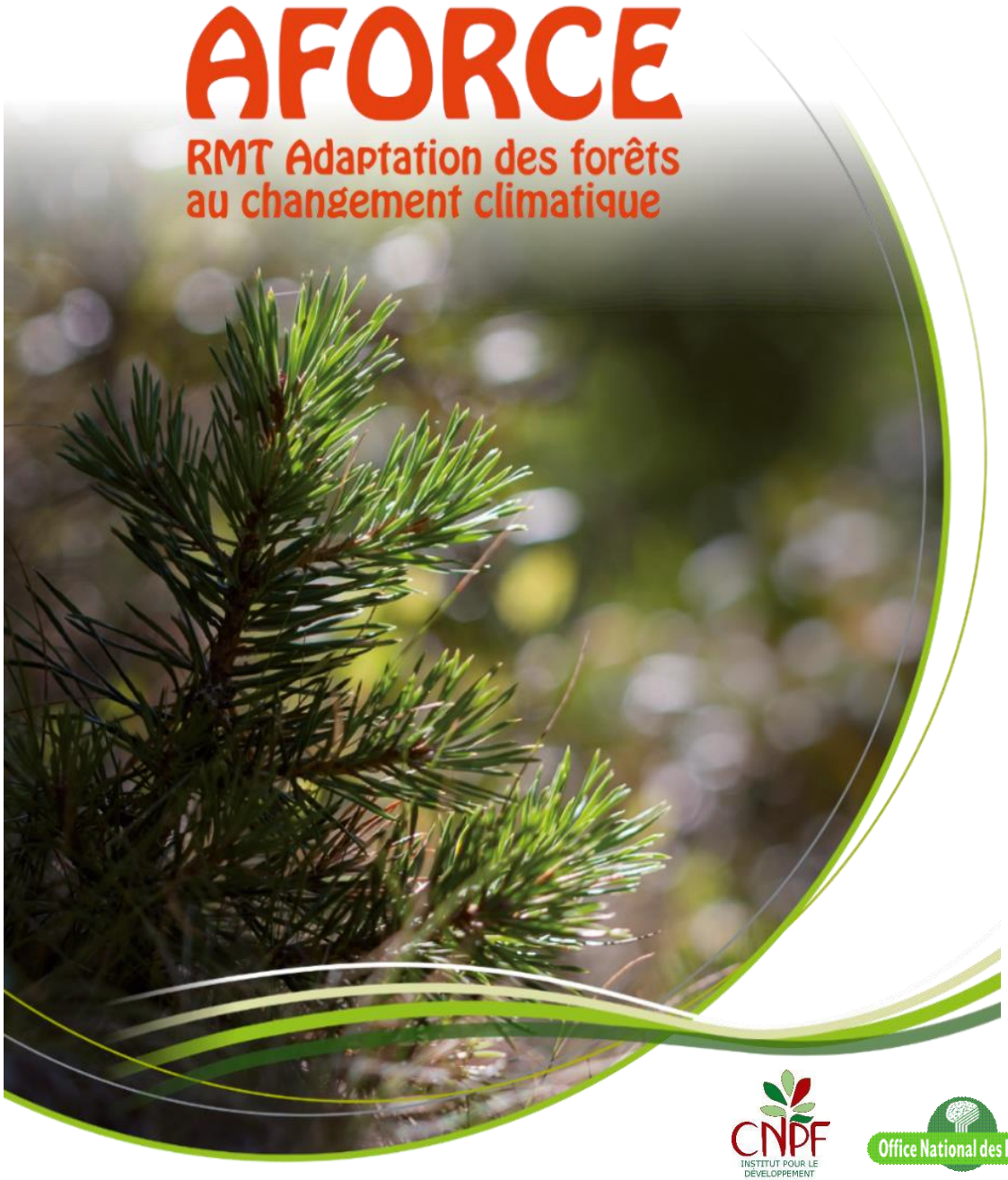

AFORCE Symposium 2019

Forests and climate change: providing support to the adaptation decision

April 2-3, 2019 in Montpellier (France)

Proceedings

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DAY 1

WELCOMING SPEECH

Olivier PICARD (CNPF, RMT AFORCE Coordinator)*

Olivier Picard firstly thanked the many participants of this fourth Symposium presenting the RMT AFORCE projects, as well as the sponsors of the event: the Ministry of Agriculture and Food, national multi-sector organisation France Bois Forêt, the Réseau rural national (National Rural Network), Europe, the Occitanie region and Montpellier SupAgro. This meeting marks ten years of the network. It brings together researchers, managers, trainers, foresters, public decision makers and regional managers, to discuss the network's projects, project results and how these can be used productively in the future.

Since 2008, global and intergenerational awareness of climate change has grown and become more widespread. Society as a whole is taking action. The Affaire du Siècle petition attracted 2 million signatures, while climate scepticism has slowly diminished.

For foresters, it is a topic which has matured and evolved. They have gained a better understanding of global warming-related terminology (hazards, risks, vulnerability, scenarios, etc.). Rather than focusing on the impacts of climate change, the questions put to them now tend to focus on solutions to adapt forests to this new context.

Climate change developments and how ecosystems respond to it are still key topics. However, research will never provide all of the solutions. Managers and forest owners must therefore make clear decisions through trial and error, without regret.

RMT AFORCE has 18 members - including 3 new members - numbering almost 40 experts from a range of organisations. The network has helped to build lasting relationships and has fostered a willingness to work collectively. 12 projects will be covered over the course of the two days, underlining the consistency of the topics and tools used. The Symposium will also provide an opportunity to draw up an overview of the network's work and activities. In addition, as the network's labelling system is due for renewal, we will look at the network's future path, with three workshops to be held on 3 April on this topic.

The Symposium will also allow participants to find out about a number of European initiatives such as the EIP (European Innovation Partnership), which opens up new opportunities and enables new partnerships to be developed, while making the best use of the network's expertise. RMT's experience is quite unique in Europe.

These two days will also provide an opportunity to share our stories. This Symposium would not have been possible without the support of the Ministry of Agriculture since 2008, and of the national multi-sector organisation France Bois Forêt since 2012. In addition, the Network receives one-off donations from the Laboratoire d'excellence (LABEX) ARBRE in Lorraine, GIP ECOFOR, the Caisse des Dépôts et Consignations (Deposit and Consignment Fund), INRA (National Institute for Agricultural Research), Europe and the regions.

RMT's partners and experts were also thanked. Their involvement shows that one euro in public money invested in the network can generate six euros. RMT AFORCE's leverage effect is really inspirational.

Finally, thanks was expressed to SupAgro, the host of this meeting in Montpellier. The Mediterranean forest could be a management model for the twenty-first century, due to its rich biodiversity and great capacity for resilience. It is however vulnerable to climatic variations and urbanisation. Although it generates little high-quality wood, it produces other diversified products and services. In this sense it provides a focus for observation and innovation.

INTRODUCTIVE SPEECH

Elisabeth VAN DE MAELE (Ministère de l'Agriculture et de l'Alimentation)

Elisabeth VAN DE MAELE, Head of the office of sustainable forest and timber management under the Ministère de l'Agriculture et de l'Alimentation (Ministry of Agriculture and Food – MAF), observed first of all that the forest community has been able to call upon its resources and work together to anticipate the impacts of climate change on forests. This action, which was launched in 2009 with the support of the Ministry of Agriculture, is essential both for collective action in the sector and for the recognition of RMT AFORCE. It is also very relevant, as demonstrated by recent unusual climate events and the related health crises which affected large swathes of our forests.

The strong attendance at this Symposium is testament to the action of the forest community, and the concrete measures that it expects. The MAF must support it in its actions. In the future, the role of RMT AFORCE will become even more important.

We still don't have straightforward and final answers to many of our questions. While the uncertainties on the future might be a cause for concern or discouragement, we must ensure that a positive attitude prevails. It is time to proceed with both caution and unity, based on an enterprising and innovative approach. Moreover, both in the forest and in other environments, diversity is a gauge for resilience and opens up new prospects

Note that RMT AFORCE's purpose is to inform public policy, particularly in the framework of the Programme National de la Forêt et du Bois (National Forest and Wood Programme – PNFB) 2016-2026. At the end of 2018, the Programme was boosted by the Plan d'action interministériel Forêt Bois (Interdepartmental Forest and Wood Action Plan). In this framework, the MAF knows that it can count on RMT AFORCE to ensure that research and test results result in real adaptation of forests to climate change.

RMT AFORCE also aims to work closely with forest decision makers on the ground. The Ministry has therefore tasked it with developing European Innovation Partnerships in the regions. This mission is set to continue over the next few years. The presence of selected European guests at this Symposium helps to enhance the network's originality. Europe has a role to play in promoting partnerships, allowing us to go further on issues which transcend national borders.

The public are interested in our forests, evidenced by the large number and wide range of public participants in symposiums organised on this theme. Technical issues reflect wider societal expectations on biodiversity, the landscape, ecosystem services, etc. Therefore, we must also draw on economic and social sciences in order to be able to listen and respond to the concerns raised.

AFORCE, a French network dedicated to forests adaptation to climate change

Céline PERRIER (CNPF-IDF, RMT AFORCE Facilitator)*

Céline PERRIER discussed how the network has developed since its creation. RMT AFORCE's objectives include facilitating the sharing of experiences, dissemination of information, drawing on multidisciplinary expertise and supporting decision makers. RMT originally had 12 partners, and has now increased this number to 18.

RMT AFORCE is the only forestry Combined Technology Network. RMT's initial target audience included R&D officers, forest advisors and teachers. It is now in the process of moving gradually towards expert managers and stakeholders within the various regions, and intends to provide more decision-making tools.

The RMT has three main bodies: the Steering Committee, the Coordination Unit and the Project Organisation Unit. This last is strongly dependent on changes to the network's working topics. In addition, it has a number of information links which include links with data and service providers, and with technical forestry education.

There were changes to the RMT's thematic directions during the 2009-2011, 2012-2013 and 2014-2019 periods, and for the latter period they can be divided into three main areas:

- Choice of species and provenances
- Risk and economic assessment of management decisions
- Adaptation strategies, new forestry and technical innovations

These directions structure the scientific and technical programme which members use as a basis on which to develop the annual action programmes.

In addition to these thematic directions, the following focus areas were adopted for the 2014-2019 period:

- Network organisation and development;
- Drawing on collective expertise;
- Incentives to launch and implement R&D projects;
- Promoting tools and services.

The 25 events organised by the network since its inception have helped to identify requirements, to provide an overview of knowledge and improve connections for a better circulation of knowledge. The network's website (www.reseau-force.fr) has been relaunched, and now attracts more project results and knowledge summaries.

RMT AFORCE is increasingly called upon for its expertise, on a European, national and regional level.

In the area of decision-making aids, three calls for R&D projects were launched during the 2009-2011 period, which funded 15 projects. During the second period, a system of working groups was put in place and led to the implementation of three projects. The calls for projects launched in the framework of the second period (2014-2019) has led to 14 projects being implemented.

Therefore, AFORCE has funded a total of 32 projects as part of six calls for projects. The network has also helped to organise seven training courses. The network's Coordination Unit has summarised the projects based on three thematic directions, highlighting the different production types (interim methodology, finalised method, etc.).

Finally, Céline Perrier noted that the network's two objectives during the 2014-2019 working period were, firstly, exploring international/European opportunities and the regional roll-out, and secondly the strengthening of the partnership with training. RMT AFORCE acts as a uniting and driving force, gradually integrating new partners. During the forthcoming working period, it must use the results of its projects and developments in knowledge in order to rise to the challenge of formulating practical recommendations for decision makers.

Climate change: what can be expected for forests in the future?

Jérôme DUVERNOY (ONERC)*

Jérôme Duvernoy of ONERC began by reminding us that the Observatoire National sur les Effets du Réchauffement Climatique (National Observatory on the Effects of Global Warming – ONERC) was created by the Act of 19 February 2001. Its three main missions are to collect and disseminate information on the effects of global warming, to formulate recommendations on potential adaptation measures to limit the impacts of climate change, and to be the French focal point of the Intergovernmental Panel on Climate Change (IPCC).

He then covered some of the conclusions of the IPCC's Special Report on Global Warming of 1.5°C. The report was published in October 2018 and was written by 91 authors of 40 countries. 133 contributors were involved in the report, who between them assessed 6,000 publications. 1,113 proofreaders added 42,001 comments. Since the pre-industrial period (1850-1900), human activities have caused global warming (land and ocean) of approximately 1°C. The effects of global warming are already visible. At the current pace, a 1.5 °C temperature increase would be reached between 2030 and 2052. However, past emissions will not inevitably lead to a 1.5°C increase.

If the temperature rise is limited to 1.5°C rather than 2 °C, extreme events will be less intense, particularly heatwaves, torrential rain and the risk of drought. By 2100, a 2°C increase in temperature would cause a 10cm greater rise in sea levels than a 1.5°C increase, exposing 10 million people additional people to the related risks.

By limiting global warming to 1.5°C rather than 2°C, the risk of loss of biodiversity and damage to ecosystems would be less pronounced. Drops in yield would be less pronounced for maize, wheat and rice, and the risk of food insecurity would therefore be lower. The portion of the world's population exposed to water shortage risks would be cut by half. Fisheries would be exposed to lower risks. Several hundred million fewer people would be exposed to climate risks and therefore liable to fall into poverty.

To limit global warming to 1.5°C, CO_2 emissions would need to fall by 45% by 2030 (compared to 2010), and CO_2 emissions would need to reach a 'net zero' by around 2050. The reduction of non-CO_2 emissions would also have direct and immediate public health benefits.

Limiting global warming to 1.5°C requires changes on an unprecedented scale in the area of system transitions (energy, agroforestry, towns and cities, industry and infrastructure), reductions of emissions in all sectors, the implementation of technological solutions, behavioural changes and investment in low-carbon solutions.

Current national commitments are not sufficient to limit global warming to 1.5°C. To avoid exceeding this threshold, carbon dioxide emissions must be reduced substantially by 2030. The IPCC has provided a breakdown of contributions to net global CO_2 emissions from fossil fuels and industry, agriculture, forestry and other land use (AFOLU), and of bioenergy with carbon capture and storage - according to the four trajectory models for global warming of 1.5°C.

