Annexe 2 : Positionnement vis-à-vis du PgI ARTEMIS

1. Bases of the ARTEMIS program : the Labex ARBRE community

The interdisciplinary program ARTEMIS is based on the dynamics engaged in the frame of the Laboratory of Excellence for Advanced Research on the Biology of TRees and Forest Ecosystems (ARBRE) and the ambition of its community to cover new areas and to serve as a cluster for a wider multidisciplinary community in Lorraine federating research and education in order to design trajectories for the ecological and industrial transitions, based on adaptation and mitigation of global changes in forest socio-ecosystems. In view of the multii-functionality of forest ecosystems, ARTEMIS also has the ambition to serve as a connection platform to other major challenges of LUE, namely to the priority fields of *new materials*, *energy transition*, and *health* to a lower extent.

The Labex ARBRE has now more than 10 years of existence. It is still in function and validated by an international jury. It will end in 2024. The Labex is a component of the I-SITE “Lorraine Université d’Excellence” (LUE) and as such, it articulates research, education and innovation in forest & wood sciences. The Labex ARBRE brings together a multidisciplinary team of scientists (ca. 260 researchers, engineers and technicians) from INRAE, Université de Lorraine, AgroParisTech, CNPF, IGN, ANSES and socio-economic partners (ONF, CRITT-Bois). Such cooperation between academic, education, social and industrial partners is a strength of this community and is essential to permit for sharing knowledge and ideas and stimulating innovations for a more sustainable forestry production system, more favorable to biodiversity and more resilient to climate change ; for the evolution of existing transformation techniques for a mastery of the life cycle. Our premise is that tackling the challenges in forestry brought on by global changes require projects relying on cutting-edge approaches in basic sciences on tree and ecosystem functioning, tree microorganisms interactions, soil biogeochemistry, then economics (of risk, adaptation trajectories and amenities) and lastly material and process engineering adapted to the specificity of local biomass and new performances. Beyond this basic research done in the best labs of the site, our strength, built on the old story of the Nancy forestry school, is our ability to connect these approaches to the more integrated disciplines of forest observation and monitoring (national inventory), forest planning and management and wood sciences, developing a strong expertise transferred to executives responsible for adaptive forest management as well as forest-based sustainable bioeconomy for the industrial transition, through collaborations, training programs and master/PhD degrees. In the last 5 years, as forests are more and more a matter of socio-technical controversies (opposing for instance conservation and “ecological intensification”, industrial resources and common goods to develop intelligent management of natural resources, optimization of their life cycle), we started to mobilize social and innovation sciences (beyond economics) to open our communities to larger innovation and training networks.

The overarching long-term goal of the Labex ARBRE until now has been to produce knowledge, information, models and scenarios guaranteeing forests sustained ability to produce quality goods to substitute petro-sourced products with bio-sourced molecules and materials, build synergies between the biosourced materials, plant chemistry and biotechnologies and energy sectors in order to optimize the biomass material cycle as a whole, in a changing environment and to form students, forest managers and citizens to all forest dimensions and the tomorrow’s challenges.

Relying on a Scientific and Technical Director and its deputies, a Steering Committee, a Scientific Advisory

Board, the Labex ARBRE has organized its activities in 4 research-working packages (Integrative Biology; Functional Ecology; Wood Sciences; Economy and Territories) and 2 transversal axes covering Innovation and Education, respectively. The research actions have been organized through annual calls (with external reviewing) granting Incitative (10k€) and Innovative projects (60 k€), and a continual support for small projects, animation (seminar, workshop, congress), and mobility support.

Achievements of the Labex ARBRE are:

