectively, of the Finnish forests. To meet certification requirements forest management must satisfy certain standards with regard to biodiversity, forest health and maintenance as well as recreational use. In addition, there are requirements for following the passage of raw materials and wood-based products throughout the whole supply chain. However, it is not clear how research results are used as a base for the criteria of certification.

PEFC membership is open to national forest certification systems as well as International Stakeholder Members. PEFC is represented in 46 countries through national organizations. PEFC National forest certification systems are developed in response to local demand, interest and commitment.

FSC members include also forestry-focused research organizations. FSC participates actively in IUFRO activities, offering interdisciplinary research opportunities about effects and impacts of FSC certification at the forest, market and governance level.

5. How the impacts of scientific results are being assessed in Finland

The impacts of scientific results of forest research are not assessed systematically in Finland. However, *the Academy of Finland*'s reviews of the state of scientific research in Finland support Finnish universities and research institutes in their efforts to further develop their operations. The reviews also serve to strengthen the knowledge base for policy-making.

The Academy of Finland has produced reviews of the state of scientific research in Finland regularly since late 1990s, at two-year intervals since 2012. In addition, the Academy prepares complementary analyses between the publication years. Such a review process requires active collaboration with stakeholders both when preparing the reviews and when making use of their results.

The 2016 review of the state of scientific research in Finland analyses research personnel and funding, publishing, scientific impact and co-publications. The bibliometric analyses compare Finland with twelve research-intensive countries. The review includes a separate section on the impact of research beyond academia, analysed using both qualitative and quantitative methods.

The Finnish Society of Forest Science has actively promoted the discussion about the assessment of the impacts of scientific results in forestry. The topic of the Forest Science Day in 2016 was "Research into products and for decisions".

6. Needs and plans for development

The process of developing the *Best Practise Guidelines for Sustainable Forest Management* – including all fields of forest management – is time consuming and resource intensive as it requires involvement from a large number of participating organizations and persons. Another challenge is that it is not always clear for the user of the Guidelines how the findings are derived – and how strong is the scientific evidence behind the recommendations presented in the Guidelines.

There are initiatives ongoing in Finland to address these challenges. The aim is to test how the principles of "evidence-based decision making" used in other fields – for instance in medical care – could be implemented in forestry. The concept of "Evidence-based Forestry" (Petrokofsky et. al. 2011) and other alternatives applied internationally need to be carefully studied and discussed among key stakeholders.

Furthermore, demonstrating impacts of alternative options need to be developed to function also in different field contitions.

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SNS-EFINORD network meeting and international workshop
Tools for improving science-practice interaction in forestry
Warsaw, Poland, May 11, 2017

Country report - France

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French forests include those of metropolitan France on the one hand and those of the overseas territories on the other. Metropolitan France belongs to four biogeographical regions (Atlantic, Alpine, Continental and Mediterranean). This diversity provides a richness of natural landscapes, tree species, forest ecosystems, silvicultural systems, goods and services, and their value chains.

With 17 to 18 million hectares, the wooded lands of metropolitan France are amongst the largest in Europe. Forests themselves cover more than 16 million hectares, about 30% of the land; 95% of them are available for wood supply. They have been used intensively until the beginning of the XIXth century but since this transition period, their area has almost doubled. This extension is largely due to natural colonisation but also to afforestation programmes: With reforestation against forest degradation, about 13% of forest area has been planted (over the period 2008-2012).

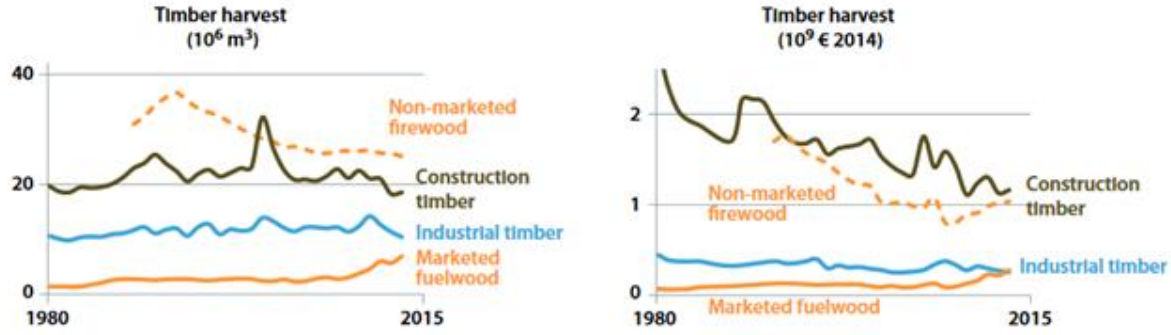
French metropolitan forests are diverse, not only biogeographically but also institutionally. Over one fourth of these belong to about seventeen thousand public institutions (state-owned forests, community forests...). The other three quarters are private, mainly non industrial holdings distributed among 3.3 million owners; two thirds of these private owners are individual persons or households and more than fifty percent of them are retired. In this context, public policies play an important role in stimulating sustainable forest management through regulations, incentives and technical assistance.

1. Short description of the role of forestry in the national economy

(extracted from Peyron, 2016 in: Maaf, IGN, 2016)

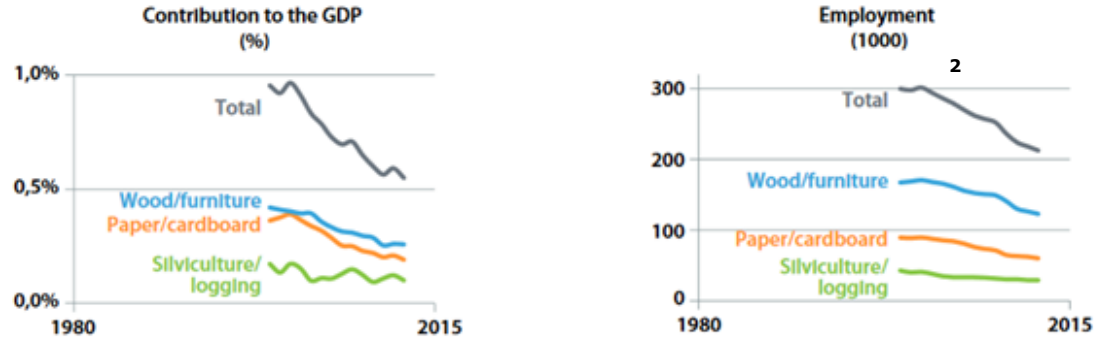
According to the summary of trends included in the 2015 edition of indicators for the sustainable management of French metropolitan forests (Peyron, 2016 in: Maaf, IGN, 2016), raw timber harvesting remained globally constant since 1980, with however an upturn at the end of the 1980s and the effects of the 1999 and 2009 storms. It varies according to the species, rising for conifers (+0.6% per year) and dropping for broadleaved species (1.3 % per year). Harvesting of industrial timber and marketed fuelwood increased regularly until 2007 (+0.5% per year and +2.7% per year, respectively), before becoming variable due to the 2009 storm for the industrial timber and to an increased demand of renewable energy (around +15% of fuelwood per year since 2007).

Figure 1 (source: Peyron, 2016 in: Maaf, IGN, 2016)



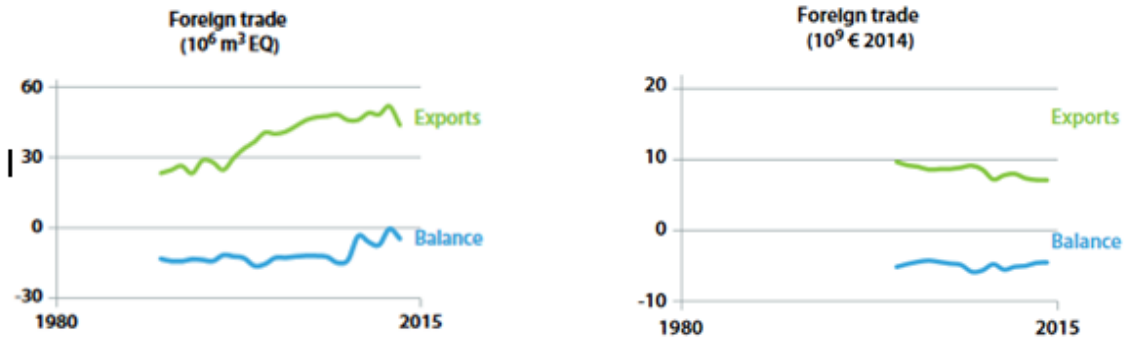
Again according to the summary of trends, the added value of the French forest sector has been decreasing in recent years (Peyron, 2016 in: Maaf, IGN, 2016). Furthermore, the primary (natural resources) and secondary (industry) sectors have been losing ground compared to the services sector. In 2012, the Forest-Wood sector contributed only to 0.55% of the gross domestic product (GDP) against 0.95% in 1999. Total direct employment of the forest-timber sector declined by nearly 30% in the same period (i.e. an average reduction of 3% per year for the various economic sectors), with a slightly lower reduction for the woodworking/furniture branch. **The Forest-Wood sector represents thus around 0.83% of the active population[6] and generates 0.55% of the gross domestic product (Peyron, 2016 in: Maaf, IGN, 2016).**

Figure 2 (source: Peyron, 2016 in: Maaf, IGN, 2016)



Finally, **the foreign trade deficit of the Forest-Wood sector has remained globally stable over the last fifteen years**, despite fluctuations dependent on the general economic and the forestry contexts (mainly climate accidents). **This deficit fluctuated between 4 and 6 billion Euros 2014**. Presently, this deficit is firstly explained by furniture (45% in 2014 against 27% in 2000) and therefore related to high added-value products. It is still significant but has declined radically in the paper sector (23% in 2014 against 56% in 2000). It is growing in the construction and building sectors (14% in 2014 against 3% in 2000) and remains stable in the sawing industry (around 12 or 13%) (Peyron, 2016 in: Maaf, IGN, 2016).

Figure 3 (source: Peyron, 2016)



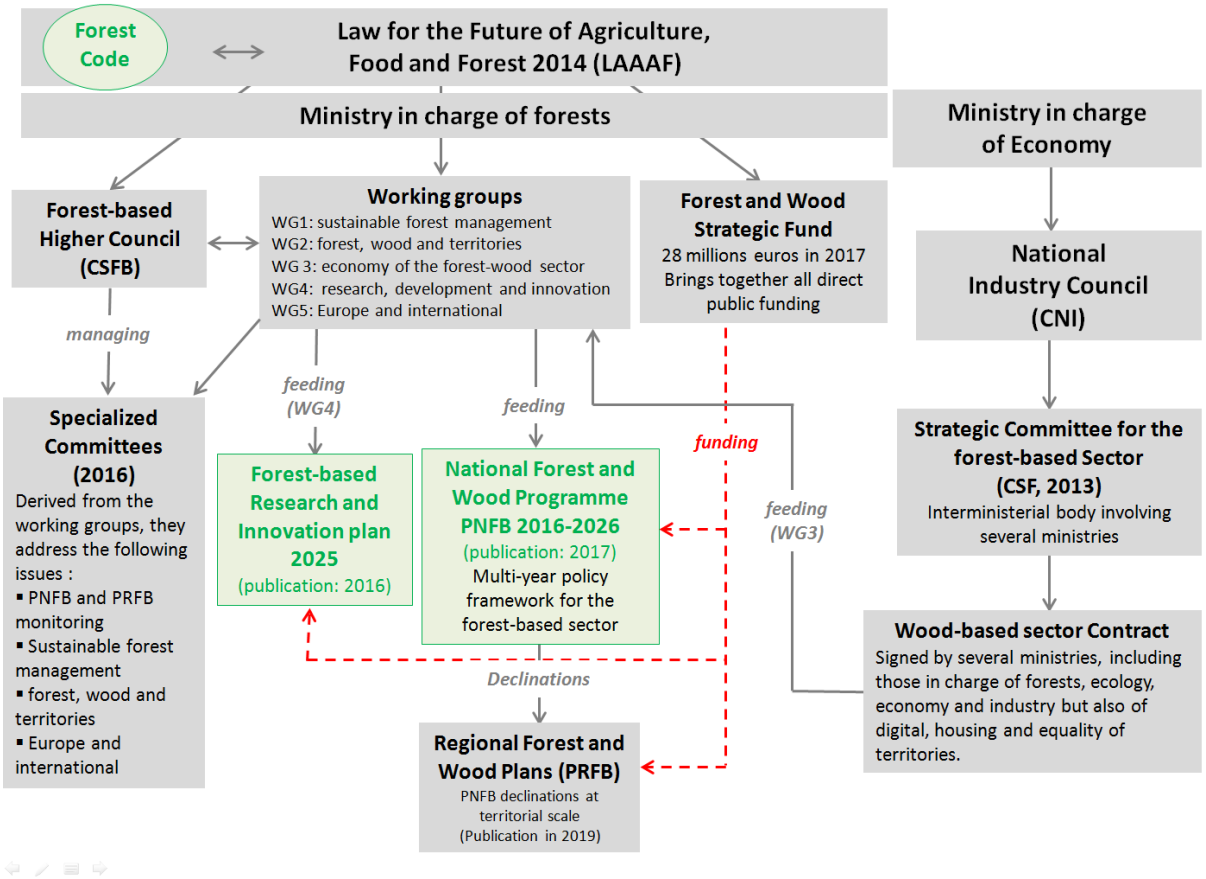
[6] without accounting for forest owners managing their own forest

[7] total direct and indirect employment in the forest-based sector currently represents more than 400 000 jobs

2. Science-practice interaction in policy documents

At the national scale, the forest-based sector is steered by several public policy processes. Before going through three main policy documents, namely the French forest code, the French National Forest and Wood Programme and the French forest-based Research and Innovation plan, here is a simplified diagram showing their integration into the National policy landscape.

Figure 4: simplified governance of the French forest-based sector at the national level, 2017



This figure shows especially that forest industries and products were the subject of a strategic approach prior to the renovation of the former National forest programme (2006-2015), as a result of the recognition of the Wood-based industry as a strategic sector monitored by the National Council of Industry. This resulted in a Wood-based sector strategic contract published in 2013, with which the National forest and wood programme (20016-2026) drawn up in 2015 (and formalized in 2017 in an agreement).

a. Science-practice interactions in the French Forest Code (Article L152-1, 2014)

The French Forest Code is a collection of legislative and regulatory articles related to the forest management and operations activities and to the protection of forests and human societies depending on them. Nevertheless, one article located in the first book ("Common provisions to all woods and

forests") of the Code is specifically dedicated to Research. This article provides a framework for the organization of applied and fundamental research on forests and timber (Chapter 2 of Title V). It specifies that :

- "Applied research on forests and Wood contributes to the sustainable management of forests, strengthens the competitiveness of the value chain and harvesting practices, adds value to forest products and meets the social expectations;

- Applied research is based on fundamental research. It is conducted in public or private organizations and institutions of higher education, and with the help of technical institutes. It is subject to periodic evaluations;

- The public research organizations carry out a mission of permanent expertise for public authorities, particularly in the field of sustainable management of metropolitan and overseas forests;

- The competent administrative authority of the State shall, after obtaining the opinion of the French forest-based higher Council (CSFB), define the methods of co-ordination of research programmes relating to forestry and forest-based products. It ensures the adaptation of research activities to the objectives of forest policies".

This article shows especially that research activities are seen as a way to add value to forests activities. Renamed and renovated by the Law for the Future of Agriculture, Food and Forest (LAAAF, 2014), the CSFB includes representatives of administrations, local authorities, forest owners, producer organizations, professional forest managers, forestry experts and other stakeholders of the forest-based sector.

b. Science-practice interactions in the National Forest and Wood Programme 2016-2026

The **National Forest and Wood Programme (PNFB)** is the national framework of forest policy which stems from the French national law on the future of agriculture, food and forest. It has been officially adopted in 2017. Hence, this programme sets guidelines for forest policy, in public and private forests, in metropolitan France and overseas territories, for a period of ten years (2016-2026). It is divided into the four following main objectives :

- **OBJECTIVE A: increase the harvesting of wood in France while at the same time ensuring forest stands renewal.** French forests are currently under harvested and have been constantly expanding over the last century. Improved management will help develop the economy of the forestry & wood sector and prepare for the future ;
- **OBJECTIVE B: take fully into account what the general public expects from forests.** Forests are both a place for recreation and a space for preservation of the biodiversity. It is also a source of territorial employment and economic wealth. Lastly, forests provide wood for material and energy production. This means that it is important to raise the awareness of the general public through communication on forestry issues, particularly by means of educational initiatives. The national programme will be adapted to fit each French region by being rolled out as a series of Regional Forest and Wood Programmes (PRFB). The PNFB provides for involvement of regional government bodies in local, sustainable projects;

- **OBJECTIVE C: address climate change.** Climate change and increasing risks are major concerns for French forests and their sustainable management, Forest fires are responsible for large damages in the Southern regions but are rather under control to the exception of large drought conditions. Destructive wind storms have hit France several times in the last

two decades. The levels of insect populations and diseases are supposed to increase in the future. **Woodland has a major role to play in absorbing carbon, thereby reducing greenhouse gases.** Climate change will also have a direct impact on forests and their biodiversity;

- **OBJECTIVE D: develop synergies between forestry and industry.** While France has one of the world's most attractive national hardwood forests (oak, beech, poplar, *etc*.) and ranks as the second-biggest producer of sawn hardwood in Europe, the Forest-Wood sector contributed only to 0.55% to the gross domestic product (GDP) and the balance of trade remain negative. Matching actual market needs with products coming from French forests is therefore a major issue.