As part of its missions to disseminate information and provide recommendations, in 2014 ONERC published a report entitled *L'arbre et la forêt à l'épreuve d'un climat qui change* (*Trees and forests put to the test by a changing climate*), published by *la Documentation française*. In France in 2018, a +2.1°C temperature rise was recorded in comparison to the 1961-1990 period. Such a temperature increase generates greater water evaporation, a greater surface area affected by drought and an increased risk of forest fires. The map of France showing visible current or future impacts (by 2050) shows in particular that the surroundings of Montpellier will be increasingly affected by forest fires.

Jérôme Duvernoy then presented France's adaptation policy. ONERC spearheaded the development of the second Plan national d'adaptation au changement climatique (National Climate Change Adaptation Plan – PNACC-2), published at the end of 2018, against a backdrop of increased climate disruption. Through this document, "*The Government has committed to*

protecting the French people and economy. (…) Its objective will be to better protect the French people against extreme climate events, but also to adapt the main sectors of the economy (agriculture, industry and tourism) to future climatic conditions and to improve resilience in response to expected changes."

PNACC-2 has been produced by six working groups (Governance and Steering, Prevention and Resilience, Nature and Environments, Economic Sectors, Knowledge and Information, and International), which have defined the following main actions for the field of forestry:

- Prevention and Resilience: Adaptation to the increased fire hazard and the extension of the areas likely to catch fire;
- Nature and Environments: Promotion of sustainable forest management taking account of climate change, as well as the implementation of 'Nature-based Solutions', and the strengthening of ecosystem resilience;
- Economic Sectors: Regional forward-looking methods for forestry resources;
- Knowledge and Information: Production of a reference book on the current and future impacts of climate change in France.

Finally, Jérôme Duvernoy noted that forests and fire risks were among the ten practical measures introduced when the PNACC-2 was published on 20 December 2018.

SESSION 1 – STATE OF THE FORESTERS' MOBILIZATION IN ORDER TO FACE CLIMATE CHANGE

Patrice MENGIN-LECREULX (ONF), moderator of the session*

In 2005, an article by Vincent Badeau et al. on the displacement of potential climate changes areas was published in the *La Croix* journal. During the same period, the Office called upon researchers to reflect on climate change adaptations, in an effort to link management and research.

This session will examine the dialogue between management and research. Regardless of our research efforts, the "cascade of uncertainty" will continue. We must learn to manage in a context of inevitable uncertainty. Opting not to implement adaptation measures, due to uncertainty, could prove to be very dangerous. Managers have not yet explored the whole range of solutions on which researchers are working. In this context, we must also ensure that we consult with society.

There must be an active conversation between researchers and managers. Therefore, I'd like to thank RMT AFORCE for properly fulfilling its mission. We must ensure that we are working together on the issue of climate change adaptation. Moreover, we need active links between research and management.

Managers still need to develop greater anticipation techniques. We still have a tendency to wait until crises happen to act. One potential anticipation method is to implement management tests known as 'islands of the future', in addition to R&D mechanisms. Managers' anticipation initiatives should be discussed at a regional level with all parties concerned, to aid understanding and prevent any breakdown in communication. In this context, it is important to remain neutral and objective, in order to assess all possible solutions.

How adaptation measures implemented to face climate change are taken into account by foresters (MACCLIF)

Annabelle AMM (GIP ECOFOR), Éric SEVRIN* (CNPF-IDF) and Brigitte PILARD-LANDEAU*
(ONF)

Annabelle AMM, GIP ECOFOR

The MACCLIF project covers climate change adaptation measures by foresters. This project is being implemented within a context which is defined by a number of components. Climate change has induced many changes in forest ecosystems. There have been many projects on the impact and perception of climate change. Initiatives have been set up to consider the adaptation of forests to climate change (including Creafor and Forum Forêt). Foresters are already well aware of the issue of climate change, but various obstacles hamper the implementation of measures. It is in this context that climate change adaptation measures must be put forward.

The objectives of the MACCLIF project are as follows:

- Better understand foresters' perceptions of climate change (both professionals and owners);
- Identify obstacles to adaptation actions;
- Take climate change into consideration in guidance and forest planning documents;
- Draw up a typology of adaptation measures.

The three components of the MACCLIF project are: Foresters' perception of climate change, taking climate change into account in regional guidance and planning documents, and assessment and education based on the actions implemented and on foresters' perception of climate change.

Eric SEVRIN, CNPF-IDF

CREDOC was asked to conduct a telephone survey with managers and both public and private advisors, to assess foresters' perception of climate change. 93% of the 1,062 respondents believe that the climate is changing. Almost 90% of respondents believe that "climate change is dependent on human action". 84.8% of professionals have already adapted their practices. The semi-directed interviews have helped to identify four adapter profiles:

- Adapter based on the existing infrastructure, seeking to boost forestry practice;
- Adapter based on innovation, which seeks to facilitate adaptation by providing external genetics;
- The cautious adapter, who prefers to 'procrastinate' pending further information and tools;

The hindrances mentioned during the semi-directed interviews were both economic and technical. They were also related to knowledge and communication. The hindrances referred to by those who have adapted (723 respondents) are mainly related to a lack of financial means and uncertainty about going further with the adaptation.

960 owners were interviewed by phone. 74% of them believe that the climate is changing. 85.4% felt that the climate change is dependent on human action. And yet, 70.6% of respondents did not intend to change their practices. The greater the surface area owned, the more the owner is changing their practices, has changed them or is planning to do so (the reverse is also true). Those with more land have greater contact with the CNPF, managers or progress groups, which may explain their greater awareness of the issue.

Overall, the survey shows that 93.3% of professionals are aware that climate change has taken hold. The trend is the same for the owners, although less marked (74%). There are very few foresters who are sceptical about climate change. While professionals are making substantial changes to their practices, owners are more reluctant.

Brigitte PILARD-LANDEAU, ONF

The second component of the MACCLIF project focuses on the inclusion of climate change in regional guidance and planning documents (DRA). A lexical analysis of the 32 French Directives Régionales d'Aménagement (Regional Planning Directives – DRA) reveals that 496 paragraphs refer to climate change. The associated thematic focus is on the health of forests, the adaptation of management, water resources, the adaptation of species in the biological sense, the description of the climate, and the risks and uncertainties.

In addition the lexical analysis of the DRA highlights that climate change is predominantly mentioned as a "context" (63 occurrences), without specifying whether climate change is happening now or will happen in the future. 24 occurrences describe climate change as "in progress", while 22 occurrences describe it as "probable or forthcoming". These results show that at the time of the drafting of the DRA, the problem was taken into account, yet the urgency of climate change was not highlighted.

However, the mapping of climate change-related expressions in the DRA and in the Schémas Régionaux de Gestion Sylvicole (Regional Blueprints for Forestry Management – SRGS) show differences in the way in which climate change is referred to in France. This finding may be explained by the year in which these documents were drafted.

An analysis of the state-owned forest planning documents shows 1,273 developments for France. 236 of them mention a species/species which is/are sensitive to climate change. The surface area perceived to be sensitive to climate change represents 6% of the state-owned forest, which has increased since 2010. Pedunculate oak, beech and spruce are the species most often cited as most the affected by climate change. Alternative species include the sessile oak, the Scots pine and other softwood species.

The two main measures contained in forest planning documents, as a percentage of the total surface area said to be sensitive to climate change include replacing species during forest renewal, and the gradual replacement of species by another (respectively 38% and 25%). Changing the origin of these species is not at the top of the list of these measures.

Annabelle AMM, GIP ECOFOR

In terms of outlook, we must support managers by creating a typology of climate change adaptation measures (qualitative and quantitative surveys, DRA analysis etc.). In addition, we must rethink the way in which we communicate, to better understand hindrances to the implementation of adaptation measures. The MACCLIF project raises a number of questions: How do we manage conflicting information? How do we accelerate changes in practices when 70% of private forest owners do not intend to change their practices? How do we generate the financial resources?

How to take into account climate change in forest management decisions, despite the uncertainty and with the tools already at our disposition?

Johann HOUSSET, Alcina Forêts*

Johann HOUSSET represents Jacques ROUSSELIN, presenting a testimony from the Experts Forestiers de France (French Forest Experts), an organisation which brings together 170 forest experts who manage more than one million hectares throughout France.

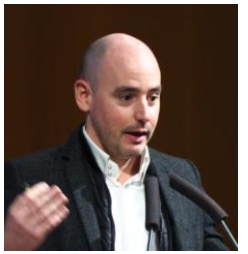
The management work of forest experts has always been a long-term undertaking. Risk management is part of the daily life of forest managers. In this context of more frequent climate crises, forest experts are convinced of the need to take climate change into account in forest management.

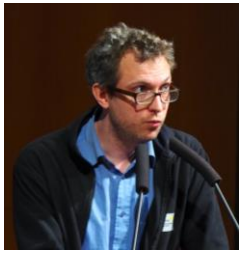
Forest experts assist owners in forest investment and in assessing the value of forest assets. They are therefore led to question the developments in the value of forest heritage, taking into account the contradiction between the increasing price of forest funds and the growing uncertainties of the future value of the stands that constitute them. In this context, far from being "firefighters" in charge of extinguishing fires, forest experts must maintain their role as forest managers, helping owners to take all of these uncertainties into account.

Since climate change will generate new, more frequent and unprecedented problems, forest experts are unable to give owners any turnkey solutions. This context still raises many questions about how to manage stands. However, it is clear that adaptative action must be taken now, even if current scientific knowledge does not allow for us to have all the solutions. Additionally, this situation invites forest experts to be proactive, to adopt a humble stance and to accept the risk of making mistakes by providing the best support to owners in this process.

With regard to the tools available to forest experts, the finding is that the offer is extensive, but that little is known about it. Appropriation and training efforts must be carried out to enable forest experts to use them in their management. Tests are also being conducted with some forest experts, including risk absorption and mitigation, and the implementation of mixed planting tests - to promote the economic and ecological resilience of stands - and silvicultural route tests. The forest experts also decided to sign the agreement to take part in the efforts of the AFORCE RMT. They will thus be able to appropriate the tools, receive better training, and be more in touch with the scientific community, with the desire to be involved in research activities and to be involved in the new solutions still to be invented.

Overwiew of the regional mobilization on forest adaptation to climate change: conclusion of an expert mission supported by the EIP-AGRI and the National Rural Network





Benjamin CHAPELET (CNPF) and Jean CROISEL* (Conseil régional Bourgogne-Franche-Comté)*

Jean CROISEL, Conseil Régional Bourgogne Franche-Comté

An overview of the European Innovation Partnership (EIP-AGRI) was provided, together with its context. This new tool, linked to the 2014-2020 schedule, was put in place to achieve the objectives of the "Europe 2020" strategy, which emphasises smart, sustainable and inclusive growth. Europe is very fond of the EIP, because it has the potential to identify innovative and practical solutions to ensure that transitions are successful. The EIP-AGRI covers both the farming and the forestry sectors (in a broad sense), and involves several project types (R&D programmes, multi-stakeholder projects and thematic networks). The European Commission is responsible for selecting projects for funding.

Moreover, regional projects revolve around Operational Groups, which involve researchers, developers, engineers and forest owners. The EIP may fund a new Operational Group, or the implementation of an innovation project. Project selection and funding is conducted at regional level, and regional councils are responsible for managing European EAFRD funds.

A number of organisational tools are used within these two major project groups, which are categorised on the basis of Focus Groups. The purpose of these tools is to ensure that innovative practices are disseminated throughout Europe. At the national level, organisation is the remit of the Réseau rural national (National Rural Network).

Two of the 34 Focus Groups are forest-related. Focus Group no. 20 focuses on forest biomass, while focus group no. 24 focuses on new tools and practices for the adaptation and mitigation of climate change in the forest sector.

Four of the 97 H2020 multi-stakeholder projects multi-actors have a forest theme (Alterfor, Homed, InnoForest and Sincere). Three of the 32 thematic networks (Agriforvalor, Afinet and Incredible) are forest-related. There are eight operational forest groups which cover 179 regional projects. The groups include "Adaptation of the 'Grand Est' forests to climate change", "Precision forestry" (Aquitaine) and "Douglas and climate change" (Burgundy), which will be covered during the course of this Symposium.

Each region has negotiated its own Rural Development Programme (RDP) with the European Commission, and its own guidelines for regional assessment. To date, EIP measures have been launched in all French regions, except in Corsica and Ile-de-France. The EIP is subject to a yearly revision, with the technical and scientific support of RMT AFORCE.

EIP budgets have been partially ringfenced. The EIP will be strengthened over the course of the next scheduling block. It is an area that we ought to take an interest in, as there are so few forest projects. The selection of forest cases is therefore far less powerful than for conventional European projects or national projects.

Benjamin CHAPELET, CNPF-IDF

Through CNPF, FRANSYLVA, FNCOFOR and the Ministry of Agriculture and Food (MAF), French foresters have been taking action since 2013 to push forest-related issues up the agenda. In 2015, a collective of 11 national forestry stakeholders, formed by the CNPF and the MAF, was set up for better integration of forestry issues in the EIP-AGRI. In 2017, the Réseau rural national and the Ministry of Agriculture launched a subject-specific expert assessment of forests, climate change and innovation. Organised around six regional discussion workshops with a total of 127 participants, this thematic event aimed to identify existing projects and initiatives, promote the sharing of information between stakeholders, communicate on the EIP scheme, and help regional authorities and project leaders to gain a global, consistent and structured vision of possible actions.

The priority forest themes identified for R&D included risk management, the sylvo-cynegetic balance (i.e. the balance between the game population and forest renewal) as a prerequisite to any forest action, climate change adaptation, promoting the role of forests in climate change mitigation, training, technical and higher education, and communication.

The following hindrances, drivers and recommendations were put forward:

- Improve awareness of funding sources for the forestry sector;
- Encourage stakeholders downstream of the sector to become more involved;
- Disseminate, promote and share information and results;
- Promote inter-regional and national co-ordination;
- Promote European cooperation.

With regard to outlook, at a regional level we need to strengthen links with the regional identified points of contact (the Regional Council, DRAAF, multi-sector organisation, CRPF) to enable RMT AFORCE to build on the information that it holds. At a national level, RMT AFORCE should strengthen its position as a united network of stakeholders and actions on this theme. Based on Creafor, a database of stakeholders, projects and events should be made available to regional stakeholders. At a European level, some priorities match those arising from the "Forest Practices and Climate Change" Focus Group, and the thematic network on climate change must continue its work.