To define these strategic objectives, actors of the forest-wood sector have been consulted through the implementation of Working Groups (WG) on "sustainable forest management" (WG1), "forest-wood and territories" (WG2), "economy of the forest-wood sector"(WG3), "research, development and innovation" (WG4) and "Europe and international" (WG5). Three transversal action types can be distinguished here to highlight the expected contribution of the research and development community to the PNFB objectives (see more information in table in appendix 1):

- **Developing observation and monitoring.** Research and development initiatives in this area are particularly expected to address climate change and biodiversity related issues;

- **Developing knowledge and providing tools to support management choices and public policies.** Many research actions are pointed out here to support stakeholders in the forest based sector. They are expected to contribute to almost all PNFB objectives, like for instance: developing silvicultural models integrating various types of scenarios, creating a research and development coordination to select and preserve genetic resources, enhancing hardwood material properties and associated transformation processes, integrating research results into forestry professional education, improving the appropriation of biodiversity-related knowledge by forest managers et policy makers,...

- **Other actions to promote interactions between scientists and other Forest-Wood stakeholders.** This action type focus on initiatives specifically oriented to strengthen the links between the researchers and the practitioners, at the national and European scale such as: building Research and Development partnerships across countries sharing common issues (hardwood promotion, genetic material selection and preservation,...), mapping research, development and innovation capacities to identify potential gaps and overlaps, sharing information between different type of actors,...

Furthermore, one of the 15 key actions of the PNFB concerns the development and implementation of an ambitious plan for research and innovation for the forest-based sector.

c. Science-practice interactions in the forest-based Research and Innovation plan 2025

The French forest-based Research and Innovation plan 2025 was developed in close connection with the PNFB and the CSFB, in order to reinforce the Research-Development-Innovation (RDI) continuum. It is the result of individual and collective consultations conducted among a large panel of forest-Wood actors. Through 13 projects and 29 associated actions, the RDI plan addresses three key and complementary priorities:

- **to improve performance in all parts of the sector through cross-cutting approaches:** this priority is expected to contribute in particular to the objectives B (meet public expectations) and D (develop synergies between forestry and industry) of the PNFB

through system approaches. Many initiatives contained in this part of the plan could contribute to the three PNFB transversal action types (see above) and therefore to the reinforcement of interactions between science and practice such as: the creation of networks and resources in the field of social and economic sciences, the establishment of a forest sector employment and training observatory, the development of living labs (i.e. innovative networks based on open innovation philosophy), of platforms dedicated to data and knowledge sharing,...

- **to develop uses for wood in a future bioeconomic context:** research projects and actions are mainly expected here to contribute to market development wood products, stimulating industrial renewal and encouraging sustainable uses for wood. This second priority includes a list of innovations coming both from the National Forest-Wood Programme (PNFB) and the Strategic Committee for the Sector (National Council for Industry). The interaction between Science and practice is mainly addressed here through the modernization of tools and processes for the industrial actors such as: developing demonstrators, enhancing large size roundwood processing, open innovation (fablab, living lab)...
- **to adapt forests and prepare forest resources for the future:** this is a core priority for the objective C of the PNFB (Adapt to climate change) but also for the other objectives of the plan in so far as they requires all the initiation of major changes in forests. National forest R&D network and long term research programs have already been initiated to advance knowledge and provide the scientific basis for developing forest adaptation measures towards climate change and other risks. This part concentrates many expectations related in particular to monitoring activities, remote sensing technologies, precision forestry, adapted Forest Reproductive Material,...

This plan also includes an analysis of RDI mechanisms and funding instruments in the sector, supplemented by recommendations. Most of them requires or relies on the enhancement of interactions between science and practice (see section 5 below) and on an increased level of funding for the RDI continuum.

3. Research and Innovation capacities in relevant fields

(mainly based or extracted from Carnus J-.M. and Richter A., 2015)

Forest and forestry are characterized in France by a great diversity of tree species and ecological conditions (from boreal to tropical), ownership status (public and private), forest type and uses (industrial, social, ...), management regimes (from short rotation coppice to protected areas), regulation and public policies and socio-economic actors.

Forest research approaches are therefore multiple amongst French research organizations and universities involved in scientific fields related to forests and forestry. Within the framework of the National Forest Program, the working group on “Research, Development, Innovation” produced a report in 2015 giving among other things a picture of the French Research-Development-Innovation capacities for the For est and Wood sector. In this report, French research is divided into three categories:

- **Category 1: fundamental or academic research**, mainly based on unresolved scientific questions put forward by the scientific community itself;

- **Category 2: finalized research**, rather driven by questions designed to meet the needs of a business sector or the society ;

- **Category 3: applied research (technological, industrial or socio-economic)** aimed at developing a product that will be sold on the market or put at the service of society.

Research activities of an institution rarely correspond to a single category. Thus, this classification aims to describe the French diversified landscape of research and development in this field.

Table 2: Distribution of main Research and Development organizations by type of research

Type of organization	Main Research and Development organizations			
Fundamental or academic research	CNRS IRD Other Universities	INRA AgroParisTech		
Finalized research	≈ 50% of scientific publications	≈ 30% of scientific publications	IRSTEA MNHN CIRAD	≈ 3% of scientific publications
Applied (technological or industrial) research			≈ 17% of scientific publications	IGN ONF- R&D CNPF - IDF FCBA

There are no official data to assess the current total number of people working in the field of forest research but informal estimations have been made in 2015 by the working group "Research, Development, Innovation" to give an order of magnitude of the human resources involved in the public sector of forest research and development. The given estimates in the following table mainly come from extrapolations based on publications and expert statements. Therefore, these results should be considered with caution.

Table 3: research capacities estimates of research capacity in major forestry research organizations (in France and by fields of Research and development, as full time person per year in 2015)

	Universities and other higher education establishment (AgroParistech, MNHN,...)	INRA	CNRS	CIRAD	IRSTEA	FCBA	IRD	CNPF - IDF	ONF	IGN	Other	∑
*Total number of human resources involved in forest research**	940	340	160	120	100	90	50	50	30	10	110	2 000
Including Ecology and silviculture	620	250	120	60	80	55	45	48	29	10	80	1 400 (70%)
*Including wood sciences and technology**	300	75	35	50	10	30	1	0	0	0	30	530 (26%)
*Including Economy, statistics, society and policy **	20	15	5	7	10	5	5	2	1	0	0	70 (4%)

****Researchers, permanent engineers, PhD student, postdocs, contractual personnel***

a. Current state of global Forest research

Even in the absence of precise knowledge about the number of people working in the field of forest research, the members of the working group used a bibliometric approach (quantitative analysis of publications) to apprehend the place of France at international and European level and its characteristics:

With 4,8 % of the world publications, the French forest research ("forest" and "wood" topics combined), rose to the 8th position, behind the United States, Canada, Germany, Brazil, Japan, The United Kingdom and Australia, and before the European Nordic countries, Spain and Italy.

In all European countries, most research activities focus on the environmental, ecological and biological forest ecosystem aspects as well as on forest trees (covering, in particular, major issues including the effects of climate change). Indeed, research activities related to silviculture and forest management occur less frequently. Thus, France ranges between countries strongly involved in the field of ecological sciences like the United Kingdom and countries most involved in research on forest management and operations like Germany, Sweden and Finland.

Machinery and logging are among the less R&D developed topics in France. More generally, research related to social and economic sciences remain poorly addressed, even if efforts have been made in the recent years.

In France, INRA ranks first with 26 % of national publications, followed by CNRS (14%), CIRAD (9 %), IRD (5 %), MNHN (5 %), AgroParisTech (3,7%), Irstea (3,4%) and CEA (2,2%). The relative modest scores of institutions generally associated with the "forest" subject (INRA in particular) are due to the high scientific production of university laboratories: 24 universities contribute together to 47 % of publications, often as co-publications with the research organizations mentioned above. The scattering of these laboratories, added to the fact that it is mostly academic research, explains their relatively low visibility in the forest world. One half of university production is concentrated in four universities: Lorraine (7.5% of the national total), Aix-Marseille and Montpellier (4-5% each) and Toulouse 3%.

The only R&D and technological research organizations that reach 1% of publications are the ONF and FCBA. These modest scores are due to the lower priority given by these organizations in terms of scientific publications, but also to the modest number of research staff involved.

b. Current state of research in wood sciences

In Europe and around the world, research related to the wood sciences represents only 6% of research related to materials, 8 times less than metals, 5 times less than polymers, and also less than ceramics or concrete. From this point of view, French public research on wood sciences ("wood" or "timber") is quite well positioned at the international level (better than other materials) and on the rise since many years, in particular thanks to state incentives initiated since the 1980s and involving in particular the universities and the CNRS (totally absent before 1975). Furthermore, since 2012, the GDR Bois, an extensive research group specifically dedicated to the wood sciences improved significantly the visibility and effectiveness of French research in this field, at national and international level. However, a strong disconnection remains between academic research and the business world in this field. The furniture industry seems in particular to be neglected compared to the packaging sector (carton for drinking) which is more visible in scientific publications. The construction sector (and related fields of study) mobilize at least half of total research effort in this field.

c. Current state of technological and industrial research

Also on the basis of the working group analysis, there are a large number of stakeholders in the field of industrial and technological research for the wood sector (Industrial Technological Centers, Technological Resource Centers, *etc.*), including the private research carried out by large companies. The visibility on the work - even collective ones - remains limited due to the confidentiality most often requested by industrial players.

Table 4: main players involved in the wood industrial and technological research

Organization	Status	Sector of activity	Total workforce	Total workforce in the forest-based sector
FCBA	Technological institute for industry (CTI)	Forest, cellulose, construction sector and furniture industry	340	340
The Pulp and Paper Research & Technical Centre (CTP)	Technological institute for industry (CTI)	Pulp, Paper, Packaging industry	130	130
The Scientific and Technical Centre for Construction (CSTB)	State-owned industrial and commercial establishment (in French, EPIC)	Construction sector	900	5
The technological institute NOBATEK	technological resources center	Construction sector	50	5
The Regional Center of innovation and technology transfer (CRITT) Bois Epinal	association	Construction sector	15	15
The Regional Center of innovation and technology transfer (CRITT) Bois Rodez	association	Construction sector	5	5

The number of patents registered in the forestry-timber sector can be considered as low. About 90 patents were registered in 2014, 60% of which are related to the construction sector. There are very few breakthrough innovations: the new products or processes rely indeed mainly on incremental innovations. An important part of the technological and industrial research is now oriented towards wood in construction and new uses of wood components (green chemistry). New developments and innovations are structured around the competitiveness industry clusters (mainly the XYLOFUTUR cluster, the only one dedicated to the forest-wood sector and Fibres-ENERGIEVIE).

4. How the interaction is arranged in the country

a. Interactions inside the main forest management bodies

In France, the RDI departments of the two main forest management organizations (ONF and CNPF) play of course an important role in the development of interactions between science and practitioners (forest managers) :

- In public forests (25 % of the French forested areas), the RDI department of the National Forests Office (ONF R&D) comprises about 30 people. Very keen to adapt forests to climate changes, they work on many projects based on observation, monitoring, research

and experimentation activities. These studies are carried out in partnership with many organizations especially those involved in research and development related activities (INRA, FCBA, IGN, …). Through the publication of a quarterly magazine (*Rendez-vous Technique*), the ONF disseminates research results to the forest manager community (to share knowledge, experiences and know-how but also new efficient methods and tools).

- Dedicated to the private forests (75 % of the French forested areas), the RDI department of the National Center for Forest Owners (CNPF IDF) comprises about 50 people. They develop in particular silvicultural models that are adapted to the technical, economic and human realities of the private forest owners. The IDF organizes and leads some working groups on specialized topics (irregular treatments, regular treatments of the main social broadleaved trees, etc.). It also acts as the umbrella organization for the Centers for forest technical studies (CETEF), which include 65 silvicultural associations developing technical and economic experiments, inviting foresters to share their silvicultural concerns, ...The IDF experts identify needs and draw up specifications for solutions, then analyse the forest research literature, study the documentation, develop some adaptations and innovations, set up experiments in close collaboration with their partners, …To disseminate results more broadly, they publish their own magazine (*Forêt entreprise*) as well as some technical or general guides and software applications. Finally, they also conduct training courses and sessions adapted to specific needs.

Among the publications playing a significant role regarding these interactions between different categories of actors, let's mention also the *Revue Forestière Française* (RFF), an AgroParisTech publication mainly dedicated to temperate forest (and its related subjects such as natural environments, wood, fauna and flora). This publication disseminates scientific and technical information aiming at building effective links between research and practice, administration and management, progress and dissemination of knowledge. Also at the interface of research and development, let's mention *Bois et forêts des Tropiques*, a CIRAD quarterly publication entirely dedicated to the forestry sciences and techniques in tropical regions and *L'IF,* the IGN quarterly newsletter which is fully dedicated to the sustainable management of French metropolitan forests.

b. Interface bodies and other initiatives

Beside these management organizations, specific bodies like **GIP ECOFOR** (a public interest group dedicated to forest ecosystems) provides in France overall R&D coordination at national level between the organisations involved in forest research and development and also a science-policy interface. Here are few examples of transversal initiatives led by the GIP ECOFOR and other organisms to strengthen the links between researchers and practitioners:

- **SEHS Network (led by GIP ECOFOR, since 2011)**: the Economic, Human and Social Sciences Network aims to create and maintain links between researchers and research teams that work on a timely or permanent basis on forest, wood industry and other forest uses. Its objectives are to develop collaborations, mainly between researchers, to stimulate research, in particular by encouraging the practice of multi-disciplinarity within the SHS disciplines (also with the life sciences) and to bring scientific developments closer to social expectations. To feed these objectives, scientific events are organized on transversal topics (Forest Values, Forest and Territories…) and a weekly newsletter is published;

- **GIS COOP (led by INRA, since 1994)**: INRA and six other forest management, development or research organizations (ONF, AgroParisTech, FCBA, IRSTEA, …) have decided to pool their resources and expertise under the Ministry of Forestry. They have created a Scientific Interest Group (GIS) "data cooperative on forest stand growth". One of the main objectives of the GIS Coop is to **collect data** among 800 plots and **make them**

accessible to research and technical operators through a common database; there are also specific GIS dedicated to the development of some forest tree species such as Maritime Pine (GIS Pin Maritime) or Poplar (GIS Peuplier).

- **GDR BOIS (created in 2012, by CNRS):** this research group dedicated to the wood sciences aims to increase the national visibility of research, to develop training and serve as a link to international networks involved in wood sciences. Financially supported by several institutions (CNRS, the Ministry of Culture and Communication, INRA, Labex and sponsors), it gathers about 600 people (including 450 permanent staff) coming from CNRS and other bodies such as INRA, CIRAD, Ministry of culture, universities, engineering schools, FCBA, *etc*.

- **RMT AFORCE (led by CNPF-IDF, since 2008)**: foresters and researchers have also joined their efforts to create AFORCE, a Mixed Technological Network (RMT) devoted to the adaptation of forests to climate change. AFORCE is a network bringing together the actors of research, development, management, education and training. Its objective is to **coordinate actions to adapt forests to climate change and provide managers with decision-making tools**;

- **Interface jobs (implemented by INRA)**: to promote the **transfer of research results,** INRA created an innovative tool based on the time limited (2-4 years) recruitment of engineers or academics coming from development bodies (such as CNPF, ONF, IGN,…) to work on specific research projects and return after that to their home organism. Even if this type of initiative seems to be a powerful way to improve connections with practitioners, a limited number of people benefit from it.

- **Collective expertise, foresight and panel studies:** many exchanges between scientists and policy makers are organised in France through collective scientific and technical expertise and panel studies. A formalized methodology makes it possible to formulate the questions that arise for decision makers in a well-defined field, and then to look for the elements of response existing in scientific publications or grey literature. The synthesis of these elements expresses not only the main lessons available, but also the gaps in knowledge that will have to be addressed in the future.

More operational, industrial and technological research and innovation are rather coordinated by technical centres such as FCBA or forest industry clusters. French research organisations are also very active nationally and internationally in coordinating or supporting forest-related networks interacting with practitioners (i.e. EFI Atlantic for planted forests), research infrastructures and collaborative projects.

c. Incentive instruments developed by the French State to increase the interactions between science and practice : a brief overview

Currently in France, the Forest-based sector is "eligible" to many multi-sectoral funding schemes. However, almost no funding flow is specifically dedicated to the Forest-based sector, even less for RDI, and most of the time, no sectorial accounting exists either, which makes it difficult to carry out follow-up exercises. Nevertheless, a Forest and Wood Strategic Fund has been created by law in 2014 to support investment and innovation in this specific sector. The total annual budget of this fund is 28 million Euros in 2017 of which 15 million Euros are dedicated to research and innovation

Among the transversal public incentives developed in France to increase the interactions between science and practice, the third wave of the French national programme called “Investments for the Future” (PIA 3) was launched beginning of 2017. Initiated in 2010, it aims to support research and innovative projects, essentially through grants and loans. All sectors are eligible, among which the

Forest-based sector. The grants are distributed through four different public operators which are managing the associated calls of project proposals : the French National Research Agency (ANR), the French Environment and Energy Management Agency (ADEME), the public investment bank Bpifrance and the Caisse des Dépôts and Consignations (CDC).

In this context, large-scale projects has already been selected and initiated in the Forest-based sector such as ADIVBOIS (around 6 million Euros of grant, 2015-2018), a short-term operation aiming to the construction of high-rise buildings or XYLOFOREST ("Forest-Wood-Fiber-Biomass of the Future"), an Innovation Platform aiming to provide the research laboratories with high-level equipment (around 10 million Euros of grant, 2011-2019).

Furthermore, under the third edition of the PIA, actions are developed at the landscape scale in close cooperation with the French regions. More broadly, regional authorities (mainly regions but also departments and municipalities) also support research and innovative projects, either alone or in complementarity with other bodies such as the Bpifrance (48 territorial delegations). Since 2009, this bank is also managing the Single Inter-Ministry Fund (FUI), which is essentially dedicated to "collaborative" R & D projects (involving, for example, large companies, SMEs and laboratories) supported by competitiveness clusters.