Presentation of European initiatives on climate change adaptation and risk mitigation by EFI and input of the EIP-AGRI via focus group

Christophe ORAZIO (EFIPLANT), Olivier PICARD (CNPF, RMT AFORCE coordinator) and Pacôme ELOUNA-EYENGA* (EIP-AGRI)*

Christophe ORAZIO, EFIPLANT

The European Forest Institute (EFI) is an international organisation established by treaty between 29 States - including France - which has 120 R&D institutes as associate members. In France, an eight-strong team dedicated to planted forests works in close collaboration with the IEFC network. It facilitates scientific and technical co-operation, the sharing of knowledge and access to stakeholders and policymakers. It also helps to inform society about planted forests, and is the European hub for this topic.

The REINFFORCE research network for climate change adaptation was launched in 2009, and brings together a network of 41 demonstration sites for adaptive management (in existing stands) and a network of 38 arboreta (in the north of England in the south of Portugal) to assist in the choice of species and provenances in a changing climate. Since 2013, it has been maintained through the contribution of funds by 11 organisations.

REINFFORCE is studying a large number of species (softwood and hardwood, exotic and non-exotic). For example, initial results obtained on six-year-old trees show that the *Pinus elliotti* species is very sensitive to global warming, whereas the sensitivity of the black pine is significantly lower. Similarly, the impact of global warming on growth varies significantly from one species to another.

PLURIFOR is a project dedicated to risk management (including storm, fire, erosion, the pine wood nematode, fusarium and emerging diseases). Increasing numbers of hazards are pushing the boundaries. The final meeting of the project will be held on 4 June in Bordeaux. Eight key risks are the subject of management plans which have been developed or improved by the project. These management plans will be implemented in a coordinated manner with France's European neighbours. 17 risk management tools will be made available through the project. These tools will, in particular, include a map showing the vulnerability of stands to the wind, a guide to improve the stability of the stands, and a free smartphone app called 'Silvalert' to report forest damage.

The HOMED project is coordinated by INRA and is currently in its implementation phase. The project is dedicated to emerging risks (pests and pathogens), related in particular to the increase in trade. The project focuses on detecting, monitoring and eradicating pests and pathogens.

In preparation, the Pre-Act project is an information network for European experts, to manage risks and improve climate change adaptation. The project will be based on tools which promote information transfer and the conducting of case studies at European level. The project could offer some useful synergies with national initiatives.

Pacôme ELOUNA-EYENGA, EIP-AGRI Service Point

The European Innovation Partnership (EIP) for farming productivity and sustainability covers both farming and forests, although the European Commission does not yet have an official forestry policy.

The purpose of EIP-AGRI is to foster competitive and sustainable farming, which achieves more and better from less, and works in harmony with the environment. It links research and practice to narrow the gap between the practical application of research results and the needs of practitioners.

The EIP-AGRI steering committee is no longer in existence. The partnership is now managed by Unit B.2: Research and Innovation under the DG Agriculture and Rural Development. Some Operational Groups focus on forest issues.

EIP-AGRI is implemented as part of the CAP, pillar 2 (the Rural Development Programme) and through a European research policy under Horizon 2020. . EIP-AGRI therefore incorporates both the thematic networks and Horizon 2020

multi-stakeholder projects, as well as the Rural Development Programme Operational Groups.

The EIP-AGRI Service Point was created in the framework of the European Regulation, and is an outsourced service of the European Commission (DG AGRI). The Service comprises a team of 30 professionals, managed by Pacôme Elouna-Eyenga, and runs EIP-AGRI at a European level. The Service Point's role is to encourage networking and knowledge sharing.

Operational Groups comprise a project on a practical topic which bring together a number of stakeholders. To date, more than 1,000 Operational Groups have been put in place at the European level, and 897 of these have been declared to the European Commission. 10% of them are directly or indirectly related to the forest. The main themes of these Operational Groups include forest management, forest products and services, land management, biodiversity, climate change, ecosystem services and agroforestry. Only five groups focus specifically on climate change.

An online database lists all of the projects. A heading, contact and description is provided for each of them. Unfortunately these are not always accurate. To date, two of the 38 Focus Groups are specifically dedicated to the forest, but forest issues are raised in at least three others. Focus Group topics are determined as part of a specific process. Each year, a call is launched online. In June, all subjects on the EIP-AGRI website are classified by priority, depending on the research agenda and on the European Rural Development Programme, and submitted to the Subgroup on Innovation, which is the steering body for EIP-AGRI activities. It includes representatives of each Member State. Once the Subgroup on Innovation has completed its discussions, the priority themes are chosen for the Service Point work programme, and therefore also the themes adopted by the Focus Groups.

Olivier PICARD, CNPF, RMT AFORCE coordinator

Focus Group no. 24 on forest practices and climate change brings together around 20 European experts. Its objectives are to identify the success factors and the constraints of forest practices for adaptation and mitigation, to select innovations, to propose ideas for Focus Groups and to identify research requirements.

In its conclusions, the Focus Group stressed the importance of facilitating the flow between the research, trials and the tools for forestry practice, and of raising the awareness of climate change policymakers, improving their risk perception and their communication needs, and finally to implement long-term policies and economic incentives for adaptation.

The Focus Group has put forward the following ideas:

- Combining adaptation and mitigation;
- Smart forestry and genetic resources,
- Adaptive management of small properties;
- Limiting the fire risk;
- Facilitating exchanges between research, management and the timber industry;
- Promoting innovative uses of timber.

The following topics were suggested for future Focus Groups:

- Forestry to promote the regeneration of hardwoods;
- The use of decision-making support tools and models to prepare adaptation recommendations;
- Improving assisted regeneration and reforestation in dry areas;
- Developing early warning systems;
- Adopting development plans which take risks into account;
- Analysis of the contribution to mitigation in the forest and timber sector.

The final report is available in English at the following address: https://ec.europa.eu/eip/agriculture/en/content/focus-groups/new-forest-practices-and-tools-adaptation-and

SESSION 2 – IMPROVING THE CHOICE OF TREE SPECIES IN A CONTEXT OF CLIMATE CHANGE

Alain BERTHELOT (FCBA), Moderator of the session

Climate change is now accepted by a large majority of the population. The likely displacement of climate envelopes to the north will happen much faster than the natural ability of the species to move. In this context, one solution would be to implement no particular measure, and rely on the adaptation of current species. Another would be to use the existing genetic diversity within the species to select the species that are best adapted to the future climate. Data sheets for the use of FRM[1] have begun to be modified, and raise the possibility of using species with more southerly origins. A third solution would be to seek out other species which are adapted to the future climate.

Then, we need to identify the zones in which the replacement species will be planted. Finally there is the issue of choosing species in an uncertain climatic context. Some species, which grow in a very limited natural area and are therefore primarily within a narrow ecological niche, are ultimately in great demand worldwide. Therefore, it is appropriate not to prohibit any species and to conduct a high number of tests.

[1] Forest Reproduction Material: https://agriculture.gouv.fr/materiels-forestiers-de-reproduction-arretes-regionaux-relatifs-aux-aides-de-letat-linvestissement

A multipartner national network to evaluate genetic forestry resources for the future (ESPERENSE)

Hedi KEBLI (CNPF-IDF)

The ESPERENSE project was created in the context of managers' strong expectations on testing alternatives to existing species, innovative approaches by partners (RENEssences, REINFFORCE etc.) with potential feedback, and RMT AFORCE initiatives. One of these initiatives is VALORESO, the aim of which is to analyse the potential of trial assets in order to assess the response of species to climate. There is also EXPRESS, the purpose of which is to draw up a structural blueprint for trials to be implemented in order to test new species and origins).

The progressively matured considerations produced by the EXPRESS approach will be promoted as part of the ESPERENSE project. In addition, stakeholders have stated their willingness to set up new mechanisms based on inter-agency consultation.

The objectives and challenges of the project include:

- Improving knowledge on the behaviour of species and provenances;
- Providing an overall framework for trials of new species and provenances;
- Setting up a sustainable partnership based on these trials.

RMT AFORCE is the project leader for the ESPERENSE project. Partners of the project include the CNPF, EFIATLANTIC, the FCBA, INRA, IRSTEA and the ONF. Other selected bodies will be invited to conduct specific project tasks. The project duration is 36 months, from 2018 to 2020. After the methodological

framework has been set out, the ESPERENSE network should be able to take charge.

The project's three main tasks are the launch of the network of multi-partner trials, setting up *in situ* tests, and setting up *ex situ* tests. From Task 1.2 relative to the definition of the overall framework of the network multi-partner trials, each task will be dependent on the outcomes obtained in the previous task.

Four main outcomes are expected in this project:

- Lay the foundations of a network of trials to assess species and provenances (global framework of the network, species and provenances to be assessed, protocols for different types of tests)
- Define high-risk timer production forest systems considered vulnerable to climate change
- Specifications to set up a multi-partner information platform enabling the sharing of trial data and meta data, which is linked to existing databases
- Creating an official multi-partner consortium based around the network

After this, the progress of the project is provided together with the initial results of Task 1.2

Finally, it is important to cover the project's constraints and restrictions. There are too few mechanisms for this initial set-up phase to be suitable for analysis. In addition, the duration is very restricted for crop growing, and there is little room for manoeuvre on the decisions adopted, particularly as regards the list of genetic units and at-risk zones. On the other hand, the project is facilitated by the considerations noted in previous projects. In addition the project has set out the basis for the ESPERENSE network, which will quickly grow if it is able to pool regional approaches. The ESPERENSE project aims to foster links with other projects working on the same themes.

Supplying foresters with quality seeds in order to test new species (TREC)

Patrice BRAHIC (ONF) and Catherine DUCATILLION (INRA)

Patrice BRAHIC, ONF

The purpose of the TREC project is to source high-quality forest seeds to test new species or origins. This project is being conducted in partnership with INRA, Villa Thuret, the INRA BioFoRa unit, the EFI, the ONF and Vilmorin.

By changing growth conditions for native forest species, climate change risks endangering current production species. Therefore, tests of 'new' species adapted to climate change are crucial in order to increase the range of choice. The first step is to supply high-quality seeds of known origin, which is not an easy task to fulfil.

Catherine DUCATILLION, INRA

The process of introducing and acclimatising new species can be broken down into two major steps: The study of wild plant species, then the trial and selection of suitable provenances. The first step can take decades or even centuries. It involves the planting of crops (from a small sample taken from natural resources) in a completely new environment for the species. This process enables propagation techniques to be tested, and provides general information on how the specimens behave in a new context. As this phase is relatively long, the specimens may be faced with climatic variations, and therefore provide additional information.

Therefore, the individual data obtained could provide indicators for the potential use of these biological resources. Some species drawn from this sample may be subject to trials. The move from the closed environment of the botanical garden to the natural environment is an important step in the process.

Thus the arboreta, created by INRA in the 70s and now managed by the ONF, are a series of shared gardens serving as disposal areas and plots to compare species and provenances. The map shows that the arboreta of the Mediterranean region are suffering particularly oppressive conditions. The species have been faced with cold and exceptional drought as well as difficult soil conditions. In addition to the taxa being well developed, the survival of a few specimens attests to the potential of the species concerned.

The results obtained in these arboreta have contributed a list of species drawn up which could have potential for the future.

Patrice BRAHIC, ONF

The TREC project is faced with a number of issues, including the supply of high-quality and high quantities of seeds which are certified and of known origin (for third-country species), and the regulatory constraints and phytosanitary measures which apply to their import and trade, as well as methods for the conservation and germination of species for which little or nothing is known of growing methods. The supply and trade components may require substantial supply periods (3 to 6 months or more).

In order to best examine all aspects of the issue, 20 species were selected, taking into account their benefit to the forest, the diversity of their geographical areas of origin (North America, South America, Asia and Europe) and their assumed supply (easy, moderately easy, difficult, and very difficult). The relatively small list of species selected by the Steering Committee helped to test and/or to identify suppliers in four continents, and to deal with the regulatory aspects. 13 species were selected for the implementation of actual supply tests and pre-germination protocols. We then prepared a list of reliable merchants offering high-quality forest seed, identified on the basis of an evaluation criteria grid.

A summary of information was also put together based on the regulations that apply to trade in species (impact of Nagoya treaty, Forestry Code, etc.), the list of processes (import, phytosanitary, etc.) and the link to access forms to fill out in order to import the seeds. In addition it is important to know which pre-treatments are required for optimal germination of the selected species. Three test protocols have been developed to identify the best pre-treatments.

The Alpine and Mediterranean forests confronted with climate change in the Provence-Alpes-Côte d'Azur region (SYLFORCLIM)

Pauline MARTY (CNPF-CRPF PACA) and Michel VENNETIER (IRSTEA)

Pauline MARTY, CNPF-CRPF PACA

The PACA region (Provence-Alpes-Côte d'Azur) is the most affected in France by the effects of climate change, in particular in terms of temperature increase (a 2°C rise between 1960 and 2010, compared with the French average of 1.5°C) and a decrease in precipitation. The Scots pine is the number one forest species in the PACA region in terms of surface area. It has reached the limit of its distributional range within the region. The species is on the decline in PACA, and between 1989 and 2015, it was affected by a considerable increase in defoliation.

The objectives of the SYLFORCLIM project were to:

- Map the sensitivity of the Scots pine to climate change;
- Estimate climate offsetting factors;
- Conduct a dendroecological study to identify the impact of climate developments;
- Propose forestry-related recommendations.

The project has been implemented with the help of financial partners (RMT AFORCE, DRAAF, the Ministry for Forestry and the multi-sector organisation), technical partners (CRPF PACA, IRSTEA and IDF) and associated partners in the working group.

The project's working method was initially to harvest existing data on the health of the Scots pine, as well as a large volume of field data and GIS data (Météo-France and AgroParisTech models). Statistical processing was applied to all of this data with the aim of explaining the decline of the Scots pine in the PACA region.

The data collected on the plots showed an average defoliation rate of 48%, with the vast majority of stands having a defoliation rate of between 30 and 70%. Statistical models were then used to explain this decline. The presence of mistletoe and the topo-edaphic index constitute the first two explanatory factors. The presence of mistletoe is explained by the climate and topography criteria. The explanatory criteria for the model used include the water balance over the vegetation period, the annual water balance, the recurrence of the climatic water deficit and the topography. It was then possible to use GIS to map the probability of the presence of mistletoe, and thus the probability of wilting and decline, with the mistletoe causing and aggravating this wilting/decline.

The climate vigilance map prepared shows the probability of finding a wilting stand of Scots pine (30% increase of trees with a defoliation rate of more than 50%). This map, which was prepared using current climate data, shows that the vast majority of stands are located in high climate vigilance zones.