Innovation in the forest-based sector is also supported at national scale through other mechanisms such as the research tax credit (CIR) granted to enterprises that carry out RDI activities : the total amount of the CIR was estimated around 54 million Euros in 2015 (see the Research and Innovation plan 2025).

Table 5: summarizing public funding of Research, Development and Innovation in the Forest-wood sector in 2015, as defined in the Research and Innovation plan 2025 (D'Amecourt *et al.*, 2016)

Source of funding	M€ - Order of magnitude in 2015
Europe (H2020, Structural Funds and Cohesion Fund FEDER, FAEDER...)	5
State - sectoral (Ministries...)	10,3 (28 in 2017)
State - public establishments (INRA, IRSTEA...)	110
State - non sectoral (ADEME, ANR, BPI, PIA, FUI....) : direct payments	22
State - research tax credit (CIR)	54
Regions	4
Total	**206**

About the main public bodies involved in the closer connection of science and practice, the **French National Research Agency (ANR)** is a funding agency of public research created in 2005. The main activity of this agency is to fund scientific or technological research projects through competitive calls for proposals (AAP). In 2013, it was estimated that ANR accounted for about 8 to 10 % of the total public research budget, about 50 % when considering the total funding allocated through incentive calls for proposals.

Promoting technical innovation and transfer of technology, as well as public-private partnerships, is part of its mission. To support projects carried out in partnership with the socio-economic world and having a direct economic impact, the ANR has developed an instrument called "Collaborative Research Projects - Enterprises" (PRCE). In addition to this instrument, the agency also proposes specific instruments, which are the subject to dedicated calls for projects:

- The **LabCom instrument** allows the creation of joint laboratories between research organizations and small or mid-sized companies (continuously open call);

- The **Industrial Chairs instrument** stimulates the creation of academic chairs co-funded with companies (dedicated calls);

- ANR manages also the **Institut Carnot** label on behalf of the Ministry of Research, which aims to develop contractual research between public research structures and the socio-economic world. In order to guarantee the real leverage effect of this programme, an associate programme called "Valorization- Institut Carnot" is also supported and managed by ANR on behalf of the State, within the "investments for the future".

Moreover, ANR cooperates with the French competitiveness clusters in order to enhance the adequacy between the research outputs and the socio-economic needs. therefore, it would be useful, in a near future, to acquire a global vision of all forest-based projects funded by ANR through these different tools but and also through other agencies such as the **French Environment and Energy Management Agency** (ADEME) which also contributes to the development of interactions between science and practice, especially through the management of a fund dedicated to renewable heat and the launch of targeted calls for proposals.

d. Other interactions through informal processes

Finally, interactions between Forest-Wood scientists, forest managers and decision makers occur also through multiple other ways, like for instance:

- through the **consultations** related to policy processes, like the PNFB 2016-2026 and the Research and Innovation plan 2025;

- through **scientific or steering committees and scientific events** held within forest national research programs like those coordinated by the GIP ECOFOR on biodiversity (BGF for "Biodiversity, Forest management and Public policies") or climatic change (GICC for "Management and Impacts of Climate Change");

- through **working groups** supporting multiple national or regional initiatives, for instance within the development of observatories, which aim to promote and disseminate data available on transversal environmental issues[8], or the management of natural parks:

Despite all these initiatives, interactions between the researchers and practitioners are perceived as relatively weak, as shown by the SWOT analysis[9] conducted by the working group on "Research, Development, Innovation" (Carnus, 2015). In recent years, researchers benefiting of state subsidies are more and more often encouraged to associate Forest managers to their activities, from the beginning (co-construction of the objectives) and all along the project life. The decision-maker invites them also to formulate recommendations, but this remains a delicate exercise that most researchers have difficulties to achieve.

[8] for example, the national observatory on the effects of global warming (ONERC) formulates recommendations concerning adaptive measures to limit the impacts of climate change using indicators and the expertise of the IPCC in France ; The French National Biodiversity Observatory published every year a set of indicators related to forest ecosystems,…

[9] Strengths, Weaknesses Opportunities, Threats Analysis

5. How the impacts of scientific results are being assessed

In France, the methods currently available to assess the impacts of public research are not fully satisfying. Most of them are designed to evaluate specific projects or programmes. They seldom look into the impact of an institution. Generally, they assess economic impacts and fail to take into account other impacts.

Measuring the global socio-economic impacts of scientific results (i.e., beyond the impacts of scientific results on research) is a relatively new field of interests in France. However, it is gradually integrated into the strategy of research bodies like INRA and CIRAD. These organisations see it as an opportunity to increase or consolidate their competitiveness, as well as to meet national and European public policies.

These actions are especially supported by the French national research alliance for the environment (ALLENVI), which aims to program and coordinate the French environmental science strategy, or by the French Parliamentary Office for the Evaluation of Scientific and Technological Choices (OPESCT).

a. Assessing the socio-economic impacts of the agronomic public research at INRA: the ASPIRA project (2011-2014)

In 2014, INRA published a first report analysing the **political, health, territorial-social, environmental and economic impacts of agronomic public research**. This three-year study relied on the analysis of 30 standardized cases, including five fully and one partly focused on forest research:

Table 4: project cases related to forest ecosystems within the study of INRA on socio-economic impacts of public agronomic research

TITLE	DESCRIPTION
CAPSIS	Modeling platform of forest growth and dynamics
PIN MARITIME	Genetic improvement of maritime pine
FIRE PARADOX	An integrated European Project on forest fire management
AMENDEMENT FRT	Limestone modification against forest dieback
PROCESSIONAIRE	Protecting trees and humans against the pine processionary caterpillar
INFOSOL	French soil information system

Three complementary analytical tools were used to analyze the impacts of these cases:

- **A chronology**, to understand the processes generating impacts over time and to identify mobilized resources (most often, they accumulated over a long time period);
- **An impact pathway** describing the research work, the circulation of knowledge outside the academic sphere, its transformation and use by socio-economic actors;
- and finally, **an Impact vector** involving a descriptive table showing the different aspects of the impacts (based on documentation and interviews), and a radar diagram to visualize them based on qualitative or quantitative evaluations, depending on the information available. The magnitude of each aspect of the impact was expressed through an ordinal scale ranging from 1 (very low impacts) to 5 (very strong impacts). Only the strongest (rated above 4) were then analyzed thoroughly and eventually quantified.

As no robust methodology, nor generic metric could be identified in the literature to apprehend the impact of research on public policies (Cozzens and Snoek, 2010), INRA developed its own methodology[10]. Regarding the economic impacts, INRA adopted conversely a classical approach based on the evaluation of the economic surplus.

Among the 30 cases, strong impacts (scores of 4 and 5) were the most frequent in the economic dimension, followed by the environmental and political dimensions. The social-territorial and health impacts were less represented, which, according to INRA, probably reflects reality rather than a sampling bias. It is interesting to underline that these results were not exactly the same when focussing only on forest related projects. Indeed, economic impacts seemed to be weaker, when the environmental dimension was the most developed.

Table 5: detail of the assessment of the economic, environmental, health, political and social-territorial impacts of forest research projects led by INRA

	Economic impacts	Environmental impacts	health impacts	Political impacts	Territorial-Social impacts
CAPSIS	3	**4**	1	2	1
PIN MARITIME	3	3	1	1	3
FIRE PARADOX	1	1	1	2	1
AMENDEMENT FRT	2	**4**	2	1	1
PROCESSIONAIRE	1	3	**5**	1	1
INFOSOL	1	3	1	**4**	**4**

Here are three examples illustrating different types of impacts highlighted in the forestry projects:

- **About the environmental impact:** the **Capsis** forest modeling platform, which houses models, tools and knowledge, simulates and compares forest production scenarios. According to INRA, the National Forests Office has **incorporated the results of Capsis into forest management guides**. In addition, since 2009, Capsis has been used by the Quebec authorities to plan harvesting operations in public forests, thus limiting overexploitation;

- **About the health impact**: through the accumulation of knowledge on the life cycle of the **pine processionary caterpillar**, an allergenic and invasive species, this project led to the development of solutions based on biological control rather than pesticides. INRA specifies that **these new technologies were patented and licensed by two start-ups and implemented on more than 50 000 hectares of forest since 1992**. They contributed to the national effort to reduce pesticides. Between 2009 and 2012, the share of chemical treatments used to fight this pest decreased by 8%;

- **About the political and territorial impacts:** created in 2001 by a Scientific interest group dedicated to the soils (GIS Sol), the **INFOSOL** unit has developed at national scale a large soil information system comprising data related to their physical, chemical and biological properties. This system ensures the centralization and permanent capitalization of all soil data in France, and offers a centralized access to data (30,000 samples). **A great diversity of territorial public policies benefit from this data, especially those involved in local planning, groundwater management or agricultural zoning (Disadvantaged**

[10] based on the analysis of the mechanisms generating impacts and the relative weight of policies concerned

Agricultural Areas). Furthermore, 21% of requests came from research offices to support their activity;

More generally, INRA has drawn several conclusions, including the following ones :

- First of all, the case studies **reflect the multidimensional nature of the generated impacts**. Indeed, 79 % of the cases affect more than one dimension, each case affecting on average 2.2 dimensions. The outputs are also multiple: they can be academic (publications, conferences ...), technical (embedded in software, marketable products ...or intangible like processes, know-how, training, expertise,...), organizational (database, collections),...

- Second, the production of impacts is the result of **long-term investments in research and partnerships other than scientific ones** for the production of knowledge. If the research identified in the different case studies is long (14 years on average), they rely on even older skills and infrastructures;

- Then, in a large majority of cases, INRA has contributed to the production of fundamental or academic knowledge, the researchers of the institute being most often among the international scientific leaders in their field. **But the cases generating high-intensity impacts (scores of 4 and 5) also require more finalized research, producing knowledge easier to access for the socio-economic actors**[11] ;

- Finally, the analysis shows that the partners most likely to participate in the research phase are not necessarily the best in the other phases of the impact pathway. **As a result, granting exclusive rights in the upstream phases can limit the downstream diffusion potential**.

b. a replication of this methodology among other research organizations

Cirad, a French agricultural research and international cooperation organization working for the sustainable development of tropical and Mediterranean regions, has recently built an impact evaluation methodology toolbox named ImpresS, using a range of participatory tools. During 2015, ImpresS has been applied to 13 case studies, representing the diversity of its activities around the world. In the long run, ImpresS is intended to boost the "impact culture" of all Cirad researchers and teams, just like the approach developed by INRA.

6. Challenges and development needs

a. An increase in Science-Practice interactions in the forest-based sector through existing or innovative funding instruments

There are many tools to finance RDI within the forest-wood sector, but few are fully specific to this sector. Generally modest, these funds could be better rationalized and, for some, increased. As pointed out in the French forest-based Research and Innovation plan 2025, the overall public efforts in favour of Research, Development and Innovation represent quite a small share of the total value created by the forest-based sector: less than 1% of the total added value. The recommendations presented in the Plan highlight some challenges and development needs. Most of them rely on the improvement of interactions between science and practice:

[11] High impact were generally observed when INRA was involved in the downstream part of the project, i.e. in the demonstration and validation stages.

- **to entrust the competitiveness centres** ("Xylofutur", "Fibres Energie Vie", *etc.*) **with the task of assisting companies in obtaining European funding**;

- **to entrust a public actor** (e.g. GIP-ECOFOR) **or a main technological institute (e.g. FCBA) with an integrated view to carry out an in-depth study of RDI capacities and funding in the forest-based sector**;

- to **increase State subsidies** distributed through the public investment bank Bpifrance (around €4.4 million in 2015) **to support innovation in the forest-based sector**;

- **to endow the forest-based sector with a funding instrument to target development and innovation actions in upstream forestry**;

- **to increase research activities on timber construction components and materials** in Public Scientific and Technical Research Establishments (EPST) such as CNRS, INRA, IRSTEA and IRD, in higher education institutions and industrial technical centres;

- **to simplify and accelerate the certification process for products with a low carbon footprint** (including wood products) **to facilitate and foster innovation**;

- **to federate, structure and increase research in wood chemistry**;

- **to support and accelerate the development of methodologies to evaluate ecosystem services and study the implementation of regulatory and fiscal provisions that will ensure long-term payment for these services;**

- to develop a research action on innovative mechanisms likely to **attract new funding in the forest-based sector**, especially in upstream forestry (e.g. in the form of a University Chair);

- to **study the potential and feasibility of innovative funding instruments that could give new impetus to the wood market**, while contributing to price transparency and securing supplies for industry;

b. New ideas to stimulate Science-Practice interactions

One major barrier to fruitful exchanges between science and policy or practices is due to the large scope of decision making in comparison with the narrower scientific systems, even when the latter are connected in interdisciplinary approaches. Scientific developments are often oriented towards greater precision of models and specialization and more rarely or hardly toward integration and broadening the scope of approaches.

- A first idea would be to break down a practical question into elementary disciplinary components that scientists could deal with in order to provide partial answers before integrating them into a global response. However, this approach is interesting in theory but does not allow satisfactory treatment of possible interactions between components.

- Another idea is based on modeling as a common method of research. One can envisage to rely on two parallel approaches that feed one another progressively and tend to converge. On the one hand, it is a question of developing a simple model for the decision-makers' policy framework, based on a rudimentary but comprehensive description of the components of the system to be managed, developed in part with expert opinions. On the other hand, scientists rely on sophisticated models that they typically try to interconnect to

better cover decision makers' scope. Under these conditions, the simple model can benefit from the existence of sophisticated models to be improved. Conversely, it constitutes a draft of the result to be obtained. It shows the gaps left by the sophisticated models in the field to be covered. It also highlights where research and improvement efforts should be concentrated.

- Among all other options, foresight approaches (particularly at territorial level) and open innovation processes (living labs, public-private partnerships,...) could also be considered as possible ways to foster interactions between research and practice.

c. An increase in Science-Practice interactions through the development of a dedicated think-thank at European level

A new COST action would be useful to enlarge and follow up on science-policy-practice interactions in forestry. At this stage, several arguments could justify the implementation of this type of action :

- the challenge to adapt forest and forestry to a changing world where it gains an increasing weight (climate change, biodiversity, need for renewable resources, natural assets, recreational areas, healthy activities,...);

- the necessity to consider the right system (forests only, forests and wood uses, forests and tourism,...) for a fair and wise decision (in terms of research, this means more interdisciplinary research);

- the need for multicriteria (biophysical and socio-economic) evaluations (this means more transdisciplinary research);

- the difficulty to consider long term to analyse the situation;

- the opportunity to better mobilize research and to imagine new types of research strengthening science-policy-practice interface;

- the consequences to be drawn from the way science should be financed and evaluated;

- the consequences to be drawn from how decisions should be made and evaluated;

- the development of open innovation process should be taken into consideration.

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List of main acronyms

ADEME - French Environment and Energy Management Agency

AgroParisTech - Paris Institute of technology for life, food and environmental sciences

ANR - French National Research Agency

ALLENVI - French National Research Alliance for the Environment

ASPIRA - Evaluating impact of public agricultural research

BGF - National research programme on biodiversity, forest management and public policies

CETEF - Centers for forest technical studies

CNI - National Industry Council

CNPF IDF - RDI department of the National Center for Forest Owners

CNRS - French National Center for Scientific Research

CSFB - Strategic committee for the forest-based sector

EPST - Public Scientific and Technical Research Establishments

FCBA - Private research and innovation institute for the French forest-based sector.

FSFB - Forest and Wood Strategic Fund

GDR SCIENCES DU BOIS - Research Group dedicated to wood sciences

GICC - National research programme on management and impacts of climate change

GIP ECOFOR - Public interest group dedicated to forest ecosystems

GIS COOP - Scientific Interest Group “data cooperative on forest stands growth”

IGN - French National Institute of Geographic and Forestry Information

INRA - French National Institute for Agricultural Research

IRD - French National Research Institute for Sustainable Development

IRSTEA - National Research Institute of Science and Technology for Environment and Agriculture

LAAAF - French law for the future of Agriculture, Food and Forestry

MNHN - French National Museum of Natural History

PNFB - French National Forest and Wood Programme

PRFB - Regional Forestry and Wood Programme

RDI - Research Development Innovation

RMT AFORCE - Mixed Technological Network devoted to the adaptation of forests to climate change

ONF - National Forests Office

OPESCT - French Parliamentary Office for the Evaluation of Scientific and Technological Choices

SEHS Network - Economic, Human and Social Sciences Network, created and managed by GIP ECOFOR

APPENDIX 1
PNFB objectives and associated actions, according three main science-practice interaction types

Objective A **Increase harvesting and ensuring woodland renewal**	***Objective B*** **Meet public expectations**	***Objective C*** **Adapt to climate change**	**Objective D** **Develop synergies between forestry and industry And match actual market needs (jobs, added value, balance of trade)**
Science-Practice interaction type 1 : developing observation and intelligent monitoring			
		To increase the resilience of forests and to tackle the risks (fire, storms, health,...) : • establishment of R&D plots for comparative plantations, workshop sites,... • development of technical tools to improve observations (remote sensing, molecular biology, ...)	
• Knowing, preserving and promoting forest biodiversity : Initiate the implementation of an ongoing monitoring of the evolution of forest biodiversity			
Science-Practice interaction type 2 : developing and making available knowledge and tools to inform on management choices and public policies			
		• assess and model the response of forest systems to future conditions • Develop silvicultural models incorporating a variety of climatic scenarios • Create a R&D centre for the preservation and development of forest genetic resources	• Continue the research effort on the profitable use of hardwood species (technical performance, competitiveness with tropical species, development of new products to meet the expectations of the public, modernization of production tools and processes, etc.) ; • Develop research on the study and evaluation of wood material performance in comparison with other materials
• Development of an R&I Plan 2025 • Development of a programme on innovation and modernization of forest-wood industries through the national “investments for the Future”			
• Setting up innovative technical itineraries and improve existing ones by in-situ experiments • Promoting results in forest management framework documents			
• Coordination and renewal of existing training in the fields of forest management and logging, wood mobilization and wood technology, in connection with research			
• In the field of biodiversity: improving the transfer of research results and naturalist inventories to foresters and managers. • Develop ecosystem services related evaluations,...			
Science-Practice interaction type 3 : other actions promoting interactions between researchers and professionals of forest-wood sector			
		• At theEuropean level : Implementation of R&D partnerships with the Mediterranean countries on the conservation, selection and transfer of genetic resources ; • Structuring the sharing of information between researchers, owners and managers	• At the European level : RDI initiative on Hardwood species
• Mapping the abilities of the various actors in research, developpment and innovation (RDI) to identify overlaps and gaps • Promote synergies between these actors by encouraging them to work together on common themes where each one would bring its expertise			

SNS-EFINORD network meeting and international workshop
Tools for improving science-practice interaction in forestry
Warsaw, Poland, May 11, 2017

Country report - Germany

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1. German forests
1.1 General Overview

Per definition the states (Länder, see below) Schleswig-Holstein, Free and Hanseatic City Hamburg (Freie und Hansestadt Hamburg) and Mecklenburg-Vorpommern are parts of the Baltic Region. However it makes sense that this Country Report considers Germany as a whole.