Michel VENNETIER, IRSTEA

The presence of mistletoe is not the only explanatory factor for the wilting of the Scots pine. The mistletoe partially absorbs the climate variability factor. However when the 'mistletoe' effect is eliminated, the impact of climate change on the species remains significant.

The results of the dendroecological study show that the productivity of the Scots pine is reduced with age. For the past 40 years, stands aged 110 years and over have begun to lose their productivity. Those currently aged 80 to 110 years have been losing their productivity for the past 25 years. To maintain the productivity of the Scots pine, it is therefore preferable to not let it grow too old, by regenerating the older stands.

A Scots pine reaches peak productivity between 25 and 40 years, and then reaches a plateau between 60 and 70 years. The Scots pine reached its growth peak (based on the same age) in the twentieth century, up to the 1970s. However, increasingly frequent and pronounced droughts have now entirely cancelled out the increase in maximum productivity, which has been declining since the 1990s.

Studies have also been carried out on the effects of altitude. At the beginning of the twentieth century, stands planted above 1,200 metres grew better than those at low altitude. From the 1940s, the growth of rings has strongly increased, in particular for stands of low altitude, which have benefited from the longer growing season and the higher rates of CO2 without suffering extensive effects of drought. Low altitude trees have therefore exceeded the growth of high altitude trees, where the cold has restricted growth. From the 1990s, the roles were reversed as the growing season extended for high-altitude stands, while drought restricted the growth of stands below 1,200 m. However, for the past 20 years, high-altitude trees have also been suffering the effects of heat and drought, and their growth is declining in the same way as low-altitude stands.

A similar effect to the altitude effect was observed on cold slopes and warm slopes.

Until the 2000s, dense stands and sparse stands followed a similar trend in terms of relative productivity. Since the drought of 2003, dense stands are far less resistant and less resilient, regardless of the location. Their mortality rate is also higher. The study therefore shows that thinning out and regeneration boost resilience and the survival of the species.

The most mistletoe-affected trees (>30%) have never recovered from the last episode of drought. They will certainly die when the next great drought comes. It takes on average 40 to 50 years between the time that the mistletoe begins to have an effect on the growth of trees and the time at which it contributes to their demise. It is estimated that 20 years elapse between the mistletoe taking hold and the beginning of its lasting effects on tree growth. This effect is accentuated with time, and makes the trees less resistant and less resilient to droughts.

Analyses of processionary caterpillar attacks between 1970 and 2017 shows that major attacks, for the same stands, result in a significant loss of growth. Caterpillar attacks always happen in the same places and with the same intensity. Over the period, the most attacked stands lost 27% of their growth, compared with 16% and 7% respectively for the stands with moderate or few attacks. The most recent attacks were so violent that certain exhausted trees were completely defoliated, causing them to die.

A 2016 analysis of the link between defoliation and the productivity of pines showed that tree growth decreases from 50% defoliation. Over the 2010-2016 period, a defoliation of more than 70% caused a very significant loss of productivity in those trees, which are thus condemned in the short term.

Pauline MARTY, CNPF-CRPF PACA

In the framework of the project, a four-page summary document was produced, linked to the climate vigilance map using GIS. The purpose of this document is to help a field operator make an assessment on the ground.

In addition a key allows you to combine the different criteria assessed on the ground with the climate vigilance map, to determine whether the Scots pine stands in the studied zone are exposed to any risks. Management recommendations are linked based on three possible cases, in order to increase the resilience and the resistance of the stands.

In the future, the results of the project will be integrated into the BioClimSol tool at a national level. The results obtained in the PACA region will be tested in other French regions. The BioClimSol tool will then be circulated to forest managers at the end of 2020. It will be presented in the form of application combining the climate vigilance maps with a field assessment tool.

The initial response following the SYLFORCLIM project will take the form of the MEDForFUTUR project, which will propose plantations and enrichment of plantations in ‘islands of the future’ covering half a hectare. The selected species have already been tested on a trial basis in PACA. Ten ‘islands of the future’ were completed in 2018. Private funds are being sought to finance the plantations planned for 2019.

SESSION 3 – WHAT SILVICULTURE PRATICES TO PROMOTE IN ORDER TO ADAPT FORESTS TO CLIMATE CHANGE?

Philippe BALANDIER (IRSTEA), moderator of the session

The presentations of this session relate primarily to the water balance of the stands. The main factors which affect the water balance are rainfall, rainfall capture by vegetation, evapotranspiration (itself determined by radiation), temperature and the relative humidity of the air, and the water reserve in the soil (determined by root depth). Even without any change to rainfall, the increase in temperatures will considerably increase evapotranspiration and thus lead to a lower water balance for the stands. The presentations below will focus on different variables (the surface perspiration, the condition of pipelines and wood pores, roots, the depth of the soil and the surrounding species). Forest actions differ according to whether you focus on tree growth or tree survival. RMT AFORCE has written a book on the water balance of forest stands which presents a summary of the scientific knowledge and suggests the implications for management.

Dendroecology study on Quercus petraea using long-term forest monitoring (ADAREEX)

François LEBOURGEOIS1 in collaboration with Anna SCHMITT[1], Raphaël TROUVE[2], Claudine RICHTER[3] and Ingrid SEYNAVE[1]

To adapt the forest to climate change, the manager has three springboards for action: The choice of species, the forest station and forest management. Adaptive forestry methods are currently under consideration to mitigate the effects of climate change on the dynamics of forest stands. In practice, we need to support transitions for management actions which improve the forest's capacity to cope with changes, while continuing to ensure that management objectives are met (i.e. producing high-quality wood).

Studies conducted in the 1990s led to the creation of a Co-operative Scientific Interest Grouping for data on the growth of forest stands (GIS Coop), which brings together a number of partners and forestry trial networks. This grouping is now covering five species. 1,206 plots have been installed on 185 sites throughout France. Trials are carried out on these plots to identify various density levels, analysed through the relative density index (RDI). A number of scenarios have already been tested, including low RDI, high RDI, ascending or descending RDI, etc.

The effects of reductions in stand density on the climate response of the sessile oak were analysed. The hypotheses tested include the overall reduction in climate sensitivity (more resources available for the trees under low density) and the increase in resistance, resilience and recovery after a major climate event (extreme droughts such as 1976 and 2003). This analysis is supported on 4 of the 22 sites (15 plots per site) within the 'sessile oak' network, with trials for low, medium and high RDI (~0.2, 0.5 and 0.8). These four sites also exhibit different water conditions (humid, mesophilic or dry). In order to complete the analyses, approximately 300 trees were cored and their growth was measured. Each tree was categorised by its social status (dominant, codominant and dominated).

Trial outcomes:

- Growth was better on the 'humid' site and under low density. The 'site' effect is always far more pronounced than the 'density' effect;
- The average climate response varies according to the water conditions, but not according to the competition (density/status);
- The reduction in density improves resistance, recovery and resilience even further in more difficult conditions.

Initial areas for recommendations:

- The best stations should be the subject of particular attention, because trees on these stations are less resilient;
- In order to increase the resilience of the stands, the RDI should be limited to 0.4. However, a density this low presents a few risks, particularly in terms of characteristics of the stands, and a fall in production and wood quality;
- More dynamic forestry methods should be implemented for the stations where conditions are difficult.

With regard to the outlook for the project, the results will be sent to the AgroParisTech engineers. The laws of mensurational growth will have to be reformulated and incorporated into the simulators. Finally the results of the project will improve decision-making tools (Beech, etc.).

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Effect of the reduction of leaf area on the sensitivity of trees to drought (REDSURF)

François COURBET (INRA-URFM), Nicolas MARTIN-St PAUL (INRA-URFM) and Jean LADIER (ONF) in collaboration with Guillaume SIMIONI (INRA-URFM) and Claude DOUSSAN (INRA-EMMAH)*

François COURBET, INRA

The two potential adaptive measures for the existing stands are the replacement of threatened species by more suitable species or provenances, and secondly the improvement of environmental conditions, in particular the water balance by controlling canopy cover (*RÉDuction de la SURFace foliaire* – reduction of the leaf surface).

The REDSURF research project focuses on the second measure. Its objectives are to study the effect of forestry interventions (thinning and pruning) on the sensitivity of trees to drought, to assess a series of adaptation indicators which incorporate these effects, and to transmit knowledge, indicators and functional methods to assess the response of trees to climate change.

The project firstly builds on an experimental method which observes the climate sensitivity of the cedar and fir tree in contrasting competitive situations induced by the forest, and secondly on functional models (the stand water balance model Biljou, and the water balance and hydraulic operation model SurEau) to simulate and test the effect of thinning under current and future climates.

The experimental approach has been implemented in the framework of both a forestry programme for the Atlas cedar in the vicinity of Avignon, and a fir tree programme to the south of Carcassonne. These two programmes have allowed us to collect data on the climate, soil, understory vegetation and the stands.

Data relating to the health status of the fir tree shows that thinning has no positive effect on the defoliation rate. Cambial necrosis was observed in the

cedars, and a there was a correlation between the rate of necrosis and the De Martonne aridity index. The lower the aridity, the more necrosis was found.

To study the growth of trees, the widths of rings were measured on 84 trees. The beneficial effect of the decrease in density is observed particularly during the first five years after thinning, when the density is at its lowest.

Nicolas MARTIN-St PAUL, INRA

A functional approach has been adopted to understand the effects of thinning and the reduction of the leaf surface on the water stress of stands. The water balance is calculated based on supply (the soil volume accessible to roots, and precipitation) and demand for water (the leaf area index and evapotranspiration). Based on the water balance of the parcel and functional traits of the species (in particular the vulnerability to cavitation), it is possible to calculate the water potential of the plant and the risk of cavitation (or embolism) which is the main phenomenon causing the mortality of trees in the event of a drought.

During the summer of 2017, the water potential decreased for all density treatments studied. However, differences in water potential could be observed between the different levels of density. The more thinned-out stands had a better water potential (and therefore less stress). An X-Ray tomograph was then used to scan the branches and view the rate of tracheids with cavities in their segments following the drought. The slightly thinned-out stands presented a low cavitation, while the cavitation level in the control stands (high-density) was up to 20%.

These results indicate that thinning has had a beneficial effect on water stress during an extreme drought, and that it decreased the risk of cavitation even if it took place 20 years ago.

There was an improvement in water comfort, even though the undergrowth had covered a large surface of the thinned-out plots, meaning that both treatments had an identical LAI (leaf area index of the undergrowth and cedar trees). The most logical explanation for this observation is that thinning of some cedars has allowed for better colonization of the soil volume by the roots of the remaining cedars, and that the undergrowth that has grown is not in competition with the cedars (it uses different areas of the soil from those used by the cedar, and is therefore not in competition). A better understanding of water use by undergrowth would appear to be crucial for any progress to be made on these issues.

The water potential data is not available for the fir stands to the south of Carcassonne. The water balance (Biljou) and cavitation (SurEau) models have been used to try to better understand the effect of the leaf area index on water stress. The first simulates the water content of the soil as an indicator of drought and the number of days below a certain extractable water reserve threshold, while the second explicitly describes water potential and levels of cavitation during a drought. The modelling results have confirmed that thinning could be a powerful driver to mitigate the effects of climate change, and to enable the cedar and the fir tree to continue living in their current environments, even in more severe scenarios.

Jean LADIER, ONF

To conclude, it should be noted that the results of the project are not sufficient to establish a clear and straightforward relationship between the density level and the health status criteria studied. This finding may be related to the fact that the causes of health symptoms are multifaceted. It is also suspected that the cedars may have been weakened by a Sphaeropsis blight.

The link between growth and high density is well known, but to reduce the effect of climatic accidents on growth the density level must be very low. Moreover, this effect is relatively temporary. On the other hand, it appears that ecophysiological variables are sensitive to smaller differences in density. Moreover, this is a long-term effect.

The two ecophysiological models gave similar results. They presented a high sensitivity to the LAI data and to the available reserve in the soil. However, estimating these two parameters is still difficult, and may be inaccurate based on the scenario.

Therefore, it does not seem appropriate to promote the project results. On the other hand, the dissemination of methods, approaches and knowledge bases needed to understand how stands work would appear to be more relevant.

The reference framework *Fonctionnement des arbres forestiers face au changement climatique : connaissances, indicateurs, modèles* (*How forest trees function in response to climate change: Knowledge, indicators and models*) has therefore been drawn up for managers and practitioners, and will be published before the summer of 2019. Its objectives are to clarify and to demonstrate the benefits of both direct and indirect ecophysiological indicators, which are usually measured and analysed by researchers in the field (water potential, transpiration, stomatal conductance, cavitation, water efficiency, growth, anatomy etc.); to replace these indicators in the corpus of knowledge on the functioning of the soil-tree-atmosphere system and its reactions in the event of drought; and to outline the benefits and limits of the operating models as well as the main operating models available in France.

EIP regional mobilization – Climate change, what future for the Douglas in Bourgogne?

Olivier PICARD (CNPF, Coordinateur du RMT AFORCE) in collaboration with Marie-Cécile DECONNINCK (CNPF-CRPF Bourgogne Franche-Comté)

This EIP project is led by the CNPF. Participants include Association Futaie Irrégulière (Association for Uneven High Stands), Société Forestière, the CNPF and INRA.

The Douglas fir occupies 8% of Burgundy's forest area. As 70,000 hectares of these plantations have now reached maturity, we need to think about the future renewal of these stands. The 2003 and 2005 heatwaves led to some decline. This project raises the question of diversifying forestry practices by applying different rotation durations.

The project promotes the station assessment tools which will be covered tomorrow. In addition, it should provide better identification of the problems related to changes in soil fertility, an assessment of the impact of forests on soils and carbon storage, and the testing and development of alternative and resilient forests both through plantations and mix-planting.

The method deployed in the framework of the project is based on the constitution of a vast and abundant network of regional reference contacts to supplement the existing network, as well as developing risk assessment tools. In addition, the project will deal with the problem of adaptation and renewal of stands to promote their resilience.

Adapting Haut-Languedoc forests to climate change: the LIFE FORECCAsT project

Juliane CASQUET (Parc naturel régional du Haut-Languedoc, coordinatrice de LIFE FORECCAST), Constance PROUTIERE* (Parc naturel régional du Haut-Languedoc) and Raphaël BEC* (CNPF-CRPF-Occitanie)*

The Parc naturel régional du Haut-Languedoc (Haut-Languedoc Regional Nature Park) is two-thirds forest. In this region, the forests provide economic wealth and environmental and social diversity. At the same time, they are particularly climate-sensitive, as the region is located at the intersection of three separate climate influences (Mediterranean, oceanic and continental). The forests of the Haut-Languedoc Regional Nature Park are also sensitive to extreme climate events, like the drought of 2003, which had a particularly marked environmental and economic impact on the region. These weather events are set to become more frequent.