Germany ranks among the densely wooded countries in Europe. Around 11 million hectares corresponding to one third of the national territory are covered with forests. In regional terms, the proportion of woodland cover varies widely, ranging from 11 % in Schleswig-Holstein to over 40 % in Rhineland-Palatinate and Hesse, the most densely wooded Länder (federal states). Forests increased by approx. 1 million hectares in Germany over the past four decades. The entire forest sector and forest-based industries have an annual turnover of some 160 billion EUR and employ more than 1.2 million people, mostly in rural regions.

Forests leave their mark on landscapes, provide a habitat for plants and animals and help to protect the climate, water and soils. At the same time, forests provide an area for recreation and exercise and form part of our cultural identity. German forests are therefore, at the same time, natural environments and places to pursue recreation and engage in economic activities (multifunctional forestry). They have been managed in a sustainable manner for 300 years now. The concept was first put forward in 1713 by the German Hans Carl von Carlowitz.

The percentage of over 80-year old stands also rose from one quarter to one third of the forest area. The timber stocks in Germany account for 320 m3 per hectare, with the annual timber increment totaling around 100 million m3 in accessible forest without logging restrictions in the main stand today, i.e. around 9.5 m3/ha. Hence, Germany occupies a leading place compared with other European countries. This is mainly a result of the efforts to rebuild high-yielding and ecologically valuable forests after the devastation and degradation of large forest areas over the past centuries.

The historical development of forestry explains why German forests are today composed of 60 % coniferous forests and around 40 % deciduous forests. In the past few decades, more importance had been attached to regeneration with site-adapted tree species.

The efforts to form the composition of forest tree species in a more semi-natural way have been done with success. Approx. 73 % of German forests nowadays consist of mixed stands. Spruce accounts for the largest share among the tree species (28 %), followed by pine (23 %), beech trees (15 %) and oak trees (10 %).

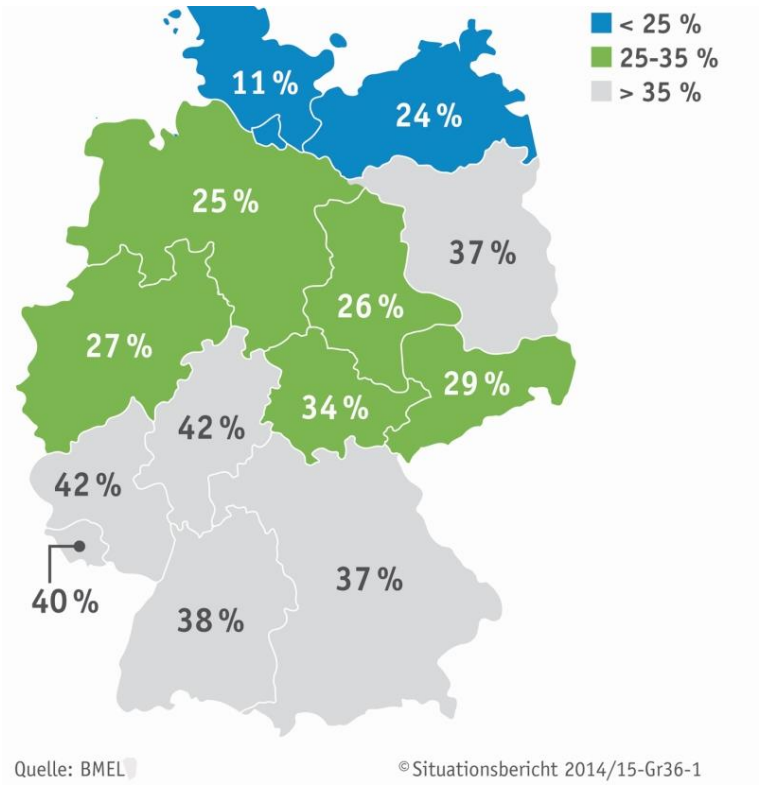

Diagram 1: Percentage of forests in 2014 (Third National Forest Inventory 2014)

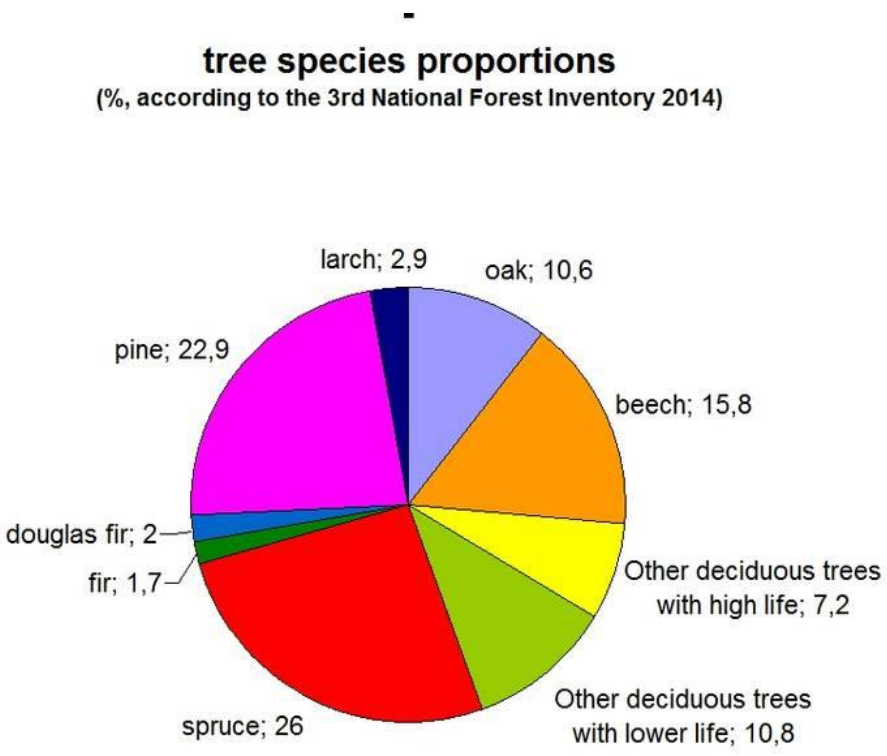

Diagram 2: Tree species proportions in Germany (Third National Forest Inventory 2014)

1.2 Ownership

The private forest in Germany is predominantly small structured and fragmented. About half of the private forest area share holdings with less than 20 hectares. Only 13% of private forest have a size of more than 1,000 hectares. The number of corporative and private forest owners in Germany is about 2 million.

Private persons, corporate entities (notably municipalities) and the state, i.e. mainly the Länder, own woodlands. Private forests with less than 20 hectares represent 50 % of the privately owned forest area with an average forest area size of 5 hectares.

The communal and other corporate body forests are evidently larger. The largest forests in terms of woodland cover are owned by the state. A state forest office manages between 8,000 and 15,000 hectares and mostly also advices private owners and municipal forests.

The Federal Government currently owns around 410,000 hectares. These are mainly forests intended for military purposes.

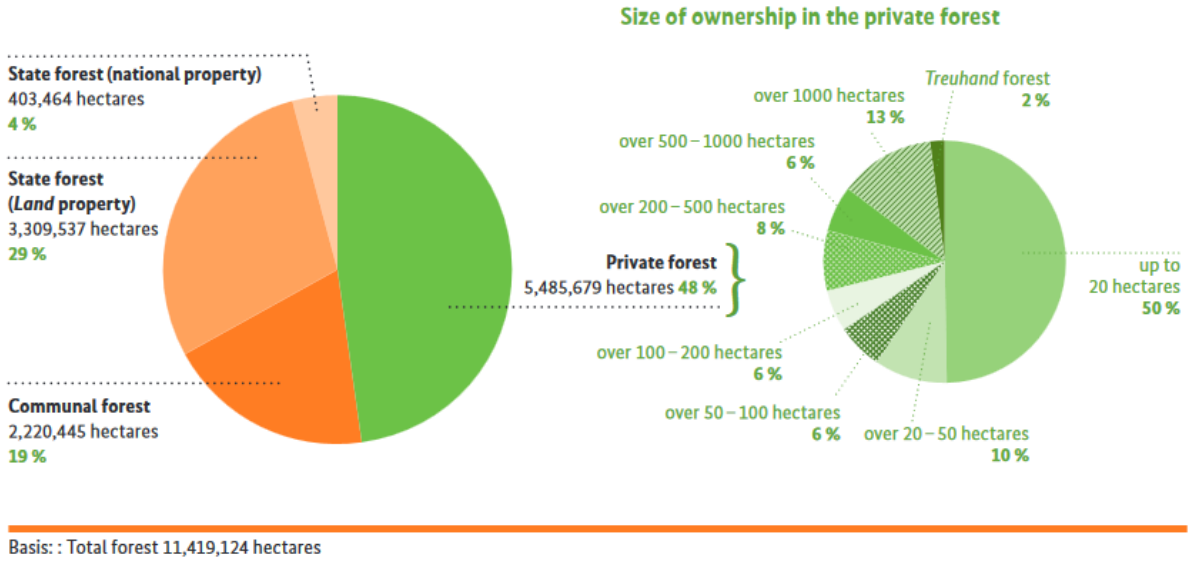

Diagram 3: Forest area by type of ownership in Germany 2002

2 Science-practice interaction in policy documents

2.1 Forest Administration

Germany is a federal organized republic (Federal Republic of Germany) of 16 states (Länder). Responsible for the forests are mainly the states. While the Federal Government merely sets the forest policy framework, the states are responsible for the formulation and implementation of concrete forest policy targets.

That means, in Germany the states have contracted an alliance in a way that the states have transferred parts of their sovereignty on the Federal Republic.

This federal structure has consequences for the forest sector as a whole and forest research and therewith for the forest legislation in Germany. In general the legislative power is shared between the Federal Republic and the 16 states. The respective rules are constituted in the Fundamental Act (Constitution, in German Grundgesetz).

The Political competence for Climate Change and Biological Diversity has the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety.

These fragmented responsibilities within Germany, national and state bodies, institutions and agencies are leading to an uncoordinated dissemination of research results to the forest sector.

Diagram 4: The 16 states of the Federal Republic of Germany

2.2 Forest policy and research capacities

2.2.1 Forest Strategy 2020

In 2011 the Federal Ministry of Food and Agriculture launched the ***Forest Strategy 2020*** - *Sustainable Forest Management – an opportunity and a challenge for society.*

The Forest Strategy 2020 was adopted for Forests as a Natural and Economic Resource. With the help of the Forest Strategy, the Ministry can coordinate the many requirements made of forests regarding climate, biodiversity, raw materials, recreation and energy, and solve potential areas of conflict.

The twin goal is to “use and protect” the forests. The Forest Strategy will also assist in help promoting knowledge and understanding about Germany’s forests in the population at large.

The Strategy 2020 is based on the goal of sustainable forestry: promoting permanent, optimum protection to the diverse economic, ecological and social contributions of forests in the interest of both today's and future generations. This goal and is pursued in Germany by means of an integrative approach to sustainable, multi-functional forestry.

The areas of action and subordinate goals of the Forest Strategy 2020 are:

- Climate protection and adaptation
- Property, work and income (value added)
- Raw materials, use and efficiency
- Biodiversity and forest conservation
- Silviculture
- Hunting
- Protection of soil and water management
- Recreation, health and tourism
- Research, education, awareness-raising

In Germany forest management and forest related political decisions should be evidence based in the sense of scientific results. Most of these scientific results come from scientific-based advising made by the State Forest Research Stations, Federal Forestry Research Institutes and partly universities.

Actually major research efforts are needed in order to avoid and reduce conflicting goals in the above areas of action of the Strategy. At the same time, it is about promoting understanding of the forest ecosystem, the contributions of sustainable forestry and the use of renewable resources within the framework of educational schemes and greater awareness raising amongst consumers about the forest ecosystem.

2.2.2 Forest Climate Fund

The Forest Climate Fund is part of the programme associated with the Energy and Climate Fund. A decision by the German Parliament (Bundestag) called for it to be established from 2013 under the joint responsibility of the Federal Ministry of Food and Agriculture (BMEL) and the Federal Ministry for Environment, Nature Conservation, Building and Nuclear Safety (BMUB).

Due to carbon storage, build-up of carbon stocks in forests and the prevention of emissions as a result of timber recycling and energy recovery, German forestry and forest industries are playing an important role in combating and mitigating climate change.

They currently prevent the release of approx. 126 million tonnes of CO_2 per year into the atmosphere. Bearing in mind the productive, protective and recreational functions of forests, the Forest Climate Fund is intended to maintain and increase this positive impact on the climate.

Adapting our forests to climate change is a precondition for achieving this aim. Given that forests expanse across very large areas and due to their great vulnerability to climate changes and their long life cycles and production periods, there is a need to take rapid and sustainable adaptation measures immediately.

BMEL and BMUB therefore regard it as a necessity to promote measures aimed at tapping the potential of forests and timber for CO_2 reduction and energy generation as well as measures aimed at adapting German forests to climate change, and in this way to help the Federal Government achieve its climate goals.

The measures are designed to achieve the greatest possible benefit in terms of protecting the climate and adapting forests to the consequences of climate change, while taking both eco-logical and economical aspects

into consideration. Wherever possible, the intention is to join synergies between climate protection, the preservation of biodiversity and the adaptation of forests to climate change.

Support measures

Measures are to be funded in the following priority areas:

- Adaptation of forests to climate change,
- Safeguarding of carbon storage and increasing the CO2 sequestration of forests,
- Increasing of storage in wood products and reduction/substitution of CO2 via wood products,
- Research and monitoring,
- Information and communication.

2.2.3 European and international Forest Policy

Germany's Federal Ministry of Food and Agriculture (BMEL) coordinates the Federal Government's international forest policy and is part of a variety of European (e.g. EU, Forest Europe. UNECE) and international bodies and involved in negotiations (e.g. UNFF, FCCC, CBD, FAO). The objective of the Federal Government in this context is to work, together with its EU partners, to make international processes more coherent and to harness potential synergies when implementing national obligations. BMEL is committed both to combating ongoing deforestation and illegal logging, and to promoting sustainable forest management.

BMEL funds projects that are designed to promote the concept of sustainable forest management worldwide, combat illegal logging and timber trading, and – through research and training – transfer knowledge about the sustainable long-term harvesting of woodlands around the world.

The principle underpinning these projects, which are generally set up as pilot schemes, is that of 'conservation through usage'. The findings and results are disseminated in the form of publications, workshops and follow-up projects in order to benefit as many people as possible. On the project development and implementation side, BMEL receives technical and administrative support from the Deutsche Gesellschaft für Internationale Zusammenarbeit/German Agency for International Cooperation (GIZ) GmbH, GFA Consulting Group GmbH (GFA) and Germany's Federal Office for Agriculture and Food (BLE).

2.3 Non-Governmental forestry Organizations

Several umbrella associations work as the representatives of the forest sector:

- The **Deutsche Forstwirtschaftsrat** (DFWR)/German Forestry Council e.V. is the representative organization of all the forestry and forest actors involved in the Federal Republic of Germany and is committed to the interests and concerns of sustainable forestry.

- **The Deutsche Holzwirtschaftsrat** (DHWR) /German Forest Products Council e.V. is the representative organization of the German forest products industry. The DHWR comprises the interests of more than 70.000 enterprises with app. 650.000 workers.

- The **Arbeitsgemeinschaft Deutscher Waldbesitzerverbände** e.V./ Association German Forest Owners Associations e.V. is the representative organization of about 2 million German private and community forest owners and is active on national and European level. The organization is member of the Confederation of European Forest Owners (CEPF), the umbrella association of national forest owner organizations in Europe.

- **The Deutsche Forstverein** /German Foresters' Assoziation. The goal is to improve the framework conditions of the German forestry by means of forest political initiatives, specific public relation and advanced training.

These Non-Governmental forestry Organizations are in close contact to ministries, policy makers, parliament and research institutions. They participate in negations of the formulation of new forest laws and forest strategies on national and state level to include the interests of their members, support and inform their members.

3. Universities and forest research organizations

At the universities and numerous other research institutes of the Federal Government and the Länder the links between forests, the environment and society are studied and possible solutions to concrete problems elaborated. The forest administrations of the Länder and their forest estates promote and support private forest owners and their associations by offering consulting activities to and assuming management duties for them.

3.1 Universities with forest faculties

In Germany basic/innovative and applied forest research, teaching and education is conducted by the forest faculties of the universities:

Göttingen, Freiburg, München, Dresden and additionally in World Forestry in Hamburg.

Further universities conducting research on forest related ecological issues are the universities of:

Kiel, Lüneburg, Osnabrück, Hohenheim and Bayreuth.