In this context, the LIFE FORECCAST project has two main objectives:

- Propose tools for managers, forest owners and politicians to adapt forestry management to climate change;
- Raise awareness among professionals and the general public on these themes and issues.

The LIFE FORECCAST project is led by three bodies (the Haut-Languedoc Regional Nature Park, the CNPF and the forestry cooperative Alliance Forêts Bois) and is co-funded by seven bodies. The project has a duration of 40 months, and will be completed in less than a year.

The project's flagship measures include:

- The creation of the 'FORECCAST by BioClimSol' mobile application, a digital decision-making tool to adapt forestry techniques ('standing timber' or 'reforestation solutions' assessment), based on field data entered by the user and geo-referenced data;
- Awareness-raising and communication measures aimed at the general public and professionals;
- Testing new methods of forestry management.

Following this overview, Constance Proutière presented the testing of new forestry management methods conducted in the framework of the LIFE FORECCAST project, with the aim of adapting forest stands to climate change. The sites in question are designed as demonstration areas for owners and professionals within the sector as well as politicians.

Three arboreta (one per climate type) have therefore been set up in the region as a whole. 21 similar species are tested in each Arboretum, under identical planting conditions. Mix-planting (different combinations of species and a variety of mix conditions) is also being tested on nine sites. Various forest strategy tests on existing stands (first thinning or mature stands), are also being conducted on 12 sites within the region. The objective is to compare different intensities of thinning, with a view to creating forests which consume less water. Finally, tests are conducted in community interest habitats. They are intended to maintain or improve the state of conservation of the habitat.

Raphaël Bec explains that these programmes, which are currently undergoing an initial follow-up in the framework of the project, will be sustained by way of an agreement between the Regional Natural Park, the CNPF and owners. The follow-up relates to vitality and the state of health, changes to fire risks, carbon storage and biodiversity. The purpose of the project results is therefore to respond to technical requests in the field, and they will probably form part of general feedback processes.

End of the first day

Olivier PICARD (CNPF, RMT AFORCE Coordinator)

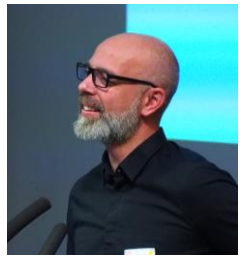
All of the day's attendees were thanked. In the morning, we saw that over 70% of owners have stated that they do not wish to take any action to respond to climate change. RMT AFORCE needs to understand why this is the case, perhaps by looking at how its results and outcomes are communicated. Changing species should enable forests to be prepared over the long term. Current knowledge on forest species must be revised and links forged. A catalogue of species and maps are amongst the tools that will be made available.

DAY 2

Welcoming speech

Olivier Picard welcomed participants for this second day of the Symposium. He then provided an overview of speakers and the morning programme, to open with two presentations on local initiatives based on the CANOPEE and LIFE FORECCAST projects. These initiatives are not directly linked to the RMT, but deal with subjects which are of concern to the network.

The impacts of climate change in the Pyrenean forests: the Pyrenean Observatory of Climate Change (CANOPEE)



Sébastien CHAUVIN (FORESPIR)*

The forest is omnipresent in the Pyrenees, and occupies more than half of the surface area of this region. This cross-border area shares many common issues, related to the different functions of the Pyrenean forest (including production, risk protection, tourism and biodiversity).

Based on these findings, stakeholders from the mountainous forest area gathered in 1999 to create the EEIG (European Economic Interest Grouping) FORESPIR, which brings together French partners (the CNPF, the ONF and the Union Grand Sud des COMmunes forestières), an Andorran partner (the Institute of Andorran Studies) and Spanish partners (the Catalonian Forest Ownership Centre, the Catalonian Forest Science and Technology Centre, the Government of Aragon, the Navarre Government through its public enterprise Navarre Environmental Management, and the Basque Government, through the HAZI Foundation).

The purpose of FORESPIR is to implement cross-border and transnational co-operation projects, and to work on maintaining and developing the economic, ecological and social functions of the Pyrenean forests. Over the past 20 years, many projects have been completed on various topics, ranging from

biodiversity to the promotion of forestry production through climate change and natural risks.

In the area of climate change, FORESPIR and its technical partners have implemented two projects as part of the Pyrenean Climate Change Observatory (OPCC): OPCC 1 and CANOPEE.

The OPCC was created in 2010 at the initiative of the Working Community of the Pyrenees, which groups together the regions of Occitanie and Nouvelle-Aquitaine, as well as the Spanish autonomous communities (Catalonia, Aragon, Navarre and the Basque Country) and Andorra.

The OPCC was set up to respond to several objectives:

- To pool knowledge;
- To analyse the vulnerability of natural environments and the socio-economic impacts;
- To allow for economic activities to be better adapted to natural environments;
- To disseminate the work of the OPCC.

The technical content provided to the OPCC is categorised by sector (climate, water, forest, flora). This content is itself supported by data from thematic projects.

The OPCC 1 project, which ran from 2010 to 2014, has enabled the Observatory to work on its constitution. Between 2016 and 2019, a number of thematic projects, including the CANOPEE project (funded by the European Union, the French State and the Occitanie region), were implemented as part of the structuring program.

The OPCC and CANOPEE projects are based around three main actions: Observe, diagnose and act.

With regard to the first component, several activities have been initiated in the framework of the OPCC project, and then continued as part of the CANOPEE project. The OPCC's Scientific Council has determined the most appropriate indicators to assess the impact of climate change on forests. These three indicators include changes to phenology (short-term), changes to pathologies and weaknesses (medium-term) and changes to the distribution of plant species (very long-term).

As regards phenology, 14 level-2 plots were already available within the Pyrenean mountain range. To complement this data and obtain a sufficient sample, 34 new plots were created in France, 4 in Andorra and 26 in Spain. The global network comprised 64 monitored plots throughout the area.

In parallel, the second indicator draws on forest monitoring data from the European network (level 1). The Pyrenean network is composed of 45 plots in France, 11 in Andorra and 98 in Spain, which enables analyses to be performed for the area as a whole. Finally, for the purpose of monitoring the third indicator, botanical conservatory (23,260 inventory points) and IFN data was used. A monitoring plot has been set up to complement this data.

The second component - 'diagnose' - comprises two elements. Firstly, it relies on the Archi assessment tool, which measures the condition of tree wilting and decline, whether reversible or irreversible. Several species are already benefiting from identification keys, while others have been developed in the framework of the CANOPEE project. Secondly, diagnosis is carried out by creating vigilance maps for the whole Pyrenean mountain range, with the aim of optimising stand monitoring.

Finally the 'Act' component is achieved through a network of 11 pilot adaptive management sites, on which the various project partners have set up a range of forestry treatments. The collected data is then used to assess the impact of the treatments applied.

The next steps will be to create new partnerships (including fleshing out the RMT partnership), to continue to monitor indicators, to conduct new actions (a new project - Acclimafor - is already in the pipeline) and to integrate the project into a network approach on a larger scale, in order to share resources and draw on lessons learned.

SESSION 4 – TAKING INTO ACCOUNT THE RISKS ASSOCIATED WITH CLIMATE CHANGE

Christophe ORAZIO (EFIPLANT), moderator of the session*

In the preamble, Christophe Orazio stressed the benefits of addressing climate change through the issue of risks and hazards such as fire, drought or wind. It is also important to incorporate the human dimension into any consideration of biotic risks, particularly as regards the correlation between developments in world trade and the introduction of new organisms to the various continents. Finally, one of the challenges that we have is to develop tools to cross-reference the recommendations made by specialists for each risk, in order to consider the issue of mediation.

Evaluation and limitation of multiple risks in planted forests (MULTIRISKS)

Céline MEREDIEU in collaboration with Thierry LABBÉ, Marielle BRUNETTE, Sylvain CAURLA, Hervé JACTEL (INRA)*

The risk can be considered as a combination of three elements: the hazard together with its probability of occurrence and its severity, the vulnerability of trees and stands, and finally the stakes i.e. the socio-economic and human consequences of the damage.

In recent years, studies have attempted to list hazards in order of their destruction potential. Some have thus shown that storms have been particularly destructive for European forests.

By choosing two components of climate change, increased temperatures and drought, and for two examples of hazards, we can report on the development of the risk in relation to climate change. One of these examples is a meta-analysis published in 2004, which showed that droughts caused a worsening of insect-related damage. In addition, we must not underestimate the consequences of a series of hazards (for example a post-storm outbreak of bark beetles).

Human actions may serve to either mitigate or exacerbate the vulnerability of forests, particularly when modifying the structure and composition of the stands. It is therefore important to question forestry practices and potential options. An article published a few years ago has identified four main processes that determine the cause and effect relationship between the management of the stand and its susceptibility: (i) Changing the physiology and development of trees, (ii) Changing the micro-climate within the stand, iii) Level of resources (or fuel) for the agents of damage, and (iv) Maintenance level of natural enemies needed for biological control.

The starting point for the MULTIRISKS project is that the combined impact of hazards is higher than the accrual of each separate impact, due to the synergy effect. The project therefore aims to analyse the bio-economic impacts of

interactions between hazards which affect forest resources, with the ultimate aim of identifying forestry strategies which can mitigate the effects simultaneously.

With this in mind, the project has focused on the maritime pine sector in Landes de Gascogne. For this study, simulations were performed using the Pinuspinaster model, developed on the Capsis platform, to assess the impacts of two interacting hazards: Pine processionary infestations and the attacks of the *Fomes* pathogenic fungus, which has become more widespread in recent years in Landes de Gascogne, and in Europe as a whole.

The advantage of a multi-risk analysis is that it highlights potential synergies between multiple catastrophic hazards, in this case pine processionary infestations and *Fomes* attacks.

For the processionary for example, the Département Santé des Forêts (Forest Health Department) has been measuring the rate of infestation very precisely, on permanent plots, for over 30 years. This element forms part of the input data for the model, because it provides the probability of occurrence of the hazard for the forest area as a whole. In parallel, work carried out by INRA has helped to better model the vulnerability of stands and trees, and therefore the likelihood of attack, defoliation and loss of growth.

The maritime pine growth model for this work was spatialised, so as to take into account the differences in the level of infestation between the inside of the stands and the edges of the stand. The model calculates both the potential growth and the reduction in the growth of stands in the event of an infestation.

The results of the simulations which calculate the impact of processionary infestations indicate that the subsequent production losses (compared to the same stand free from pine processionary attacks) in the basal area vary from between 0.1% (median defoliation of 10%) and 11% (for the 5% of the most defoliated stands, with an average attack rate of 54%).

A similar process has been implemented for *Fomes*. For this hazard, the spatialised aspect of the model was very important, using the distance between the trees to measure the speed of spread of this root fungus. The results showed that the impact of *Fomes* on production is relatively low for the first contaminated rotation. However, the trend towards strain contamination is extremely strong, with probable consequences for the next rotation.

Ultimately, the simulations show that losses of production from the combination of the two hazards are greater than the sum of the impacts of the separate hazards.

At this stage, not all of the simulations have been completed. The final component of the project lies in incorporating the results into the FFSM forest resource model.

Certain limits have already been identified in respect of stand simulations:

- To our knowledge, there is no independent data to validate growth losses simulated by the model for a forest rotation;
- The climate is not directly taken into account in the probability of occurrence of hazards, or in the growth model;
- The model is not spatially clear at landscape level, and for the processionary, vicinity effects may not be negligible to the probability of the hazard.

Amongst the possible outcomes, tests have already been conducted in collaboration with CNRS researchers, to incorporate the processionary model into a process-based model. In addition, other forestry options and other outputs (money, carbon, biodiversity etc.) may still be explored.

Feasibility of forest health status diagnosis using remote sensing: example of chestnut in Dordogne (CASTELDIAG)

Michel CHARTIER (CNPF-IDF) and Véronique CHERET (Dynafor Purpan) in collaboration with Michel GOULARD (Dynafor Purpan)*

The Casteldiag programme (*Castanea*, remote sensing and diagnosis) was based on the following findings:

First of all, in France the chestnut tree is the third leafy species in terms of surface area, and represents half of the world's surface area of chestnut plantations. In the Dordogne, it corresponds to approximately a quarter of the forest surface area, and is a key species for the economy. And yet, the species is suffering from disease and decline. It is impossible to calculate the surface area affected. Moreover, climate change tends to increase the risk of mortality.

Dealing with these issues may rely on knowledge and the contribution of new technologies. Firstly, the Archi method, developed by CNPF-IDF, provides a diagnosis of the state of decline and the future of these stands. Secondly, new remote sensing images provide an option to refine knowledge on the current state of decline.

The Casteldiag programme has forged links with a number of partners (IGN, CNPF, DSF, UMR Dynafor) and was funded by the RMT for two years (2016-2018). It is based on two objectives:

- Create an evaluation tool for the state of health of chestnut tree coppices;
- Put together a mapping method for annual monitoring of how coppices of chestnut trees respond to biological and abiotic hazards.

The first stage of the programme was to adapt the Archi method to coppices of chestnut trees. The work carried out has begun to take into account different situations, including coppices, high forests and fruit orchards. Ultimately, the Archi allows you to achieve a dual diagnosis, based on both the stage of development and on the physiological state. This Archi key has been validated on private forest plots, which have also provided calibration components for remote sensing.

In relation to the remote sensing component, the objective of the project is to explore the potential of remote sensing for mapping the state of health of the chestnut plantation, which distinguishes between healthy stands and declining stands. The work has focused on the processing of images from the Sentinel-2A satellite, linked to the European Copernicus programme. Indeed, this new sensor offers valuable assets, which include wide coverage, frequency of revisits, spectral richness and spatial resolution.

The approach taken was to analyse, for a year of data (2016), the spatial variability of the state of the surface areas of chestnut tree coppices. As 2016 was a particularly rainy year, only two usable images were captured, one in July and another in September. The goal then was to develop a statistical model incorporating three types of variables, based on the remote sensing information:

- 10 spectral bands for 10m and 20m (visible, Red Edge, PIR and MIR);
- 36 vegetation indices, calculated from these 10 spectral bands and selected for their ability to translate the plant activity, productivity, the water content or the content of leaf pigments;
- 5 biophysical parameters, estimated by applying models for simulating the radiative transfer in the vegetation using the Overland software (Airbus Defence and Space).