According to their full scientific freedom universities are not committed to conduct governmental research – but they can do in specific temporary projects.

3.2 Forestry universities of applied sciences

Applied forestry research is conducted by polytechnics:

- Fachhochschule für nachhaltige Entwicklung Eberswalde,
- Fachhochschule Rottenburg,
- Hochschule Weihenstephan-Triesdorf
- HAWK Hochschule für angewandte Wissenschaft und Kunst - Hildesheim/Holzminden/Göttingen

3.3 Federal Forestry Research

Federal Forestry Research (departmental research) of the Federal Ministry of Food and Agriculture (BMEL) is conducted by the **Johann Heinrich von Thünen Institute,** Federal Research Institute for Rural Areas, Forestry and Fisheries (HQ Braunschweig) with three forestry institutes

- Institute of International Forestry and Forest Economics (Hamburg)
- Institute of Forest Ecosystems (Eberswalde, east of Berlin)

- Forest Genetics (north of Hamburg)

3.4 State Forest Research Stations

Forestry is (like education, science, culture, public security) a matter of the states. Each state has a Ministry responsible forestry. For forestry research many but not all states have an own State Forest Research Station (FVA) conducting applied forest research (departmental research) and advise forest owners under all ownership titles, e.g. the

- FVA Baden-Württemberg (Freiburg)
- Bayerische Landesanstalt für Wald und Forstwirtschaft (München)
- Landeskompetenzzentrum Forst Eberswalde (LFE)
- Nordwestdeutsche Forstliche Versuchsanstalt (NW-FVA) in Göttingen/ The Northwest German Forest Research Institute) active in Hesse, Lower Saxony, Saxony-Anhalt and , Schleswig-Holstein
- Lehr- und Versuchsforstamt Arnsberger Wald, Arnsberg
- Forstliche Versuchsanstalt Rheinland-Pfalz (Rhine-Palatinate) in Trippstadt
- Staatsbetrieb Sachsenforst - Kompetenzzentrum Wald und Forstwirtschaft (Saxony) in Pirna.
- Forstliche Forschungs- und Kompetenzzentrum Gotha (FFK Gotha)

4. How the impacts of scientific results are being assessed

4.1 German research institutions

The written outputs of the state forest research institutions are published in journals (e.g. Allgemeine Forstzeitschrift/Der Wald, Forstwissenschaftliches Centralblatt, Forstarchiv), self-published series, flyers or on their websites. Usually, they are written in German. Annual meetings and excursions of researchers with forest practitioners, policy makers and forest owners are further forms of communication. The forest faculties of the universities publish their scientific results mainly in reviewed international journals as the quotation index is of high relevance for reputation in the light of external project funding.

4.2 An alternative way – waldwissen.net

According to its website, waldwissen.net is a forest information and communication platform and is a joint project on the research institutions Forstliche Versuchs- und Forschungsanstalt Baden-Württemberg (FVA) Freiburg, Bundesforschungszentrum für Wald (BFW) Schönbrunn, Vienna, Landesbetrieb Wald und Holz Nordrhein-Westfalen, Eidg. Forschungsanstalt für Wald, Schnee und Landschaft WSL, Staatsbetrieb Sachsenforst, Landeskompetenzzentrum Forst Eberswalde (LFE) and Centre Inra de Nancy-Lorraine.

Waldwissen.net evolved from the following idea: The research sector provides a large amount of knowledge, which can only be partly incorporated into the day to day processes of improving professional competence or decision making.

Therefore, the WSL had the idea of making relevant practical knowledge available for a broad audience in an easily accessible forum. In the summer of 2003 the prototype waldwissen.ch went online. waldwissen.net links research institutions, forest administrations, forest owner associations and other Non-Governmental Organisations to each other and provides access to experts. The platform is multilingual: German, English, French, and Italian.

waldwissen.net provides compact, edited information on a wide range of forestry topics in understandable forest terminology and provides validated, up-to-date information on forests and forest management. For further information visit the official website at www.waldwissen.net.

5. Needs and plans for development – future research challenges and dissemination of results

The Federal Government will assign greater importance in departmental forest research to the following areas:

- Impact of climate change on forests and ways of increasing the climate protection performance of forests and timber;
- Impact of climate change on the biodiversity of forest ecosystems;
- Environmental forest monitoring and biodiversity monitoring in forests;
- Development of more effective approaches to the preservation and sustainable use of biodiversity in managed forests,
- clarification of the links between biodiversity and the economic and ecological functions of forests;
- Ongoing scientific estimates of future timber needs and ways of sustainably securing supply including suitable biomass potential outside forests;
- Development of innovative timber products and more efficient production methods, particularly through the cascaded utilisation of timber.

Important research activities are carried out and coordinated in the departmental research of the Federal Government and the Länder. This network is fragmented must be improved and extended. Cooperation with other European organisations must be stepped up through e.g. existing ERA-NET schemes.

As the Finnish Country Report stated, the process of developing a strategy for an effective dissemination of forest research results into practise is time consuming and resource intensive as it requires involvement from a large number of participating organizations and persons. The situation in Germany is the same .

In Germany for universities with temporary scientific staff the implementation it is much more a challenge as for federal or state research institutions with a basic permanent staff.

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Country report - Iceland

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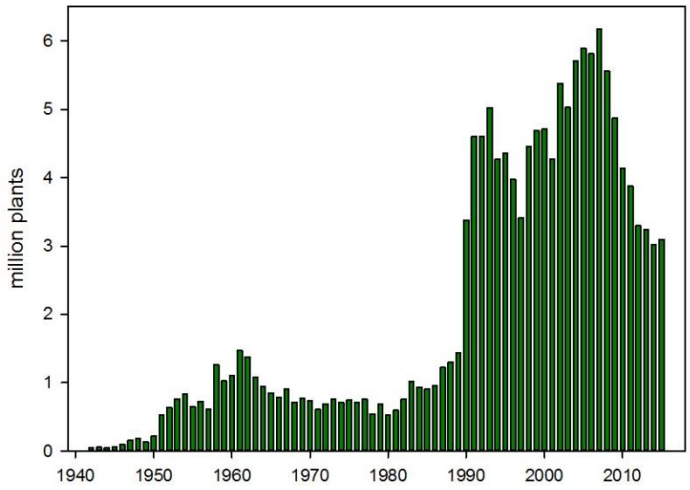
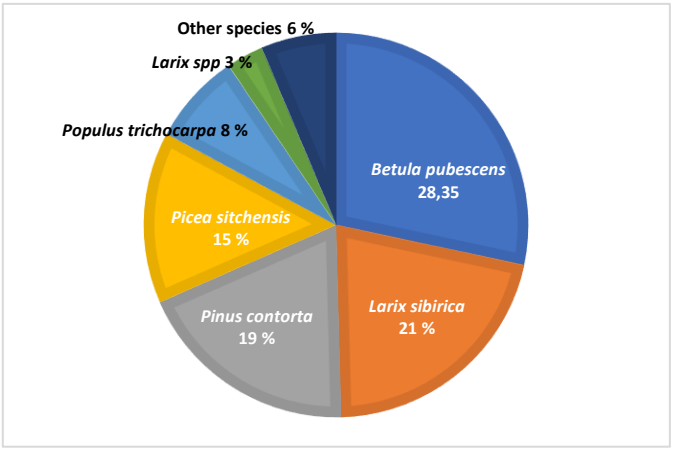
1. Icelandic forests and forestry in brief

The total cover of forest and woodland in Iceland was only 1.9% in 2017, making Iceland one of Europe's least forested country. Despite this low cover, Iceland has increased its forests in a high rate during the last decades. At the time of the settlement of Iceland, around 900 AD, birch (*Betula pubescens*) covered between 25-40% of Iceland's land area. In the sheltered inland valleys, relatively tall birch forests were found, but lower birch and willow shrubs grew on areas closer to the shore and on exposed sites (Eysteinsson 2017). Following the settlement, the forests were cut down to create fields and grazing land, and sheep grazing prevented regeneration of the birch woods after cutting. This led to decline of the woodland cover and around 1300 there are indication that woodland remnants were becoming valuable resource because of their increasing rarity. In the beginning of 20th century the birch woodlands probably reached their post-glacial minimum of about 1% of land area (Aradóttir and Eysteinsson 2005).

The afforestation efforts in Iceland started in 1899 with planting in Thingvellir the arena of the old parliament. However, it took time to change from deforestation to afforestation, and the number of planted seedlings didn't reach 1 million until 1958. The highest number of planted trees were in 2009, when over 6 million were planted, but the number has declined since then. In 2015, the total number of planted trees was little over 3 million plants, with almost 1/3rd the native birch, but other important tree species include Siberian larch (*Larix sibirica*), lodgepole pine (*Pinus contorta*), Sitka spruce (*Picea sitchensins*) and black cottonwood (*Populus trichocarpa*) (Figure 1).

Figure 1. Number of planted trees (in million) 1942-2015 in Iceland and tree species planted in 2015 Gunnarsson (2016).





In the 1950s and 60s it came clear that scientific research was essential to identify the best species and provenances that could grow in Iceland, and also to develop afforestation methods, suitable for the harsh environment in the country. The Icelandic Forest Research (IFR) was established in 1967, with the aid from Norway and has been the center of forest research since then.

2. Research capacities in relevant fields

The core of forest research activities in Iceland are based at the Icelandic Forest Research, Mógilsá (IFR). In addition, some are located within the Forestry department at the Agricultural University of Iceland (AUI), which graduates students with both technical and scientific degree in forestry, and to less extend at the University of Akureyri (UA). The scientists at IFR take active part in the forest education at AUI, by teaching and supervising students. In addition, there is cooperation and interaction between forest researchers and other institutes and Universities, such as the Soil Conservation Service of Iceland, Icelandic Institute of Natural History and the University of Iceland. The interaction is mostly informal and based on individual research projects.

Table 1. Research capacity in forest research in Iceland.

Science field	IFR	AUI	UA	Total
Ecology and silviculture	5	2	1	8
Forest technology				
Economy, statistics, society and policy	4			4
Researchers, total	**9**	**2**	**1**	**12**

3. Science-policy interaction in policy documents

The first legislation on forestry in Iceland is since 1907, but the current one was legislated in 1955 (Lög um skógrækt 1955). However, research is not mentioned in either of the legislation. In 2013, Forests in Iceland - Policy during the 21st century (Skógar á Íslandi - Stefna á 21.öld) was initiated. Importance of research to improve forestry at all stages (protection of natural forests, afforestation and forest use and services, such as carbon sequestration and wood supply) is emphasized, and intensive forest research is listed as one of the prerequisite for the progress of the policy (Loftsson *et al* 2013). This is echoed in the draft of new legislation on forestry in Iceland that has been submitted to the Icelandic parliament Althingi and is planned to be legislated in 2017-18. In the newly submitted legislation, research is defined as one of the main objective of the Icelandic Forest Service (IFS). (Frumvarp til laga um skóga og skógrækt 2017).

4. Arrangement for science-practice interactions

The Icelandic Forest Service is an institution that works with and for the government, the public and other interested parties, about research, development, consultation and distribution of knowledge within forestry. The institution is also Iceland's representative in cooperation with other countries. The Icelandic Forest Research (IFR) is one of the divisions within IFS. Another one is the division of National Forests and Afforestation Program that supervises afforestation activities on farms, with distribution of grants, consultation on forest planning, and provision of education and extension services (Figure 2).

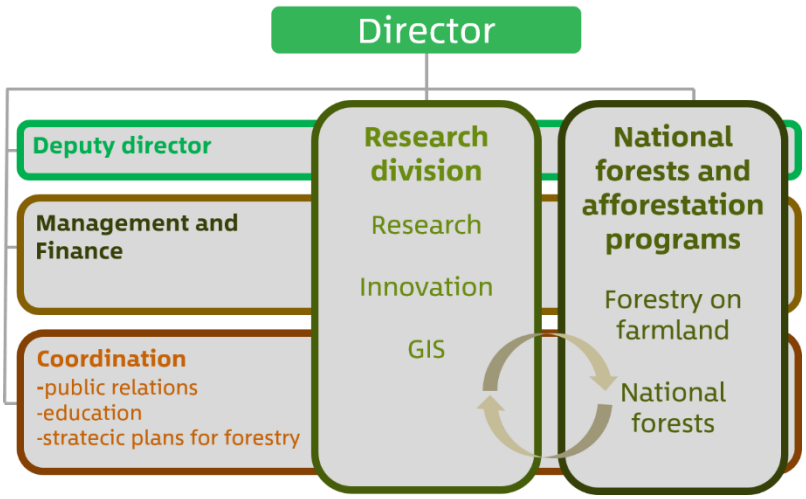


Figure 2. Organization of the Icelandic Forest Service

This organization, in addition to the small forestry community in Iceland, benefits the interaction between science and practice greatly. Scientists take active part in forming guidelines and educational material for foresters, and feedback from practice to scientists rely greatly on personal contacts between researchers and practical foresters. In addition to the personal connection between scientists and foresters, the scientific knowledge is channeled through publications, media and regular conferences. Scientific results are published regularly both at international and national level, and scientists regularly write short papers and communications in local papers aimed for those interested in forestry. The IFS maintain an active website and once a year, IFS organize a conference on forestry in Iceland, open for all interested. The number of participants is usually between 90-150 persons, including forest farmers, scientists and politicians. In addition, forest researchers participate in other conferences and are active in giving presentations and seminars.

5. Challenges and development needs

One of the most critical issue is to convince decision-makers on the importance of forestry as a part of solution to global challenges. This involves both strengthening the scientific information we have, but even more important we need new ways of communicating to the government. As forestry in Iceland is a young branch, it is important to build up knowledge in all aspects of forest management, from selecting the right material too methods of utilizing a new resource in the most sustainable way.Being a small nation with young forestry branch, it is a unique opportunity to ground it on scientific knowledge and to be able to do so, international cooperation is of vital importance.

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Forest research and practice interactions in Norway

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Norwegian forests and forestry in brief

Forests and other wooded land cover about 14 million ha or 43% of the land area in Norway. Of this, approximately 8.6 million ha or 61% of this is classified as productive forest area, i.e. forest area which can produce more than one m^3 wood per ha per year (Tomter and Dalen 2014). Norway is dominated by small forest properties (Figure 1). As of 2015, there were approximately 128 000 forest owners with a minimum of 2.5 ha of productive forest. 85% of the productive forest area is owned by private forest owners. The state-owned forest is managed by Statskog, a state-owned enterprise, and make up 7.2% of the total forest area and 3.4% of the productive forest. The average size of privately owned properties is around 45 ha (Statistics Norway 2016). The implementation of Norwegian forest policy is based on a variety of measures and instruments. These include legislation, tax policy, financial support schemes, research, and guidelines.

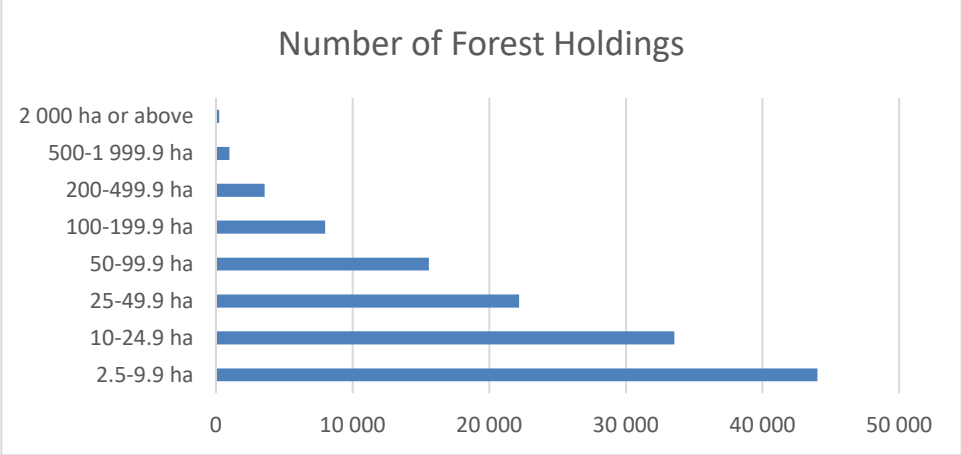

Fig. 1: Distribution of forest holdings by size classes.

Since the start of the national forest inventory in 1919, the annual increment in Norwegian forests has increased by 150% and the growing stock with more than 200%. The growing stock now amounts to about 1 000 million m^3 (Figure 2). Annual harvested volumes have been relatively stable over the last 90 years (Statistics Norway 2017). In 2015 10.1 million m^3 was sold as timber for industrial purposes. In addition, around 2 million m^3 is harvested as fuelwood. The gross value of the harvested timber is estimated to be around 3.4 billion NOK (Ministry of Agriculture and Food 2016). Around 21 000 persons are employed in forestry and the forest-industry sector, and the sector has an estimated production value of 32 billion NOK annually.

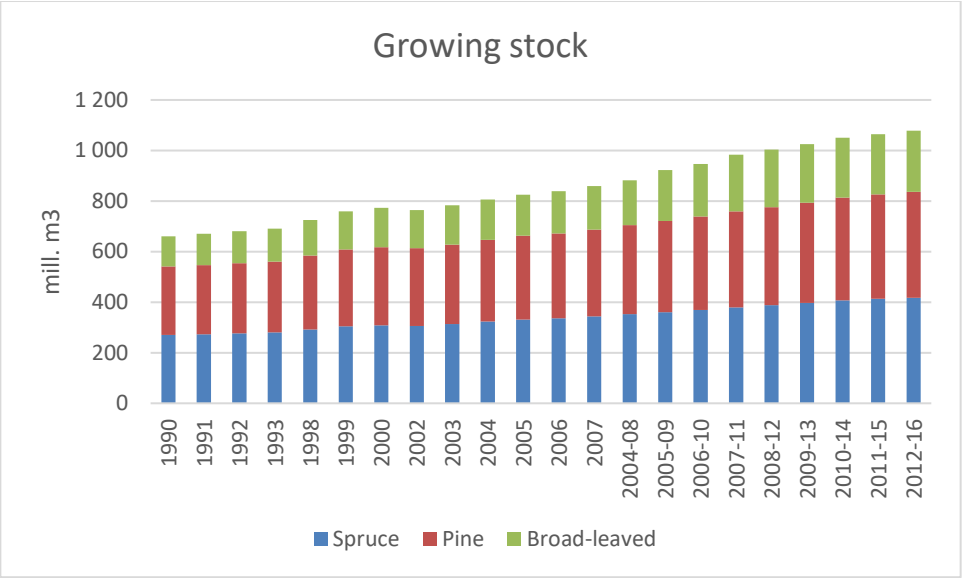

Fig. 2: Growing stock in million m³ inside bark for spruce, pine and broad-leaves (Norwegian Institute of Bioeconomy Research 2017).