A number of predictive models for decline were constructed from these 51 variables. Their calibration has been carried out thanks to observations on the ground of the state of health of the stands, conducted according to two approaches, by applying the Archi assessment and through an expert appraisal (CRPF).

A first level of analysis enabled the most significant variables to be selected in order to build the models, and to assess how their contribution should be weighted in the prediction. Next, a validation step was completed in the framework of a second field campaign, with the aim of retaining the models that were obtaining the best statistical results.

The questions raised by this approach were as follows:

- What are the most meaningful remote sensing variables?
- What contribution is made by spectral diversity and biophysical parameters?
- Which image dates provide the information?
- Of the two reference field approaches which have been tested, which provides the most information?

As regards the contribution of variables, a very strong correlation has been observed between certain remote sensing variables and decline categories. The selection of variables has shown that Red Edge and PIR have made the greatest contribution in terms of spectral bands. Similarly, nine vegetation indices are the most frequently selected for the best models. Finally, the analysis has led to the conclusion that the biophysical parameters were of relatively little relevance in the best models.

Several indices were used to assess the quality. One of them is the Kappa index, which allows you to measure the level of match between the reference data and the observed data, taking into account any uncertainties. With this in mind, the best Kappa indices have been obtained from the Archi references and from the July image, for a model with two-three categories (healthy/in decline).

The map representation can take two forms: Maps showing decline categories or maps showing the probability of belonging to categories 2 and 3 (in decline).

The Archi chestnut key, used in the validation phase of the model, is now considered to be fully operational. It may now be disseminated to professional managers through training courses. In parallel, the results from the processing of the Sentinel-2 data are promising, and the first findings established may serve as the basis for the continuation of the work.

In terms of outlook, one of Dynafor's ambitions is to improve and test the robustness of the model, based on a larger volume of images and on other regions.

The CNPF intends to use these models for consultancy missions. This approach should also be combined with other information sources (climate, soil etc.), in order to be able to perform a pre-assessment on the origins of decline.

At the end of the presentation, Michel Chartier thanked all of the partners who had participated in the programme and the local CRPF, for their support and the resources that they provided.

EIP regional mobilization - Precision forestry in Nouvelle Aquitaine

Roland DE LARY (CNPF-CRPF Nouvelle-Aquitaine) in collaboration with Céline MEREDIEU (INRA)*

This project forms part of a European Innovation Partnership (EIP), which brings together public institutions (CNPF, ONF, IGN), research laboratories (FCBA, INRA, Purpan School of Engineers), economic stakeholders (Alliance Forêts Bois) and other regional stakeholders (Community of Fumel communes in Lot-et-Garonne). This project covers precision forestry in Nouvelle-Aquitaine (SPNA). It has only recently received the EIP certification, and is currently being implemented over a three-year period.

At plot level, precision forestry must be positioned at the crossroads of economic factors, societal factors and environmental issues. It must be able to optimize interventions, to use modern technology and to continuously calibrate tools as part of a process of permanent adjustment.

The SPNA is designed two work on two levels: the macro level (the forest area and forest ownership) and on a more local level (the forest plot, or even each individual tree). It aims to create links between the two levels and the various risk factors (station, physiology, natural enemies, resources), focusing on two species: the maritime pine and the chestnut tree.

With regard to the maritime pine, the SPNA project aims to create and develop a decision-making smartphone tool for owners to launch thinning operations for maritime pine forests, based on the standards of precision forestry (the Maugé rule was presented as one of the examples). In parallel, it aims to create a 'participatory forestry' database, which will receive data from the smartphone application. In this regard, foresters using the application may, if they wish, send their data and in return participate in the continuous improvement of the growth model used.

Concerning the chestnut tree, the aim is to increase the popularity of assessment tools with forest managers and regional managers, as well as forestry and carbon impact simulation tools, thereby giving a boost to the forestry sector and attracting carbon projects that can help to fund the renewal of chestnut plantations.

The project also aims to:

- Propose a mapping method for annual monitoring of how coppices of chestnut trees respond to biological and abiotic hazards, using satellite images.
- Provide managers with field assessment tools, including Archi and BioClimSol;
- Make the Climafor tool available for stands of chestnut trees;
- Roll out a smartphone app (developed by INRA) for epidemic monitoring of chestnut ink disease by the public.

In conclusion, the partnership to be deployed in the framework of the project will develop local mechanisms (mobile applications, tests of embedded tools, on-site training) as well as innovation at macro level (continuous calibration of data, use of remote sensing in health monitoring, enhancement of the tool Climafor).

DEMONSTRATION OF DCEISION MAKING TOOLS

Three tool demonstration workshops will be held in parallel.

LUBERON2, a simulation tool for the evaluation of genetic impacts of silviculture practices (IGS)

Claire GODINEAU (INRA, ISEM), Nicolas BEUDEZ (INRA) and Sabine GIRARD (CNPF)

Luberon2 is a tool created as part of the RMT programme, and forms part of the project: “Evaluation des impacts génétiques de pratiques sylvicoles pour l’adaptation” or "Evaluation of the genetic impacts of forestry practices for adaptation" (IGS). Forestry represents a basis on which to change the behaviour of forest stands in response to climatic hazards. Using thinning, regular or occasional treatments, natural regeneration or even plantations, it is possible to impact upon the numbers of trees in the stands in question, and on the demographic processes at work within these stands, which impact on their genetic diversity. As a general rule, this will enable us to take action on the productivity of the stand and, in the longer term, on the capacity of a stand to respond to disturbances.

The IGS program, coordinated by François Lefèvre (INRA), is dedicated to assessing the genetic impacts of various forestry operations on different time scales, in forests where there is natural regeneration.

Claire Godineau demonstrated the Luberon2 simulation tool, hosted by the Capsis software platform and simulating the growth of Atlas cedar stands (*Cedrus Atlantica)*. This simulator is based on a cedar growth model. The reproduction and regeneration processes have been integrated into this model, and it takes into account the genetic variability of growth performance between trees within the same stand. The Capsis platform provides the simulation of forestry interventions as well as new features to simulate disturbances likely to have an impact on the genetic diversity of forest stands (fires, droughts, storms, extreme temperatures, pest outbreaks etc.). The objective is to provide managers with a tool to simulate different forestry strategies, which reconcile productivity and the capacity of stands to cope with disruptions. At the present time, the tool is still in development and only takes into account one type of disturbance, namely drought. However in the long term, the goal is of course to list all of the disturbances, and even to establish links between each of them. The tool will then be extended to other tree species.

Claire Godineau showed various simulations carried out using Luberon2, and their effects on the average genetic value and genetic variance of the stand in terms of increase in diameter. The average reflects the current genetic quality, while the variance reflects the capacity of future developments. The same type of results can be obtained for another factor under genetic control, i.e. sensitivity to disturbances. The initial scenarios show that different forestry types give rise to very different genetic effects. The choice of a particular forestry type has a high impact on genetic quality, and the evolutionary potential of the stands. This is the first quantitative information of this kind.

Spatial predictions of forest sites in the North West of France (PRESTATION-NO)

Jean-Baptiste REBOUL (CNPF-CRPF Normandie) and Christian PIEDALLU (AgroParisTech)

Few private forests are covered by forest station maps. The PRESTATION NO project therefore aims to pre-map sites in order to encourage managers to assess them, and if possible to facilitate the implementation of forest station mapping. For this reason, the method of pre-mapping forest stations, established in the Vosges in 2003, has been resumed and improved.

The project focuses on the regions of Normandy, Hauts-de-France, Centre-Val de Loire and Ile-de-France, as these regions are completely covered by the species selection guides developed by local services or by service provider firms. It is possible to establish links between these guides and the pre-mapping, which also enables the reliability of the pre-mapping to be measured and user instructions to be drafted. RMT SOL has requested climate zoning of the study region, based on the Joly methodology (2010), which Météo France had used to create a climate typology on a national scale. The purpose is to see how this climate zoning changes according to the various models and climate scenarios.

The location of forestry stations is logical, and depends on geology, surface formations, topography, vegetation, the previous managers (former forests), the climate and exposure. One of the bases of the pre-mapping is to have access to exact phytoecological readings, so as to establish the link with the geology, with indices derived from the digital elevation model (DEM), climate indices and with existing vegetation indices. The data used to calibrate pre-mapping tools was that of the former IFN method (17,000 readings), linked to 10,000 validation readings. All of this data had to be retrieved and harmonised. It is essential to take readings from located stations.

Modelling was applied to three soil properties: The bioindicated pH of horizon A, the maximum usable reserve of Wösten water over 90 centimetres, and the level of hydromorphic soils. These models have subsequently been reclassified based on local typologies, in order to cross-reference them for pre-mapping purposes.

Christian Piedalu explained that mapping is a fast-moving discipline both on a national and international level. The mapped data is varied, covering both thematic data related to the soil or climate, and data related to the soil properties. This data can be collated in summary maps or be used in derivative maps, i.e. predictive maps (of species distribution, productivity, tree health etc.).

These tools show much potential for improvement. Point data must be high-volume. As a general rule we need to improve our data sets. For climate data, we need to standardise Météo France's climatic series and take into account topography-related effects. For the spatial data, geology is the predominant factor. There is also a need to make better use of superficial units, the most finely-tuned digital models and soil mapping. Former soil availability should also be incorporated, i.e. the mapping of former forests. Finally, the methodology, including spatialisation methodology, could be improved.

The selection of data resolution is another crucial issue to improve the relevance of the map. The goal is to check if the map is able to make local predictions, at forest level, and to restore local gradients. The map validation procedure is an essential step in this process.

In addition, the model should be automatically updated, i.e. amended using data collected in the field. For example, correcting pH map will have an effect on the species map. This aspect does not yet exist.

It is still difficult to improve the local prediction. Many studies are under way on this subject. Methodologies for combining climate aspects, soil data and the choice of species still requires further reflection. Climate data must also be incorporated in a more efficient manner.

Jean-Baptiste Reboul stressed that the pre-mapping of stations is not the same as a map of forest stations. Pre-mapping is a tool to encourage the manager and owner to return to the field and to check its validity by observation. In addition, the quality of the pre-mapping depends on the quality of the input data. However the geology is often false, because it lacks the surface

formations. Pre-mapping should therefore be approached with caution, and it is best to return to the field to establish a final map of forest stations.

Nevertheless, pre-mapping simplifies the work of station mapping, by facilitating the provision of transects of validation readings, while also gaining an overview of the overall site context. In Normandy, 21 pilot forests were created. A final soil map was established for these forests, based on the method described above. This network of forest covers all of the possible contexts. On average in Normandy, thanks to this methodology, it is possible to go down to one reading point for every 3.7 hectares. However, the situation varies greatly based on the geological context.

One of the limits of pre-mapping is that of the geology, and particularly the taking into account of silty layers. Pre-mapping is able to predict potentially congested areas, but the model also lacks finesse in this area. The use of soil maps can improve pre-mapping, as can using maps of former forests.

In Normandy, for two thirds of cases, pre-mapping is sufficient to create a map of forest sites. In 20% of cases, pre-mapping provides the overall context and the major gradients, but does not provide the necessary degree of accuracy. Finally, in 15% of cases, pre-mapping is not usable at all.

A methodological handbook was drawn up (https://normandie.cnpf.fr/data/notice_utilisation_de_la_precartographie.pdf), to create a final map of sites using these new tools. The idea is to put in place validation points based on the different pre-mapping units, and to cover the whole of the property and the all topographic positions.

A question was asked about what level of accuracy is required of the forest sites map. Indeed, forest soils can vary greatly on a small scale (less than 100 m), and a map of the forestry stations with a patchwork of units of less than 0.5 ha will be unusable for the manager.

In Normandy, pre-mapping is made available to forest managers. Maps showing water reserve gradients are also available, as are maps showing the level of hydromorphic soils, bearing in mind that transect positioning can be adjusted on these two rough models. Managers who want to prepare forest station maps have also been offered personalised support.

The pre-mapping tool is available on GéoNormandie and on the Normandy CRPFN website. Pre-mapping can be consulted and searched, but not downloaded.

At present, the Normandy and Hauts-de-France are offering financial support for forest site maps. In these two regions, support is dependent on the provision of accurately-located field documents (complete flora readings and full soil description) and a final map of forest sites.

In the context of climate change, the forest station map can be broken down into a map for the adaptation of the species to the station. The guides for the regions concerned must take climate change into account on the basis of recent research. It is possible to think about current and future adaptations based on the various global warming assumptions. One of the limits of the implementation of these new tools is that many managers do not have the time to create forest site maps, despite their best intentions. They should therefore be given the option to perform these essential assessments, primarily through financial support.

A tool for the selection of tree species (CARAVANE & IKSMAPS)

Sophie BERTIN (EKOLOG), Myriam LEGAY (ONF) and Alexandre PIBOULE (ONF)

Myriam Legay presented an online help tool to choose forest species. The work carried out is based on two projects conducted in parallel. The CARAVANE project, coordinated by Brigitte Musch (ONF), which collates information relating to autecological knowledge, based on a generic analysis grid for all of species. The IKSMAPS project, which was coordinated by Myriam Legay, the purpose of which was to model the distribution of the species through an approach based on restrictive climatic factors. These two projects were created under the NOMADES project, coordinated by Hervé Le Bouler.

The Caravane project presents approximately 200 species in the form of individual sheets. Each of them includes 37 criteria which are entered systematically for all species. These criteria include firstly a general description of the species (appearance, distribution, etc.), and secondly ecological information, information on wood production, on the production of ecosystem services, the ease of introduction into the forest, etc. Contributors to the CARAVANE project have endeavoured to qualify and to provide details on the quality of the information provided. All of the documented data has been structured in the form of a database, which currently lists 75 species.

The second modelling approach, IKS, takes into account three restrictive climate factors which therefore determine the area of distribution of the plant species in each temperate zone: Excessively cold, lacking in water and lacking in heat. Each factor is represented by a climate variable: The average temperature of the coldest month for the first, a type of water balance for the second, and total degrees during the daytime for the third. A threshold is defined for each variable and for each species, and the combination of the three thresholds obtained in this way enables the climate compatibility envelope for that species to be reproduced. The model was calibrated using data from the presence of the species obtained from a collection of national forest inventories. Thresholds are defined to represent the distributional range of different species. 37 species were modelled in this way during the final stage of the work, and various future scenarios were established. The scenario diagram incorporates a pessimistic model, an optimistic model and an average of the models. The pessimistic and optimistic models were established based on the water deficit forecast for France for up to 2080. The simulations carried out were incorporated into a global vision, at the level of the eco forest region ("*sylvoécorégion*" – SER).

A model of a decision-making tool was developed based on the two approaches described, in order to respond to the needs of different types of users. It now needs to be validated by users before computer development begins.

Sophie Bertin (EKOLOG) presented the prototype of this decision-making tool. Alexandre Piboule (ONF) then completed this presentation.

PROSPECTIVE WORKSHOPS

Three forward-looking workshops were held in parallel.

Workshop 1: How to connect strategies for forests adaptation to climate change and strategies for climate change mitigation by forests?

Moderator: Olivier PICARD (CNPF, RMT AFORCE Coordinator)
Guests: Julia GRIMAULT (I4CE) and Simon MARTEL (CNPF-IDF)

The forest and timber sector help to reduce greenhouse gas emissions, because the forest is a carbon sink but also because the use of timber, due to the substitution effect, mitigates the adverse effects of climate change. The forest therefore forms part of the low-carbon strategy, and is one of the national tools contributing to the national objective of carbon neutrality by 2050.

Olivier Picard recalled that the workshops that have been taking place over the past two days have highlighted the issues to be addressed in the face of the climate disruption and climatic variations. He asked the questions: When confronting these issues, which sustainable strategies should we emphasise? What will be the extent of forest adaptation? What will be the impacts on biological growth?

In this context, many questions arise, including: What about the bioeconomy and the use of bio-sourced products? Can the use of timber act as an alternative to the consumption of fossil fuels? Would the potential of wood substitution be sufficient to counter the force of climate change? Do we need to speed up the renewal of the stands and forests? On the contrary, in the absence of certain data on the potential of forests as carbon sinks, should we not adopt a reasonable approach by first protecting our existing forest capital?

During this workshop, Simon Martel will return to the scientific context, in particular on the role of forestry in the mitigation of phenomena. Julia Grimault will return to the components of the carbon policy.

A 2017 INRA-IGN study clarifies the role of French forests in climate change mitigation. This mission is related to the 5S principle, namely the sequestration of carbon in the biomass, soil sequestration, storage in timber products, energy substitution and material substitution.

Carbon sequestration is enabled by increasing the surface area and volume of forests. Each year, approximately 70 million tonnes of CO_2 are sequestered in the forest biomass. By way of comparison, national greenhouse gas emissions amount to 450 million tonnes of CO_2.

In terms of soil sequestration, the latest studies show that French forest soils accumulate carbon at a rate of 18 million tonnes of CO_2 per year. The two sequestration methods (biomass and soil) therefore total a volume of 88 million tonnes of CO_2 sequestered per year in France.

Forest operators offer timber products which constitute an interim stock. The incoming flow from the forest to the timber products amounts to 53 million tons of CO_2, i.e. the equivalent of the flow from the timber products to the atmosphere.

Energy substitution refers to the use of wood in place of fossil fuels. This substitution reduces greenhouse gas emissions.

Finally, the aim of materials substitution is to to use wood as a material instead of using competing materials which release more greenhouse gas emissions. The two effects of substitution (energy and material) are quantified at 42 million tonnes of CO_2 per year.

Thus, the 450 million tonnes of CO_2 recorded in France could reach 490 million tonnes without the effects of wood substitution.

The INRA-IGN study has modelled scenarios of changes to French forest resources based on each 5S driver. This work has led to the preparation of a 2050 model. These scenarios vary depending on harvest levels. The first scenario is based on a continuation of the volume harvested (approximately 50 million m^3), the second on an increased harvest of 75 million m^3, and the third on an intensive harvest of 90 million m^3. This scenario is accompanied by an afforestation plan. By 2050, the carbon effect would vary depending on the scenario used. For example, the first scenario will emphasise storage in the

ecosystem (in hardwood, softwood, and dead wood) but will target substitution to a lesser extent. The other scenarios will give less emphasis to storage in the ecosystem, although this option will remain on the table.

This comparison of the various potential options shows that the first scenario is the most beneficial for 2050. However, this modelling is limited as it only goes up to 2050. Over a longer time period, it is likely that the third scenario would be the most beneficial. This work also has limitations because these models are established at constant climate. In the framework of this same study, alternative climate scenarios were also looked at, including RCP 8.5, the most pessimistic climate change scenario. This option changes the storage capacity in the ecosystem, and to a lesser extent, the effects of substitution. The study also incorporates crises, including the combination of three shocks: A national storm, followed by an attack of bark beetles and a fire. Under the effect of these three disasters, in the second scenario, the carbon sink effect would be lessened - but would nevertheless be maintained. In addition, if the timber industry is dynamic and able to absorb a large volume of wood affected by the storm, the substitution effects would then be greatly increased. If the sector provides a coordinated response to any timber surplus, the recorded loss of sequestration in the ecosystem could be offset by the effects of substitution.

Simon Martel also took the opportunity to cite a corpus of studies on the biophysical effects which go beyond the effects linked to the carbon cycle, to encompass the albedo effect, i.e. the reflective power of a surface, as well as evapotranspiration. The conclusion of this work is that certain biophysical effects are sometimes contrary to the recorded effects on the carbon cycle. For example, in boreal zones, planting to store carbon may in fact have the opposite effect to that intended, since this afforestation would decrease the albedo effect provided by snow cover, by creating a deeper cover which heats up more.

This study, which was recently published in the *Nature* journal, demonstrates that the role of forest management is not to "save" the climate solely through mitigation, but rather to adapt the forests to the future climate in order to maintain significant levels of carbon stock and associated services for the forest.

Finally, the locally-led Evafora project has modelled a number of climate scenarios for two species (the maritime pine and the Douglas fir), defining technical climate change adaptation strategies and projecting them onto a model which takes into account climate developments between now and 2100. It shows the partial compensation effect of water stress caused by CO2 fertilization. This study also demonstrates that strategies based on active forest management with thinning allow a reasonable LAI to be maintained in order to absorb water stress. In contrast, high-density biomass-focused forest management without thinning causes a lower tolerance to water stress, as does a complete lack of management.

Julia Grimault continued the presentation by focusing on the tool developed by the Ministère de la transition écologique et solidaire (Ministry of the Ecological and Inclusive Transition), whose aim is to provide a method of estimating carbon gains.

The forest activates various drivers towards meeting the objective of carbon neutrality. Historically, climate policies have focused on wood-based energy pursuant to the European directive on renewable energies. Other drivers, including forest sequestration and the use of materials, have so far been little promoted in either French or European policies. The objective is to create an economic incentive to strengthen the other drivers.

The Club Carbone Forêt Bois (I4EC) is a forum for discussion and reflection created by foresters in 2010. Several companies are currently financing environmental projects including international forestry projects, but could finance such projects in France provided that they can obtain guarantees and are able to act within a methodological framework. In order to meet demand, the idea of creating a national certification framework was put forward. This framework was tested by the Vocal project launched in 2015, together with the CNPF and the Massif Central Public Interest Group. In 2018, the initiative resulted in the establishment of carbon certification guidelines, which have been adopted by the Ministère de la transition écologique et solidaire.

The carbon certification tends to assess stand scenarios against benchmark scenarios, while incorporating various quality criteria. These criteria include the criterion of 'additionality' promoted by the 'Bas Carbone' (low carbon) label, which promotes changes in practices which would not have been possible without ad hoc funding. The label also incorporates the buffer principle, a tool used worldwide, where you can set aside a CO_2 reserve based on the risk level of the project.

The adaptation of stands will be the key to the success of mitigation policies, but these policies will depend on the risk level, and in particular the fire risk. In all cases, an assessment will be required prior to implementing a project to renew a deteriorating stand. In addition, the joint benefits of the project must be taken into account by the project leader, at least as far as quality is concerned. In this framework, bonuses will be granted if the initiative offers a mixture of species.

At this stage, the tool does not take into account regional differences apart from measuring the fire risk. Another limitation of the tool is that the chosen scenario is based on a constant climate. In the long term, the tool could be improved by incorporating projection tables on climate trends.

In the case of a strong climate change impact and a low resilience, the risk of carbon stock depletion will be very high. In this context, rapid renewal strategies might be preferable with a view to maximizing carbon pump and substitution effects. On the other hand, if the climate impact is more moderate and resilience is better, then the existing stock preservation strategies would be more relevant. The preferred options will depend therefore on the time frame, i.e. 2050 or more long-term.

To facilitate the search for both public and private funding, the label has put the emphasis on 'no regrets' options, i.e. 30 years or up to 2050. This deadline remains acceptable and can be easily understood by a funding provider. This time frame also corresponds to the objectives of the IPCC.

Workshop 1 summary

The first workshop speaker provided an inventory of current knowledge on the role of the forest in mitigating climate change. The second speech adopted a more political angle, focusing on the implementation of the 'Bas Carbone' label.

Discussions covered the impact of climate change on forests and on stock management, despite the uncertainty that surrounds climate projections. They also provided an opportunity to address the issue of using the new 'Bas Carbone' label. Talks also addressed the tools and methods used to measure carbon and the future of certain outputs for new species providing genetic and adaptive renewal. The discussion also focused on the topic of risks and their impact on forest productivity. The label, which is currently undergoing ad hoc testing, is based on three methods: the afforestation of non-forest land, improvements to damaged or wilting stands and the transformation of high-forest coppices. In this context, the RMT must take action to propose new methods and suggest new species.

Workshop 2: How to make sure that Research and forest managers' community better communicate?

Moderator: Myriam LEGAY (ONF)
Guests: Ceydric SEDILOT-GASMI (SFCDC) and Luc PAQUES (INRA)

The dialogue between research and management is sometimes difficult, particularly because researchers and managers are communities bound to different objectives. Researchers and managers do not necessarily have numerous opportunities to meet one another. RMT AFORCE provides such an opportunity. Moreover, there are few intermediaries to provide an interface between the two communities.

In addition, in a context of climate change, the relationship between researchers and managers has changed, and is sometimes strained due to the urgency of the matter. In their traditional roles, researchers would gain the knowledge which they would then transfer to managers. However, the context of climate change means that we cannot continue to view the relationship in this manner.

Finally, the issue of dialogue between researchers and managers is one of RMT's main focus areas. Therefore, the workshop aimed to find strategies to improve dialogue.

Ceydric Sedilot-Gasmi indicated that the Forest Society of the Caisse des Dépôts et Consignations (Deposit and Consignment Fund) (SFCDC) has been part of RMT since its creation. The accession of the SFCDC, which, strictly speaking, works in management, has provided an opportunity to express a number of issues for which, at the time, research seemed like an easy solution.

Currently, the north-east quarter of France is facing an unprecedented crisis in terms of spruce bark beetles. For the first time, faced with a crisis of a species impacted over a wide area and in a very short period of time, managers have had to deal with logistics to be put in place for timber clearance and operations in record time. Shortly after that, they had to face the fact that the spruce was not in the right place, and that the brutal effects of climate change were causing this species to disappear.

The teams therefore contacted Ceydric Sedilot-Gasmi to ask for his advice, given his 10-year involvement with RMT. The Symposium provides feedback on a number of studies and research projects, and provides various components including decision-making tools. Around six months or a year ago, the teams were still struggling to provide a pragmatic response by relying on the results of research.

Luc Pâques has been a geneticist with INRA for 36 years. The component that affects him the most is that he has not been able to identify true joint stakeholders through his research. Many of the owners are interested in INRA's work. However, there are not enough parties involved in order to be able to communicate, make suggestions, build solutions and work together.

Researchers usually work alone on their research, and are often have difficulty finding private partners willing to be involved as stakeholders of a project. They are also assessed on their publications rather than other output. They are often biologists, who increasingly have a reduced awareness of the forestry sector.

Researchers like to have the freedom to do what they wish, which enables them to put forward initiatives and develop interesting innovations. This freedom is a real source of creativity.

Researchers work on generic topics, and even if they try to create a model that works well, applying it to a series of situations is far more complicated. The same issues arise in the area of genetics/improvement, for both human and budgetary reasons. It can therefore be extremely complicated to make recommendations at a national level, and researchers need a relay.

When researchers obtain results, the policy of publication at any price prevents them from taking the necessary step back in order to provide long-term legitimate and relevant information.

From the point of view of the researcher, managers represent a multitude of stakeholders, from the seed merchant to the manufacturer. For the

researcher, the question is how to reach all of these stakeholders. For example, the size of the participants can be problematic.

There is also the issue of the number of theses financed by managers in France. Managers must in effect question how they will support research.

While researchers are trying to respond to long-term concerns, managers' concerns are often short-term. Consequently, time issues are often raised. In addition, managers have a very local outlook, while researchers have a broader vision and look to find valid solutions for the region as a whole.

In addition, there is the issue of how informed managers and owners are. A survey conducted in Belgium unfortunately showed that they read very few publications. It would therefore be relevant to gauge the interest of French managers in publications.

Luc Paques indicated that suspicion of researchers is systemic, and managers/owners often have preconceptions. As soon as there is a problem, it is all too easy to point the finger at genetics. The same observation was made manufacturers, who sometimes demonstrate a blatant lack of openness.

Workshop 2 summary

On the proposed theme, the group attempted to respond to a three-pronged question regarding stakeholders, content and the tools that can encourage dialogue between researchers and managers. (Who? What? How?)

With regard to the first component, all RMT stakeholders have been mentioned, while stressing the need to involve more regional stakeholders (parks or forest communes for example), as they have an overarching vision of the various functions of the forest.

In terms of content (What should the outcomes of the research-management conversation be?), it might be worth putting the emphasis on decision-making tools and on the promotion of partial results. It is a case of communicating as much as possible on the results, even if they are not completely finalised. The role of reference sites is also important, and they should have greater visibility within the network. Managers must be able to draw on these sites to transpose or generalise a approach.

Lastly, concerning the third aspect, the discussion focused on discussion formats. The presentation format should rely less on scientific research codes. On the contrary, the emphasis should be on the results of such research and its potential scope of use, as these two dimensions are of primary consideration to managers. Similarly, symposiums should provide more time for discussions. Managers should be able to express their opinions as soon as discussions begin. The network must be able to adapt to regional problems. A proposal was made to organise more meetings in the region.

With regard to the projects carried out within the network, we thought it was essential to retain and strengthen joint construction, in an approach which links the scientific challenges and practical issues of management professionals. Indeed, research questions are not always motivated by practical issues. This approach can be applied by establishing a process that allows for a gradual emergence of projects. For example, could setting out a statement of intent based on a shared project before the call for projects in released provide more time to build a consistent shared project?