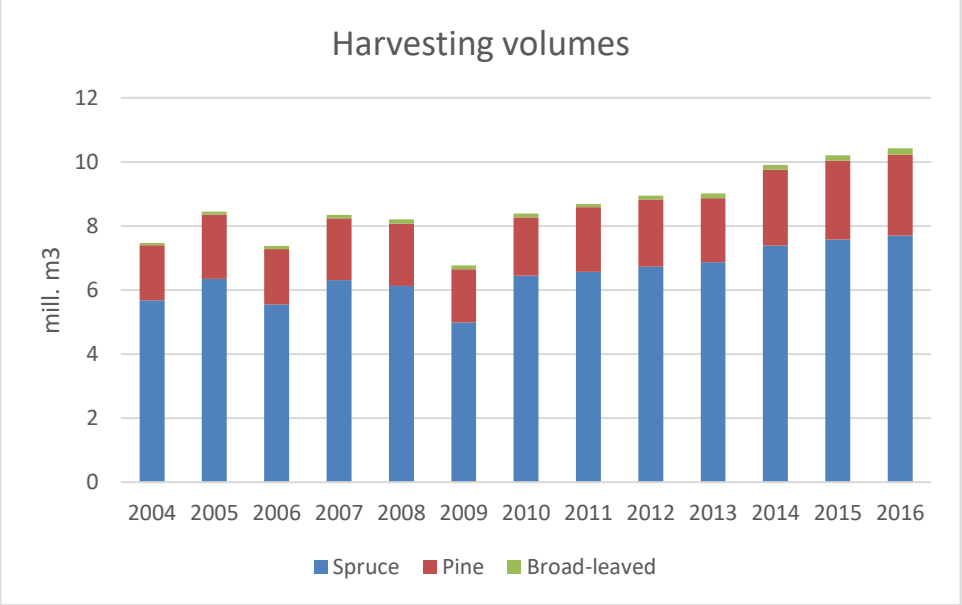

Fig. 2: Annual harvesting (excluding wood for energy) in million m³ between 2004 and 2016 (Norwegian Agriculture Agency 2016).

Science-practice interaction in policy documents

The current Forestry Act (Forestry Act 2005) came into force in 2006. Together with the act, several other regulations like the Nature Diversity Act (Nature Diversity Act 2009), creates a framework for forestry activities. In agriculture, forestry and the food industry, the Norwegian Agriculture Agency (NAA) implements administrative measures and is, therefore, responsible for ensuring a consistent administration throughout the country and throughout the value chain. The NAA's primary target groups are farmers,

foresters, the food industry and importers. The practical work of implementing the regulations, funding and practical support to the forest service in counties and municipalities is delegated to the NAA. Norway has no regular process for creating and updating of forest management guidelines. Only in the field of environmental certification, there is a more formal process, under the umbrella of the European PEFC, (Programme for the Endorsement of Forest Certification). The secretariat of PEFC Norway is located in the Norwegian Forest Owners' Federation.

In the process of preparing a white paper, a document from the government of Norway to the parliament, research institutions are often requested to prepare scientific background information and statements. These documents, together with a parliamentary discussion, often form the basis of future policies and parliamentary propositions.

The Norwegian Forestry Extension Institute (Skogkurs) is a partnership organization with 37 members including forestry organizations and scientific institutions. Skogkurs prepares courses and educational material on forestry related topics. These materials are based on scientific results, as well as acts and regulations.

Research capacities in relevant fields

Research capacities in forestry are mainly found in three organizations: the Norwegian University of Life Sciences (NMBU), the Norwegian Institute of Bioeconomy Research (NIBIO), and the Norwegian Institute of Wood Technology (Treteknisk). These three institutions cover different aspects of forestry research, and as can be read from the table below (Table 3), have their main focus on each of the main research areas of forestry research.

Table 3: Research capacities (number of persons) dealing with forestry issues

	Norwegian University of Life Sciences	Norwegian Institute of Bioeconomy Research	Norwegian Institute of Wood Technology	Total
Ecology and silviculture	*8*	*55*		***63***
Forest technology	*7*	*15*	*11*	***33***
Economy, statistics, society and policy	*26*	*8*	*2*	***36***
Total	***41***	***78***	***13***	***132***

Research communication

Scientific results from are primarily published as scientific publications in peer-reviewed journals. In addition, both NMBU and NIBIO have their own report-series:
http://statisk.umb.no/ina/publikasjoner/ina_fagrapport/if.php,
https://brage.bibsys.no/xmlui/handle/11250/92917

Other channels of research communication include the web-site http://forskning.no/ which publishes general research news, and trade journals such as "Norsk Skogbruk" published by the Norwegian Forestry Society, and "Magasinet Skog", published by the Norwegian Forest Owners' Federation.

How the impacts of scientific results are being assessed

The importance of scientific work, or research and development, is discussed in several strategy documents on the forest- and wood industry (Ministry of Agriculture and Food 2015, Ministry of Agriculture and Food 2016). The long-term plan for research and higher education (Ministry of Education and Research 2014) also focused on the need for research facilitating the transition to green growth and a bio-economy.

A recent survey of resources and scientific publishing in agricultural and food-related research and development show that the combined budget for the wood and energy category was 369 million NOK (Rørstad and Sundnes 2017). The university sector had a yearly increase of 12% in the period 2007 to 2015 (Fig. 3). Most of the increase, however, came between 2007 and 2009. The institute sector had a yearly decrease of 7% in real prices. The private sector had a yearly increase of 8%. However, this increase can largely be explained by the fact that a lot more private firms were part of the recent survey compared to the 2007 and 2009 surveys.

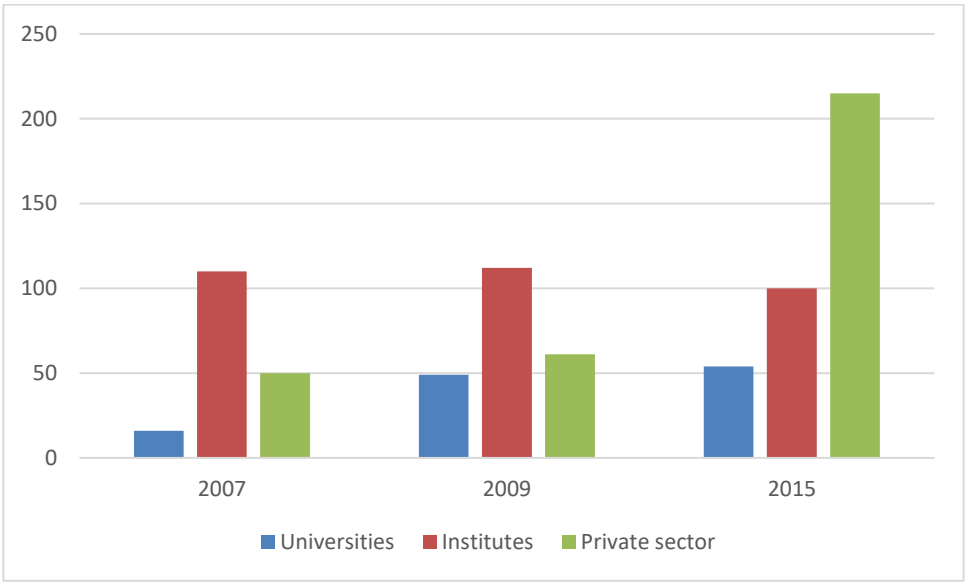

Fig. 3. Expenditure in million NOK on research and development in the wood and energy category (Rørstad and Sundnes 2017, table 4.2, 4.4, and 4.6).

The survey further shows that a total of 3410 scientific papers in agricultural and food-related research was published in the period 2006 to 2015. Of this 9 % was categorized as forestry papers.

Challenges and development needs

Challenges and development needs are described in the strategy document SKOG22 (Ministry of Agriculture and Food 2015). It highlights the needs for prioritization and operationalization of research. The report categorizes research needs in five categories from shorth-term, problem-solving, research to long-term research securing a sustainable forestry production. The financing should take this into account and the need for long-term funding, facilitating research with high innovation-potential, and the need to put innovation into production are highlighted.

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Forest research and practice interactions in Poland

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Polish forests and forestry in brief

The total official area of forests under different forms of ownership in Poland amounts to about 9.2 million ha (forest cover of 29.4%). According to the recent results obtained by the Institute of Geodesy and Cartography using the remote sensing techniques, the total forest area in Poland reaches almost 10 million ha (forest cover of 32%). The vast majority of this area are forests owned by the state, out of which almost 7.6 million hectares are under the State Forests Holding management (*Wielkoobszarowa inwentaryzacja stanu lasów* 2015).

Based on the principle of self-financing. State Forests do not use taxpayers' money. Forest units operate at the national (1), regional (17) and local levels (430 forest districts). They employ a total of nearly 25 thousand people. The State Forests National Forest Holding is an organizational unit without legal personality. The structure of the organization is defined by its statute, released by the regulation of the Minister of the Environment in 1994. The basic document for the organization of State Forests and forestry in the country is the Forest Act of September 28, 1991. It defines the principles of forest management of the State Forests and in forests of other ownerships. Private forests accounts for 1.7 million ha. Since 1995 the share of privately-owned forests has increased from 17.1% to 18.8% (Fig. 1).

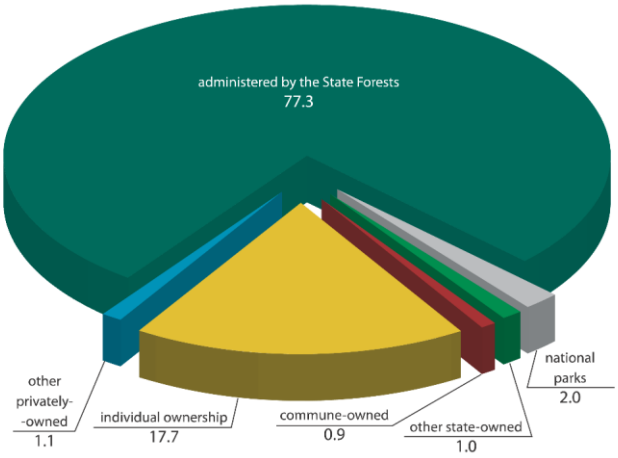

Figure 1. Forms of forest ownerships in Poland (*The State Forests in figures*, 2013)

The amount of removals in Polish forestry in 2015 reached 40 247 thousand m^3, of which large timber equals 38 327 thousand m^3 (~1 m^3 per capita). The average wood price per 1m^3 in 2015 was 191.77 PLN (1 Euro = 4,23 PLN as of September 5, 2017). Gross output of forest raw material equals 1 373 PLN per ha, which accounts for 0.36% share in national economy (*Leśnictwo Forestry 2016*, 2016). Annual harvesting in the State Forest Holding by category of fellings for large timber has been described in Table 1.

Table 1. Gross fellings (in 1 000 m^3) based on the official country statistics between 2011 and 2015 (*Leśnictwo Forestry 2016*, 2016)

Felling type		2011	2012	2013	2014	2015
Grand total		32 789	33 212	34 149	35 686	36 497
Final felling		15 703	16 017	16 671	17 716	18 253
	Of which: incidental felling	1 579	1 522	1 340	1 550	1 575
	Of which: deadwood, wind-broken, wind thrown trees	1 526	1 554	1 201	1 601	1 779
Pre-final felling		17 086	17 195	17 478	17 970	18 243
	Of which: thinning	14 165	14 470	15 543	15 452	15 589
	Of which: incidental felling	2 921	2 725	1 935	2 513	2 654
	Of which: deadwood, wind-broken, wind thrown trees	3 919	3 413	2 603	3 215	3 318

Science-practice interaction in policy documents

The basic document for the State Forests is the Forest Act of September 28, 1991 (*Forest Act*, 1991). According to paragraph 58.1, Forest Fund (special account formed by forest districts to support administrative units working in unfavorable conditions and to cover other costs on the entire State Forests level) is a source of funding for research projects. Environmental Protection Law (27.04.2001), Law on Higher Education (27.07.2005), Act on Research Institutes (30.04.2010), Act on National Centre for Research and Development (30.04.2010) can be also seen as a base for science – practice interaction.

To connect business with science on the national level, research strategies are applied with coordination by:

- National Centre for Research and Development - the implementing agency of the Minister of Science and Higher Education. It was appointed in the summer 2007. Currently, it operates under the Act on National Centre for Research and Development dated 30 April 2010 (Journal of Laws from 2010, No. 96 item 616). The main task of the National Centre for Research and Development is management and execution of strategic research and development programs, which lead directly to the development of innovativeness. Among the tasks of the National Centre for Research and Development, are the support of commercialization and other forms of transfer of scientific research results, the management of applied research programs and the performance of national security and defense projects.
- National Fund for Environmental Protection and Water Management - established in 1989 as a result of the political system transformation in Poland, in cooperation with voivodship funds for environmental protection and water management is the pillar of the Polish system of financing environmental protection. The basis of the National Fund's operation as a State legal person is the Act on Environmental Protection Law. The main activity of Fund focus on:
    - ability to create a variety of financial instruments that meet the needs of beneficiaries
    - active participation in solving environmental problems on legal, financial and organizational grounds
    - long-term planning of revenues and expenses, which ensures funds for beneficiaries for the full balance of projects
- Ministry of the Environment – Department of Forestry
- National Science Centre (NCN) - government agency, supervised by the Ministry of Science and Higher Education, set up in 2011 to support basic research in Poland. Basic research is defined as experimental or theoretical endeavors undertaken to gain new knowledge of the foundations of phenomena and observable facts, without any direct commercial use. With a budget of over € 200 Million a year NCN funds projects in Arts, Humanities and Social Sciences, Life Sciences and Physical Sciences and Engineering. The NCN has set up 11 types of funding schemes dedicated to researchers at different stages of their career.

Research capacities in relevant fields

Forestry-related research in Poland is led by various institutions, but core activities are provided by Faculties of Forestry at three universities and Forest Research Institute. In Warsaw University of Life Sciences-SGGW in 2016, a total of 97 employees dealt with forestry or forestry related issues, including 69 scientists. At the same time at Poznań University of Life Sciences there were 93 people employed for research activities, including 76 scientists, while University of Agriculture in Kraków had 120 people employed, including 89 scientists. In the case of Faculties, scientists usually work also as academic teachers. Different situation is observed in Forest Research Institute, where the total of 181 employees, including 94 scientific staff, works in research and supports forest and environmental monitoring, fire protection and large-scale forest inventory on the country level. The number of researchers in the forestry-related fields by major institutions and specialties is presented in Table. 2.

There are also groups of scientists dealing with forestry related issues in other universities and research institutes, such as, among others, Polish Academy of Sciences Institute of Dendrology, Institute of Environmental Protection, University of Warmia and Mazury in Olsztyn, Technical University in Białystok, University of Łódź, but an exact number of people in those institutions is difficult to estimate. According to the Polish Research Information System (OPI Nauka Polska – nauka-polska.pl – access on October 6, 2017) there have been 1010 people related to forest sciences when using the classification of Central Commission for Academic Degrees and Titles. However, this result includes all people having scientific degrees (PhD, DSc) and titles (professor) – not only active, but also working outside of forestry research or retired.

Table 2: Research capacities (number of persons – scientific and technical staff) in main Universities and research institutes dealing with forestry (-related) issues (own elaboration based on POLON system, internal reports of respective institutions and direct contacts)

	Warsaw University of Life Sciences-SGGW	Poznań University of Life Sciences	University of Agriculture in Kraków	Forest Research Institute	Total
Silviculture	15	14	14	28	71
Forest management, inventory, economics, geodesy, GIS, remote sensing	35	23	29	50	137
Forest and nature protection, ecology, entomology, phytopathology	16	22	33	85	156
Forest utilization and engineering, wood science	16	23	29	7	75
Natural bases of forestry (botany, physiology, dendrology, zoology)	15	11	15	11	52
Total	**97**	**93**	**120**	**181**	**491**

Universities obtain part of their funds for teaching activities directly from the Ministry of Science and Higher Education or in the form of the tuition fees covered by part-time students. Research activity in turn is financed from variety of sources. Exemplary levels of financing by sources for 3 faculties of forestry in 2016 are shown in Table 3. The most stable are funds obtained from the Ministry of Science and Higher Education, as this depends, among others, on evaluation of the institution performed every few years. The distribution of remaining funds

between institutions varies from year to year, and on average, is approximately similar. The structure and magnitude of funds of Forest Research Institute differ from universities, as its subordination, role and tasks are defined in a different way. They are mostly financed by State Forests, but also a significant part consists of projects commissioned by various domestic and international funding agencies.

Table 3: Forest research financing (thousand €) in the year 2016 by institutions and financing sources (own elaboration based on POLON system, internal reports of respective institutions and direct contacts, 1EUR=4.23PLN)

Source	Total [thous. Euro]	Share [%]
Ministry of Science and Higher Education research subsidies	509.2	18.0
National Science Center, National Center for Research and Development	969.0	34.3
International sources (7FP, Horizon 2020, Interreg, etc.)	25.3	0.9
State Forests research development grants from "Forest fund"	1 118.9	39.7
Other sources (industry, public administration, etc.)	200.8	7.1
Total	2 823.2	100.0

Data in Table 3 illustrates the current financial situation of university forest research institutions. In the near future core Ministry subsidies for research are expected to be even lower while the importance of external funds from various domestic and international competitive sources, as well as private investments for contracted or joint R&D projects, are expected to significantly increase. This will force various institutions to cooperate and present much more collaborative, interdisciplinary, innovative and economy-oriented approach, regardless of the so-far existing practices. This will also put more attention to international sources, especially European funds.

Arrangements for science-policy-practice interactions

Interactions between science, practice and policy in Polish forestry cannot be characterized without taking into account ownership structure mentioned in the first chapter, i.e. majority of forests being under the supervision of State Forests National Forest Holding. Such a structure determines the model of natural resource management in the country and defines directions of information flow and knowledge transfer in this field.

Forest and nature protection management is implemented on two basic levels: governmental institutions and local (self-) governmental units, determining territorial range of activity and impact (nationwide, regional and local). Complementary role in the Polish model of nature resource management (interaction with both above-mentioned levels, initiating of activities, scientific research, etc.) is played by academic institutions providing higher education in forestry and various non-governmental advisory boards.

The first managerial platform for natural resource management and protection is the Ministry of Environment responsible for sustainable development policy of the country with the preservation of native natural resources. It is also responsible for nature conservation, rational forest management and effective use of natural resources according to legislation covered by Act on Nature Conservation, Forestry Act and other regulations. Nature conservation on the national level is dealt by the Minister of Environment with the help of Chief Nature Conservator and the General Directorate of Environmental Protection. On the regional level (provinces called voivodships) responsible are: voivodship (regional) governor (representative of the government) and Regional Directorates of Environmental Protection.

Other nature-protection institutions supervised by or working with the Ministry of Environment are [www.mos.gov.pl]:

- national parks (institutions of local and regional range). Each National Park creates Scientific Advisory Board (appointed by the Minister) to validate state of Park's resources, evaluate projects of protection plans and conservation tasks as well as their implementation and results, give opinion on research projects regarding nature conservation, present conclusions and opinions regarding nature conservation and operation of the Park. The Board consist of representatives of scientific and research institutions and various state and local bodies and organizations [Act on Nature Conservation 2004],
- State Council for Nature Conservation is a consultative and advisory board which considers issues and expresses opinions on matters of nature conservation at the request of the Minister, on their own initiative and at the request of other bodies, institutions and individuals (including foreign institutions as Polish scientific body of CITES). Members of the Council are appointed by the Minister of Environment from representatives of scientific institutions, practice and ecological organizations acting for nature conservation. Its role includes evaluations of implementation of laws, plans and programs regarding nature conservation, validation of programs for nature protection and sustainable use of biological biodiversity, giving opinions on projected legal acts regarding nature conservation, presenting conclusions and opinions regarding nature conservation, and popularizing of nature conservation [Act on Nature Conservation 2004, Law on Hunting 1995],
- State Council for Environmental Protection is an advisory body in nature conservation and environmental protection aimed for elaborating opinions and making proposals and conclusions supporting sustainable development and protection, as well as improving the state of environment. Council members are appointed by the Minister [Act on Nature Conservation 2004].

The Minister of Environment also supervises forests of all ownerships and is responsible for forest policy of the state. On behalf of the Minister state-owned forests are managed by State Forests National Forest Holding [www.lasy.gov.pl/en]. The Director General of State Forests appoints advisory body – State Forests Council, to express opinions addressing such issues as prospective plans for the development of the State Forests and State Forest Policy, the draft of the State Forests financial and economic plan, legal and organizational changes in the State Forests, forest status report, and other matters deemed necessary by the Council. The Council comprises of representatives of State Forests employees, scientific, research and teaching institutions, forest entrepreneurs associations, wood industry and other organizations operating in forestry and nature conservation. Some of the organizational units of State Forests (forest districts) established 25 Forest Promotional Complexes covering 1 273 693 ha – model forests aimed for testing new technologies for forest operations and nature conservation, staff training, performing research and experiments to be further implemented in the entire organization. This is also a forum for promoting cooperation between foresters and society, supported by Scientific and Social Councils formed by representatives of local self-governments, non-governmental organizations, wood industry, local media and scientists.

Other institutions subordinate to the Minister of Environment, supporting his activities in the field of forestry and nature conservation, are [www.mos.gov.pl]:

- Forest Research Institute [www.ibles.pl], performing research and development activities in all branches of forest science and forestry, as well as ecology and nature conservation. The Institute also supports legislative process and elaborates other documents for decision-makers, including those required by international agreements and conventions, and State Forest Policy. The Institute has its Scientific Board, the decision-making body consisting of representatives of academia, research institutes, State Forests and the Institute itself, possessing rights to grant scientific degrees and titles,
- Environment Protection Institute [www.ios.edu.pl] – State Research Institute with a wide scope of statutory activities in environmental protection, including protection of landscape and life natural resources,
- Bureau for Forest Management and Geodesy [www.buligl.pl] – a nationwide forest management planning enterprise. It is the main contractor for forest management plans preparation for forest districts. Bureau carries out the periodic National Forest Inventory and habitat inventories, performs tasks of environmental monitoring, prepares protection plans for national parks and nature reserves, elaborates

inventories of Natura 2000 areas and performs other studies related to nature conservation and environmental protection. One of its important activities is the development and maintaining of Forest Data Bank [www.bdl.lasy.gov.pl], one of major official sources of free-of-charge, up-to-date public information about forests (regarding their ownership), natural resources and their state. The databank allows for environmental and economic analyses of resource development on different levels and supports forest research.

Relatively new institution (since 2016) dealing with forestry-related issues is Forestry Scientific Board appointed by Polish Prime Minister, an advisory and consulting body in forest management and the functioning of Polish forest ecosystems. It consists of independent experts - forest scientists representing various universities and research institutes, providing opinions and analyses concerning current situation of forestry, particularly various processes, factors and risks threatening Polish forests [www.premier.gov.pl].

The second level is self-government institutions involved in nature protection on a local scale, namely staroste (poviat, district governor) and mayor or city president (commune) [Forest Act 1991]. Self-governments on voivodship level can create landscape parks – large-scale forms of nature conservation aimed for protection, maintenance and popularization of natural, historic, cultural and landscape values. Landscape parks can in turn appoint scientific advisory boards consisting mainly of representatives of universities, non-governmental ecological organizations and local self-governments.

Staroste supervises forest management in private forests [Forest Act 1991]. Privileges and duties of forest owners are regulated by simplified forest management plans or decisions of staroste based on forest resource inventory. This supervision can be commissioned to State Forests districts (such a situation exists in 70% of poviats). Regardless of the situation, according to the Forest Act of 1991, State Forests are obliged to advice and help private forest owners with matters related to forest management and operations.

Supplementary role in the Polish system of natural resource management on various levels is also played by:

- higher education institutions providing education in forestry and nature protection, especially Warsaw University of Life Sciences – SGGW [www.sggw.pl], Poznań University of Life Sciences [www.puls.pl] and University of Agriculture in Kraków [www.ur.krakow.pl],
- Forest Sciences and Wood Technology Committee of the Polish Academy of Sciences – a permanent body of the Polish Academy of Sciences, which is a self-governing representation of scientists dealing with forestry and wood technology and aimed at the integration and cooperation of scientific community. The Committee was established in 2016 within the Department of Biological and Agricultural Sciences. It was formed from the merger of two committees: Forest Sciences Committee, existing since 1956, and Wood Technology Committee existing since 1961. The Forest Sciences and Wood Technology Committee consists of members of Polish Academy of Sciences as well as outstanding academics, representing higher education institutions and research institutes, elected by all the scientists (holding the scientific degree of doctor habilitated of the professor scientific title) from the forestry scientific discipline every five years. The Committee deals with all aspects of forest sciences, including multifunctionality of forests and the environment, as well as broadly understood wood science, including various processing technologies as well as the preservation of wooden historical monuments. Together with the Forest Research Institute the Committee publishes quarterly "Folia Forestalia Polonica" – scientific Journal indexed by Index Copernicus. The Committee plays a role of the National IUFRO Committee [www.knlitd.pan.pl].
- League for the Preservation of Nature – nationwide association established in 1928, public benefit organization aimed to support and promote nature protection [www.lop.org.pl].
- Scientific journals: apart from the already mentioned quarterly „Folia Forestalia Polonica", the most important and influential undoubtedly is „Sylwan" – the oldest forest science journal established in 1820. It serves the development of Polish forestry, the dissemination of forest research results and the development of forest science. This is the only Polish forestry-related scientific journal with impact factor by Journal Citation Report. Besides it is indexed by Science Citation Index Expanded (SciSearch),

CAB International and Polish Scientific Journal Contents, Index Copernicus Journal Master List [www.sylwan.lasy.gov.pl].

Challenges and development needs

Challenges of science-policy interface in Poland can be seen from different angles.

The existing theoretical and factual involvement of scientists in activities of various advisory bodies on different levels seems to be well-established and significant. The most important issue is to convince decision-makers to better utilize the existing expertise. At the same time the potential of representatives of science and research should be focused not only on general issues, but also guided to solve current and most urgent practical and technical problems.

Looking at the current problems of Polish forestry, scientists should get more involved in research on solutions ensuring increased sustainability and stability of forest related to intensification of natural biotic and abiotic phenomena causing large-scale disturbances. Nowadays large-scale catastrophic windthrows (the last one of August 11-12, 2017 caused damage of almost 10 mln m^3 trees on almost 80 thousand hectares), massive outbrakes of harmful insects (e.g. bark beetle) and fungi deceases (root rot, ash dying) are observed more frequently. These threads force an active search for new solutions for forest protection and the development of more resistant forests. This is why much emphasis is now placed on the development of multi-species, multi-generational stands that are considered relatively more resistant to the above-mentioned threats. Forest conversion from simple, one species, one generation structure to complex one, with many species and consisting of more than one generation of trees, forces new methodological and technological solutions in the field of silviculture, forest management and utilization. Improving the techniques and technologies used in contemporary forestry is also stimulated by the situation on the labor market, manifested by the lack of people willing to undertake forestry-related work and increasing labor costs.
When analyzing the research potential, sources of funds and their use, as well as current trends in legal regulations, Poland needs more activity of scientists in raising funds and obtaining grants for research, especially from international (European) sources. This in turn requires much more collaboration between various research institutions from the country and abroad. The existing research projects, both: domestic and international, show that this is the most efficient way to increase scientific output, its visibility and better support the policy-makers. Two examples of such projects are:

- REMBIOFOR (Remote sensing based assessment of woody biomass and carbon storage in forests) funded by the National Centre for Research and Development within the program „Natural environment, agriculture and forestry" BIOSTRATEG. The aim of the project is to work out the complex method of defining selected forest stand descriptions as well as aboveground biomass and carbon sequestration, based on the use of remote sensing for the purposes of forest management planning. The consortium consists of 7 scientific institutions (3 universities and 4 research institutes from Poland) and State Forests [www.rembiofor.pl],
- TECH4EFFECT (Knowledge and technologies for effective wood procurement) funded the Bio Based Industries Joint Undertaking under the European Union's Horizon 2020 research and innovation program. The objective of the Project is to improve the efficiency of European forest management by enabling a data-driven knowledge-based revolution of the European forest sector while also providing key incremental improvements in technology. The international consortium includes two machine manufacturers and two other specialized SMEs, two large forest organizations, two forest owner associations, 1 forest contractor company, one research center, 7 universities and research institutes and international organization (EFI) [www.tech4effect.eu].

International cooperation in application and implementation of research projects gives opportunity to exchange and enhance knowledge and skills for solving vital research problems in forestry. As a result of interdisciplinary international projects universal solutions are created that can be applied in various countries. From this point of view activity of such networks as e.g. SNS-EFINORD is of high importance for all the partners.

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SNS-EFINORD network meeting and international workshop
Tools for improving science-practice interaction in forestry
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Science-practice interaction in Skogforsks research and communication - strategies and experiences

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1. Swedish forests and forest industries

The forest products industry accounts for around 10 percent of the Swedish industry's total employment, exports, sales and added value respectively. This comprise pulp and paper industry and wood-mechanical industry. Around 90 percent of the pulp and paper products and 75 percent of sawn-wood products are exported. The wood raw material is manly domestic 65 million m^3sub are harvested in Sweden annually), some additional 5 - 7 million m^3sub roundwood are imported and around 0,5-4 million m^3sub are exported (based on Swedish Forest Agency 2013). Fig 1 shows the export and import values in SEK (1 €=9,72 SEK, June 2017).

The labour engaged in forest operations/silviculture to roadside, kind of operations and distribution on genders are presented in table 2. Observe that these figures do not include employees in forest based industry sectors, the transportation sector, machine and equipment manufacturers, service providers except forestry contractors, recreation, wild-life, nature protection/preservation beside forestry, cultural heritage, water management and other ecosystem services, nor research organisations.

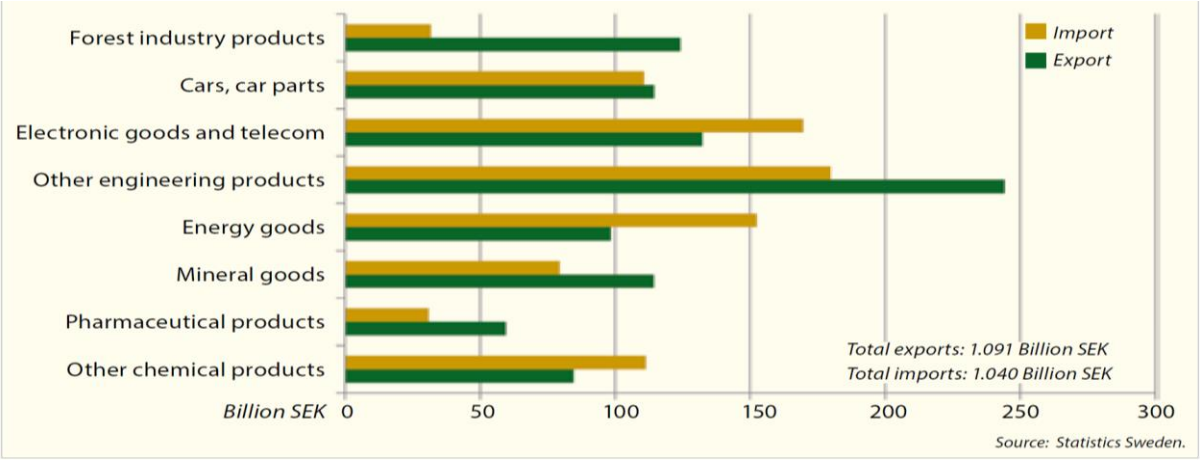

Fig 1. Swedish export and import values by grouped industry branches according to Statistics Sweden (Fig from Forests and Forestry in Sweden 2015).

The Swedish Forest Industries Federation present a total of around 70 000 employees and another 30 000 one-man businesses in the entire forest based branch 2015.

Table 1: Statistics on forest operations and silviculture in Sweden. Averages 2012-2016, *2011-2015; and **-2013 respectively. (Compilation of Statistics Sweden/Swedish Forest Agency)

Forest operations/silviculture	
Final felling at the end of rotation period (ha/year)	249,000
Thinning (ha/year)**	361,000
Scarification for regeneration (ha/year)*	183,000
Regeneration by planting or sawing (ha/year)*	181,000
Forest tree seedlings produced (no/year)*	363,000,000
Cleaning (ha/year)*	401,000
Forest Fertilization (ha/year)*	35,600

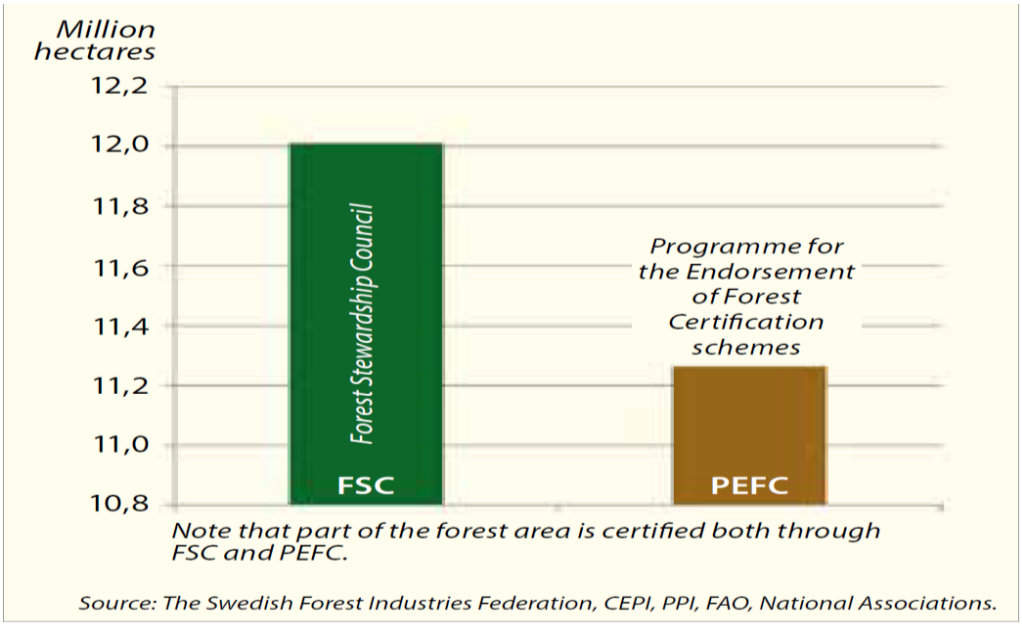

Fig 2. Certification of forestry on Swedish forest land according to FSC and PFC. (Fig from Forests and Forestry in Sweden 2015).