Regional projects on EIP funding should be encouraged.

Workshop 3: How to dialogue with society and raise awareness on forests adaptation to climate change?

Moderator: Marielle BRUNETTE (INRA)*
Guests: Christine FARCY (Université de Louvain) and Adeline FAVREL* (FNE)*

In 2017, an RMT AFORCE evaluation highlighted the gaps and inconsistencies in its communication strategy. A communication unit was therefore created to set up a new graphic charter and a new website. During this reflection, questions were raised about the network's target audience, about preferred information formats and media, but also on how to avoid strong reactions to results obtained by the network and to its strategies. It is clear that the network has not given sufficient attention to communicating with society.

As a result, this workshop was set up on order to discuss ways in which to interact with the society and raise awareness on the issue of adapting forests to climate change. This topic raised many different types of questions.

On the theme of dialogue and awareness, the initial question raised is on the challenges posed by dialogue. Is the objective to circulate information, look at ideas and share good practice? Should information be circulated in both directions? Does a large quantity of information not risk diluting the message? Conversely, would over-simplification of the information not be contrary to the objective, and might it pose a risk of misunderstanding? Secondly, the objective of dialogue is to create or consolidate relationships, but not to scare people. Finally, the aim is to use dialogue and raise awareness in order to change ideas and behaviours. Therefore, we should also consider the issue of where to draw the line in order to avoid being too direct or too intrusive.

There are many potential methods to establish dialogue, but which of them should we prioritize in order to ensure that stakeholders are taking ownership and action? How do we instil dialogue and ensure that it is sustainable? How do we give the public an opportunity to express themselves? Is increasing the number of communication methods to reach the largest possible number of recipients a relevant strategy? What role do social networks play in this strategy?

In order to create a dialogue with society, we first need to define what we mean by 'society'. All forest users should be covered (walkers, school trips, owners, associations, etc.). The question then arises on how to adapt the dialogue to its target audience. How can we foster mutual understanding? Who should communicate on the issue of adaptation? Should communication on forest adaptation be separate to other forest issues and climate change? What is the role of RMT AFORCE in this communication and awareness?

Christine Farcy presented the results of a European Commission survey carried out in 2015 on the benefits of the forest as perceived by respondents. The majority of the responses related to climate and biodiversity, but highlighted the lack of an immediate link between forests and timber. A previous survey carried out in Belgium revealed that two thirds of young people aged 15-24 years thought that the felling of trees should be prohibited.

Social portrayals and society's knowledge on forests are primarily forged by the media. The mass media often tends to highlight the sensational and extraordinary. Communication also relies on an advertising-based model, and seeks to achieve its targets by frequently bombarding its audience with information. While people are able to understand the complexity of forest issues, this type of advertising comprises simple, visual messages which are taken out of context, and which appeal to our emotions without adding anything in terms of understanding. Moreover, the mass media relies on dominant portrayals to be understood and, in so doing, they contribute to strengthening these portrayals. Christine Farcy therefore suggested that there was often a gap between the messages communicated and the reality.

And yet, foresters must realize that this type of viewpoint is still legitimate. To the extent that the world is becoming an increasingly threatening place in which the climate is deteriorating, it is normal that some do not want the forest to be cut back further. Therefore, forests hold real appeal.

For Adeline Favrel, the issue of adapting forests to climate change demonstrates the need to establish a dialogue with society, and more specifically between foresters and non-foresters.

Furthermore, climate change adaptation may lead to changes in practices. Initiatives to conserve and protect forests are now becoming more and more widespread, and interest in the forest is growing. In particular, there are models to develop more industrial forests, including through monospecific plantations. Often, this type of model gives rise to opposition from certain communities. Climate change adaptation is therefore a sensitive subject because entire forest practices may be called into question, even if they have existed for decades. On this point, it is important to establish a dialogue with society. In some regions, management methods are perceived as unsustainable, and practices such as increasing harvests, fir tree planting and the shortening of cycles are viewed negatively by society. This should not necessarily be put down to a lack of knowledge. On the contrary, it is the reality and it is unhelpful to criticise these views by arguing that people not know about the forest. It is better to foster debate and to recognise the legitimacy of all those who are interested in the forest, regardless of their identity or role. Everyone must be able to participate in this debate, and a social contract must be established for forests and their management. This should enable trials to be set up and solutions to be implemented, to avoid a total deadlock which would delay progress on climate change.

The FNE (France Nature Environnement) has identified various avenues of action with the aim of bringing everyone together and avoiding deadlock.

The first is based on ‘Nature-based Solutions’, a concept created by the IUCN. This approach involves implementing management strategies based on forest ecosystems and on biodiversity, to help make timber production more resilient to disturbances (including those due to the climatic effects). The advantage of these nature-based solutions and practices is the fact that they facilitate dialogue with society.

In addition, it could be beneficial to avoid national projects and instead to set up social science-based action research projects on a regional scale, to adapt to local contexts. These projects would cover climate change-related matters, and would draw up a sociological analysis on the perception of the topic and the practices of local communities. They would also analyse methodologies to determine which practices could be reproduced in other regions. Adeline Favrel gave the example of Forêt Vigie, which proposes using control regions as a basis, as well as a social science-based analysis to put forward different solutions.

Workshop 3 summary

The discussion focused on three points: stakeholders, resources and the challenges for awareness.

The need to properly identify the stakeholders involved was reiterated, regardless of whether this relates to the institutional position of the parties issuing the information, or of the intended recipients. Awareness campaigns should cover as wide an audience as possible, including policymakers, owners and even students. Dialogue should also be structured on several levels, promoting talks between the various parties.

The issue of discussion platforms and the role of the mediators in this awareness-raising approach was also addressed. With this in mind, the International Day of Forests would seem to be a good time to meet.

As far as focus issues are concerned, rather than focusing solely on adaptation, a global approach based on "the forest and climate change” should be adopted, to further capture the public’s interest. For forest management stakeholders, this approach must also be based on an attitude of openness and communication.

Finally, the importance of terminology and the need not to confuse ‘information’, ‘communication’, ‘awareness’ and ‘knowledge’ was reiterated.

The issue of the positioning of the stakeholders also refers to the philosophical context in which they build the subjects of discourse.

As far as communication is concerned, methods and tools are lacking, as are serious games on climate change. Deployed at regional or forest area scale, these tools should address the intelligence and the complexity of the topics in question, and go beyond the current ‘ballistic’ communications.

RMT's action overview sets out plans for participatory exercises in the regions. These would be based on serious games or simulations. A working group has been set up on this topic, to identify two pilot regions in which the methodology could be implemented in practice.

Assessment and prospects for the AFORCE Network

Olivier PICARD (CNPF, RMT AFORCE Coordinator) and Céline PERRIER (CNPF-IDF, RMT AFORCE Facilitator)

Céline PERRIER, CNPF-IDF, RMT AFORCE Facilitator

RMT AFORCE is now reaching the end of a five-year working period which began in 2014. It is therefore currently in the evaluation phase of its work, which will be completed at the end of the year. Therefore, the network announced that a satisfaction survey would be conducted in 2019 in order to collect feedback, feelings and perceptions of different target audiences of the network. In parallel, this year the network is due to make a new submission to renew the RMT label for the 2020-2025 period, in the framework of the call for projects launched by the Directorate General of the Ministry of Agriculture.

In 2017, France Bois Forêt commissioned a network evaluation which was conducted by the firm Arcane. The strategic assessment of the network took the form of a SWOT analysis, which was summarised in the presentation.

With regard to the strengths, Arcane pointed out the structuring and uniting qualities of the network, the diversity of its members and the skills that it brings. It also praised its ability to organise discussion and networking opportunities, and to promote research and development projects, on the basis of solid scientific assessment.

As for weaknesses, the report emphasised a strong need for coordination, improvements to be made to the dissemination of the results, as well as a certain lack of legibility for managers. Certain thematic areas, related in particular to economic and social factors, still require development, while training actions need to be reinforced.

Finally, the assessment set out an inventory of opportunities and threats in the RMT AFORCE environment. In a context of increased awareness of climate change, the network responds to certain socio-economic demands and to the expectations of managers. Amongst the threats identified by the evaluation were the issue of funding, as well as the possible discouragement of managers, due to the uncertainty and complexity of adaptation. The cabinet also referred to a possible lack of connection between adaptation and mitigation strategies.

The areas of progress identified in 2017 included the launch of the new website. The network was also expanded to managers, through new partnerships (les Experts Forestiers de France and Groupe Coopération Forestière). Other developments are ongoing, including the promotion and dissemination of work, the strengthening of training support, the deployment of a network of correspondents in the region and systematic end-of-project evaluation. Other focus areas include feeding back requirements on the ground, and creating synergies between adaptation and mitigation.

Olivier PICARD, CNPF, RMT AFORCE Coordinator

In such a fast-moving area, the network has responded to a multitude of both internal and external requests (contribution to the National Climate Change Adaptation Plan – PNACC, participation in the National Forest and Wood Programme – PNFB, etc.). These contributions have helped to enhance the status of the work carried out within the network, and are positive elements for the network's subsequent action.

The other important point concerns the scale of the network's actions. While AFORCE currently works primarily at national level, it also wishes to establish partnerships at European level, as well as responding to regional and local requests which are closer to the ground.

The main issues currently include calling on collective expertise to boost public policies, the 'regionalisation' of solutions and the ownership of tools by managers.

Finally, the thematic directions for the forthcoming period will favour the construction of adaptation strategies, continuing work on exposure to hazards, sensitivity and adaptation capacity, as well as on the issue of risks and mediation in this area.

To conclude Céline Perrier stated that at the end of 10 years of work, the network's partners wanted to give the network a new, more dynamic visual identity which demonstrates the diversity of the stakeholders. They therefore

sought the advice of an expert communications firm, which has created the network's new logo. The logo was unveiled for the first time at this Symposium. In parallel, by 2020, the network will develop a new graphic charter which will be used in all of its publications.

Ending speech

Claire HUBERT (CNPF, Director)

Claire Hubert thanked all participants and organisers for the quality of the discussions which took place over the two days.

She talked about having witnessed the emergence of the issue of climate change impacts on forests. The RMT label was launched at a time at which research organisations and managers were not able to reach any agreement. It was in this context that the network was set up. She congratulated all of the stakeholders who have contributed to the success of this adventure over the past decade.

RMT AFORCE is now a highly respected network which responds to numerous requests. Umbrella bodies have an important role to play at a time at which problems are becoming wider and greater in number. They cannot however cover all topics. It is therefore important that while RMT AFORCE continues to organise events which are open to all, each institution must also retain its own purpose.

She concluded by once again thanking everyone who contributed to the two-day Symposium, and praising the friendly and open atmosphere.

CONCLUSION

Jean-Luc PEYRON (GIP ECOFOR, Director)

"In conclusion, it is difficult to provide a full overview of RMT AFORCE. In order to fulfil the task assigned to me, I have drawn up an A to Z of the network, which covers the topics and concepts that we have referred to throughout the past two days:

- A of course stands for AFORCE, and of course Anniversary as today marks 10 years of the network's existence. It also stands for Adaptation, *Atténuation* (mitigation) and Arboreta.
- B is for Bravo, referring to the high quality of the presentations and discussions, as well as Bioeconomy, Biomass, Biodiversity, (carbon/water) Balance, financial Balance sheet, etc.
- C is for Climate Change, and the current Certainty on this issue which has reduced the number of Climate sceptics, including forest owners. C is for Carbon and the Climafor tool. Of course it also stands for CNPF, which leads RMT AFORCE. I would like to thank CNPF's organising team.
- D is for Decade, and also Diagnosis (assessment), a concept which has been widely discussed over the past two days.
- E is for *Eau* (water), which has also been a theme of this Symposium, as well as multi-criteria Evaluation, Ecosystems and carbon Emissions.
- F is for Forest or France Bois Forêt, which is one of the network's sponsors.
- G is for Greenhouse Gases, and for *Gestion* (management) and *Gestionnaires* (managers), and even *Grundfläche*, which is German for basal area.
- H is for *bilan Hydrique* (water balance) and forest Habitats.
- I is for Impact, Insect Infestations, Indicators or even *Incertitudes* (uncertainties) that persist and are sometimes poorly understood by managers.
- J is for *Joyeux anniversaire* (Happy Birthday)!
- K is for climate KIC (www.climate-kic.org)
- L is for LAI (Leaf Area Index), and LabEx ARBRE.
- M is for Ministry, which is a major sponsor of the network, as well as Mortality which can be reduced through Measures for adaptation and mitigation. M also stands for Mixtures of species.
- N is for Nature, carbon Neutrality or New technologies, which have been discussed extensively over the past two days.
- O is for ONF, which is widely represented in this Symposium, and also for Optimisation strategy. Optimisation is still an area for reflection, but is less often a goal due to the uncertainties of the future.
- P is for Projections, *Propriétaires forestiers* (forest owners), Partnership, National Climate Change Adaptation Plan, National Forest and Wood Programme, *Pertes* (loss) of growth on poor sites.
- Q is for Quebec, with which links have been forged.
- R is for *Réchauffement climatique* (global warming), *Réseau* (network), Risks, and of course Regions which are now of increasing importance.
- S is for RCP or SSP Scenarios, Station, Sequestration, Substitution, *Sécheresse* (drought), and of course Services affected by climate change.
- T is for Temperature and warming Trends, such as *Tempêtes* (storms) or *Télédétection* (remote sensing) to monitor vegetation.
- U is for (European) Union. RMT AFORCE must be open to the EU as the Union is the driver of AFORCE (climate change adaptation).
- V stands for Vulnerability.
- W stands for the new RMT AFORCE website.
- X is for *Xylophage* (woodworm) or Xylophilius, with wood being one option for adaptation and mitigation.
- Y is for Yeuse, the French name for the holm oak, which looks to have a positive future.
- And finally, Z stands for *zehn Jahre* (ten years). During this International Symposium, we have already had the opportunity to

speak French and English. Therefore it is now time to speak German: *Herzliche Glückwünsche zum Geburtstag*, which means Happy Birthday! ”

The AFORCE network would like to thank all stakeholders and moderators who have contributed to the AFORCE 2019 Symposium.

Report by Ubiqus translated by Global Voices

Pictures of the document: Sabine BARETS © CNPF

* Person on the picture located to the right of the speech title

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