To efficiently bring research results and knowledge based development into practice it is crucial to have viable relationships with partners in practical forestry, forest based industry, representatives for the society and other stakeholders who can take use of the results.

From long time series of applied research, we conclude that a common prerequisite for achieving action in practice is to actively involve driving practitioners in research and innovation activities, responding to the need for direct individual benefit and ensuring that communication increases its ability to move towards progress i.e. increased sustainability (economic, environmental and social criteria).

Table 2: Labour engaged in forest operations(to roadside)/silviculture by categories numbers and percentages in Swedish forestry 2015

Labour and operation categories	Numbers and percentages
Annual Working Units (AWU) -Contractors -Small scale forestry -Large scale forestry	 8697 6655 1421
Own work performed by small-scale forest farmers (out of 100 % per subline below) - Final felling - Thinning - Planting - Pre-commercial thinning (cleaning)	 10% 15% 33% 55%
Share of employed females - Large scale forestry - Small scale forestry - Contractors	 16% ? 3%

2. Research capacities in relevant fields

The number of employed researchers working with silviculture forest operations, products from forestry (to roadside). and not the least environmental research are presented in table 3. When regards gender aspects in forest research at Skogforsk 62% are men and 38% women. We could not find the corresponding figures for the Forest Faculty at SLU, but the entire SLU (The Swedish University of Life Sciences) presents 53% men and 47% women (4 faculties).

Table 3. Research capacities of main forest research organizations in Sweden by fields of science (as full academic person years 2014)

Science field	Chal-mers	Dalarna Univ	IVL	Linköp. Univ	Linné Univ	Lund Univ	RISE	Skog-forsk	SLU	Umeå Univ	Total
Ecology and silviculture	6	5	12		10	10		45	458	64	610
Forest technology and raw materials (forestry)				5	5		6	45	30	5	96
Economy, statistics, society and policy	7						17	6	40	5	75
Researchers, total	13	5	12	5	15	10	23	96	528	74	781

3. Science-practice interaction - the Skogforsk example

Skogforsk has developed a strategy directed to increase the efficiency in bringing research relevant for Swedish forestry and its impact on forest industry into practitioners' mind and operations when feasible regarding different conditions and goals.

Skogforsk also has the task of clarifying the social benefits of forest and forestry in dialogue with society. And to facilitate dialogue with society about the use of forests. Politicians, authorities, associations and the media are the most important target groups to reach in society, as these groups have the greatest impact on the development of their business and industry. The main purpose of the dialogue is to ensure that the knowledge they communicate with the members and the public is in line with the current state of knowledge and to create an understanding of the role of forestry in society.

The strategy is based upon four principles.

Principle 1 – Build relationship over time.

Skogforsk will build strong relationships with people who influence the development of the industry through active and structured world-wide surveillance, well-planned, coherent chains of personal messages and invitations, and Skogforsk is personal without being person-dependent.

Skogforsks target groups are mainly in forestry, but also in the surrounding community - nationally and internationally.

To create efficiency and development willingness, communication will focus common needs, conditions and driving forces. Skogforsk has therefore grouped into three needs groups, which Skogforsk denotes as "The Knowledge Seekers", "Impactors" and "Networkers".

“Knowledge seekers” want to stay constantly updated to prepare for future changes. Knowledge seekers want Skogforsks help to create an overview of the knowledge situation - both in the research front and on current issues, by offering a steady flow of new or current knowledge.

“Impactors” take great responsibility for the industry's future and want influence over the focus of research and development. The impactor wants Skogforsks help to be linked with the right actor and lift ideas from the operational day to a strategic level.

“Networkers” see the potential of knowing the right people and putting great effort and effort into creating and maintaining the personal network. Networkers want Skogforsks help to create platforms for exchange of experiences and to initiate joint power collections.

Principle 2 – Take the commitment through open contact routes

Many want to engage in sustainable development. Skogforsk will make it easy for them by linking people who benefit from each other, making it easy to get in touch with Skogforsk and facilitate personal meetings with researchers.

Principle 3 – Customize communication according to needs

Skogforsk is always based on the individual's perspective, actively listens as needed and uses available knowledge about partners, customers and colleagues, building all communication of knowledge on a scientific basis, and evaluating their projects and their communication routinely.

The communication system is based on a sustainable diversity of meeting places that complement each other and together meet the requirements set by the needs groups.

“Knowledge seekers” meet Skogforsk online and in person. The centre for Skogforsks communication with external knowledge giant is skogforsk.se. There, all new findings, syntheses on current issues and articles on important future issues are available in a popular science form.

Skogforsk also actively communicates its knowledge in social media, develops digital meeting forms, develops the range of interactive, web-based courses and webinars, and develops tools that can be integrated into their partners 'and customers' own platforms and decision support.

“Impactors” meet Skogforsk primarily in different collaborative groups, such as advisory groups, user groups and project and reference groups.

“Networkers” meet Skogforsk primarily in physical meetings such as at fairs, events, conferences and seminars. But also in digital meeting rooms, as in social media and on interactive meetings and web courses.

The purpose of the PR work is to ensure long-term funding by influencing the scope and content of the Swedish R&I system. The work focuses on a few of Skogforsks important issues and is conducted through, for example, press releases, social media, personal contacts, debate articles and alliances. To maintain credibility and unobtrusiveness, Skogforsk does not conduct public relations in matters relating to the design of forestry. In these cases, Skogforsk provides partners with knowledge bases that can facilitate the social dialogue on forest use.

Being well in the consciousness of journalists is important because they affect public opinion and set the agenda in society. To capture the interests of the media, Skogforsk raises its knowledge from a social perspective. And writes their press releases based on important social issues.

Since the writers of the major newspapers have a major impact on opinion's views on forestry and forestry, Skogforsk directs specific communication efforts to them in the form of adapted knowledge bases and invitations to seminars and conferences.

Principle 4 – Communicate Sustainably

Skogforsk shall recruit equally, put together multifunctional work groups, allocate resources fairly, visualize and counteract conservative norms, depict the world Skogforsk wants to see, drive projects to increase diversity, train their subcontractors, and ensure that Skogforsk leaders go ahead.

In front of each major initiated communication effort, Skogforsk collects a working group consisting of researchers and communicators to identify relevant knowledge, collect previously produced material and, if necessary, write new syntheses. Communication is also included as a separate section in Skogforsks project model.

A communications council, consisting of communicators researchers and management, continuously responds to customer needs through joint planning and communication of knowledge.

Each researcher has the overall responsibility for communicating his own research results, both scientific and popular science. This enables Skogforsk to communicate its results to a sufficient extent to bring about real change in the industry.

Each researcher and employee has access to communicative support, in the form of coaching, education, tools and templates, to be able to perform as much of the popular science knowledge communication as possible. Quality assurance is done according to established procedures in cooperation with the communications department.

The communications department ensures that the organization has effective communication systems and tools. The Communications Department is also responsible for providing communication support, in the form of coaching and training for employees and managers. The communications department quality assures and produces or purchases communications services.

The managers are our main channel for communicating important events in the organization. Important decisions are communicated through oral dialogue. The managers should enable all employees to influence and contribute on equal terms. The managers' communication skills are ensured by ongoing evaluation, training and coaching.

The administration department is responsible for customer management and customer support and for an updated customer register in the CRM system.

IT department is responsible for technical operation and maintenance of web servers and CRM systems

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Forestry Knowledge, a comprehensive decision support system for forest owners

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***Skogskunskap* (www.skogskunskap.se, Forestry Knowledge) is a web-based decision support system aimed to guide forest owners in their decisions about silviculture, nature concern and road building. The first version was launched in 1999, and the system has over the years evolved to cover most of the topics a forest owner or his/her advisors need in their planning and operations.**

1. Shortcut from science to practice

Private forest owners own about half of the forest in Sweden. In total, there are about 330.000 individuals or families who make important decisions affecting the health, growth and economy of the forests in the country. Competent decisions require access to information and knowledge. If the forest owner does not possess the experience and knowledge, he/she has to rely on personal advisors or skilled entrepreneurs. Internet has provided a new channel for accessing knowledge and advises. This is where *Skogskunskap* fills the needs (Figure 1).

Skogskunskap is produced by *Skogforsk*, the Forestry Research Institute of Sweden, with additional support from the Swedish Forest Agency (*Skogsstyrelsen*) and the Forest Owners Association (*LRF Skogsägarna*). Experts in each of the topics safeguard the quality of the content and give input to an editor who runs the daily work. The close collaboration with researchers makes it possible to update instructions and contents in line with new scientific findings. In this sense, *Skogskunskap* is a shortcut in the communication chain from science to practice.

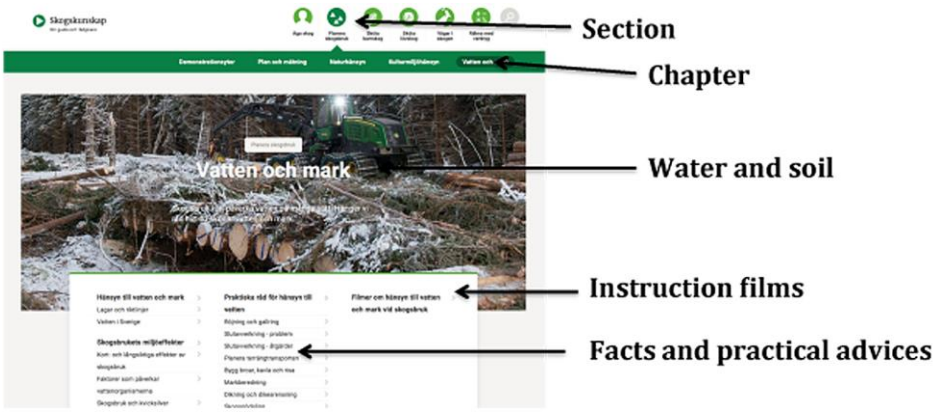

Fig. 1. Skogskunskap is organised in sections and chapters. This is an example from the chapter Soil and water concern. In each chapter, the user finds thorough facts about the theme, practical guidelines, instruction films and knowledge tests.

2. Calculation tools

One of the core contents is the kit of practical calculation tools. In these, a forest owner can use data from his/her own forest stands and calculate for example harvest possibilities, costs, revenues and growth. Currently, there are about 50 tools ranging from simple stock estimates to more complex calculations of frost risk in a changing climate.

The first tool to be published (in 2001) was Pre-commercial thinning analysis (*Röjningsanalys*), where the cost of thinning is compared with the value of the stand at time for the first and coming commercial thinnings (Figure 2).

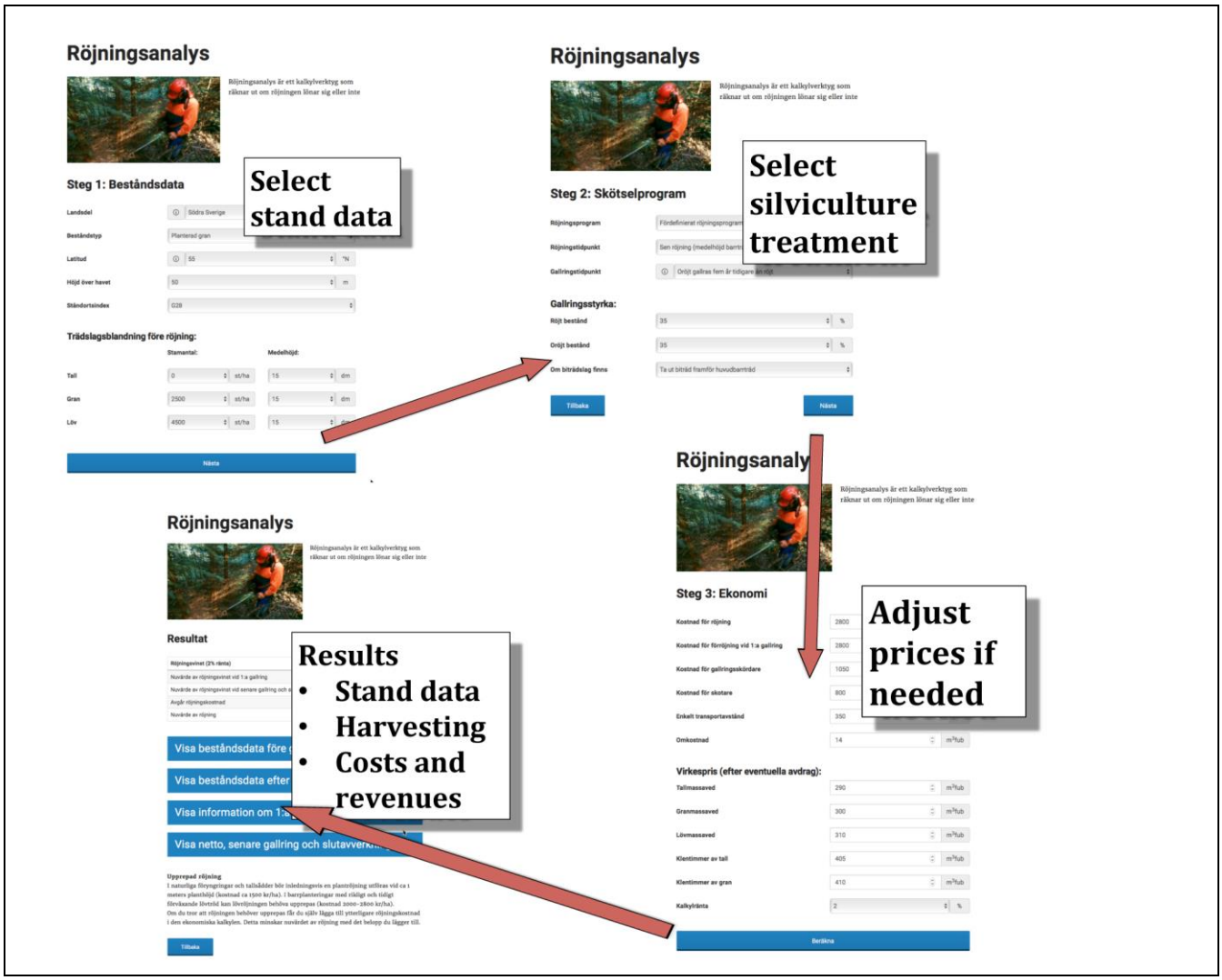

Fig. 2. An example from the calculation tool *Röjningsanalys*. The user selects options for the stand in three steps. The tool uses functions for growth, thinning costs and stand value, showing if the operation was rewarding or not. The user can also list details about the stand and its development.

Röjningsanalys was soon followed by other tools allowing the user to calculate e.g. benefits of genetically improved regeneration materials, fertilization or priority of stands for final felling. Table 1 shows the most used tools in 2016 based on user statistics. It is noticeable that many of these tools are rather simple, giving quick answers to relevant daily questions. The more complex tools, which integrate a chain of economic and yield functions, also have their enthusiastic users, but their imprint on the user statistics is less.

Table 1: Most used calculation tools in Skogskunskap in 2016 based on user statistics.

Tool	Swedish name	Number of hits
Volume of a tree	*Volymberäkning*	18118
Choise of harvesting stand	*Beståndsval*	15777
Thinning guidelines for pine and spruce	*Gallringsmall - tall och gran*	13299
Standing volume	*Virkesförråd*	8688
Choise of regeneration material	*Plantval*	8128
Site quality	*Bonitet*	6140
Costs for building roads	*Kostnad för vägbyggnad*	6002
Site index for spruce and pine	*Ståndortsindex - gran och tall*	5869

3. Instruction films

The user of Skogskunskap can find over 50 instructive short films on all operations from using a chain saw to planning a logging without leaving any traces on the ground or in the water. These films, or often clippings from full films, support the written instructions and calculation tools, and are very popular among users. The films are available on Youtube and are also embedded in *Skogskunskap*. Until 2016, the films had been viewed 1,5 million times according to Youtube statistics.

4. Project financing

The running costs for maintaining the content are provided by *Skogforsk* and the partners *Skogsstyrelsen* and *LRF Skogsägarna*. Development of new content needs however to be funded by external sources, often research grants. The implementation of new knowledge and functions into *Skogskunskap* has proved to be a successful argument in the applications, rewarded by many grants over the years. *Formas, KSLA, Skogssällskapet, Södra* and *Norrskog* are examples of financial sources supporting the decision support system over the years.

An example of an externally financed project is the build up of a package for forest road building and management. An expert group from *Skogforsk*, *Skogsstyrelsen* and the forest industry produced the content, and EU through *Skogsstyrelsen* provided the funding. The text content was complemented with tools for calculation of road building benefits, costs for building and management of the road and for calculation of how much stone and gravel that has to be used for various roads.

5. New design and new name

The decision support system was first known as *Kunskap Direkt* (Knowledge Direct). The first section, about management of broad-leaved forests, was launched in 1999. Since then, the system has changed design and technique several times. The currently growing use of mobile equipment (smartphones and iPads) has put a pressure on making the content accessible for many kinds of devices. In December 2016, a new responsive

design was launched. The relatively complete make-over of the system was also a trigger to change the name. Since then, it is known as *Skogskunskap*.

6. Used by forest owners and their advisers

The number of visits to the website amounts to about 250.000 per year, and 150.000 of these are unique visitors. Inquiries have shown that about 50% of the visitors are forest owners, 12% are forest students, and 16% are staff in the forest companies working with advisory.

Several inquiries and evaluations have been made over the years about how forest owners and forest servants use different communication channels in general, and *Skogskunskap* in particular. It is apparent that forest owners still prioritise personal communication with skilled advisers, but internet increases as a complement, particular among younger and well educated users. Several of the test reports along with the history of *Kunskap Direkt/Skogskunskap* are summarised in Hannerz (2012), and a more comprehensive study can be found in Hannerz et al. (2010). A recent overview of digital sources for forest owners in Sweden is also given in Hannerz & Ahlstedt (2015).

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