- more than 730 granted projects (8.4 M€ injected + leveraging effect);
- more than 50 national and international workshops/conferences organized or granted;
- a strong scientific production (2012--2022): +825 articles, h index : 56;
- the support for 26 PhD thesis and 47 post-doctoral scientists;
- 4 'Highly Cited Researchers' + 1 IUF junior => on the 2012-2022 period;
- an active international partnership at different Universities/Research structures (Beijing Forestry University; U.S. DOE ORNL; UC Berkeley; Swiss Federal Institute for Forest, Snow and Landscape Research (WSL) => common projects, visitors.... ;
- the improvement of collective facilities in monitoring (ICOS ...), silvicultural experiments (In SYLVA France, GIS Coop, RENFOR group), analytic platforms (SILVATECH, ASIA), demonstrators of new wood uses (thanks to CPER FORBOIS2);
- a support for technological transfer (coll. with the RMT AFORCE) and industrial developments (ERBE platform on wood based energy, EXTRAFOREST on the valorization of high added value wood sourced molecules), "RESINOEUD" PSPC project for the construction of a full value chain from wood resources to the cosmetic market; for the creation of start-ups (WeTruff, FORESTYS), with declarations of invention;
- the creation of 'Tous Chercheurs" =>Recognized expertise in citizen sciences
- an active implication in education and teaching in different levels: IUT, Masters and graduate schools in engineering, doctorate schools, with the development of summer schools, MOOC, a comprehensive international master track, interdisciplinary research-based master tracks joining ecology, economics and learningby doing in project mode.
- The creation of "Forest Inn Lab" in the general dynamics of the "Territoire d'Innovation" Des Hommes et des Arbres with links with the Bioregions facility of European Forest Institute, of other living labs based on diagnosis and adaptation to crisis situation (Chantilly, Doller valley) =>Recognized expertise in 360° innovation;
- a support for artistic developments (Sungate 2, theatre,).

2. Ambition and long-term vision

2.1) Program context and positioning

At the global, European and national scales, forests are considered as effective carbon sinks and havens of biodiversity, sources of green materials and renewable energy. European managed forests offer a triple lever to mitigate climate change, through carbon sequestration in trees and forest soils, substitution of wood-based products and energy to carbon emitting technologies, while stocking carbon in long lasting wood products. They provide also various other benefits, such as protection of populations against natural hazards, space for recreations, and even local climate buffering. At the same time, due to their specificities relatively to agroecosystems (*i.e*., nutrient-poor and acidic or basic soils, rarely amended, long-term production system), they are particularly vulnerable to climate change that could jeopardize all these benefits – mitigation potential included. Perceived as refuges against the threatening degradation of the planet and its biodiversity, they are under the increasing scrutiny of citizens.

As an extensively (though for centuries) managed ecosystem, forests may also provide original clue to the ecological transition in agriculture, in a context of increasing demand for more extensively elaborated agricultural products. Thanks to tree interactions, the soils supporting forest development are considered as very efficient, as forests function on their own resources, in terms of nutrient cycling, biodiversity, and represent an essential compartment where long term interactions between trees, symbiotic or pathogenic microorganisms are established.

This trajectory adopted by France to meet carbon (C) neutrality by 2050 strongly relies on the capacity of forest ecosystems and wood products to substitute to fossil-based energy and materials and to sequester C in the long term (*i.e*., SNBC strategy). Alongside with a rapid reduction in net greenhouse gas emissions, this requires the development of a sustainable, circular and inclusive bioeconomy. Beyond climate mitigation issues, the adaptation of forest socio-ecosystems are strongly solicited to climate change - and will face more and more in the future – as they are facing multi-risks and an unprecedented ecological crisis (mortality due to drought and high temperatures, fires, reduced regeneration…). Achieving the ecological and energy transitions implies filling the knowledge gaps

in order to design strategies with the common objective of reducing vulnerability, increasing the resistance and resilience of forest systems, enhancing their capacity to mitigate climate change, while preserving the provision of ecosystem services, taking into account trade-offs and synergies. Such priorities have been identified at both national and international levels. The European Forest Institute (EFI) has also clearly identified adaptation and restoration of forest ecosystems as key topics in a context of high uncertainty and never experienced environmental and socioeconomic situations. Several institutions dealing with forest research and development, such as INRAE in France, the Swiss Federal Institute for Forest, Snow and Landscape Research (WSL), identified such goals as research priorities in their strategic plan as it is in the Lorraine Region. All of them also identified the importance to develop integrative approaches based on research, education and formation on forest socio-ecosystems with all stakeholders.

In this challenging context, the ambition of the ARTEMIS program is to go beyond the developments done in the frame of the Labex ARBRE and to federate and expand a scientific community handling these multidisciplinary research issues in order to design forest trajectories based on a trade-off between adaptation and climate mitigation for the ecological transition in the forest socio-ecosystems and a better inclusion of local communities of stakeholders and citizens, and authorities (*i.e.*, territories). ARTEMIS covers the whole quadruple helix (RED/I&S), through academic research (R, Research) and higher education (E, Education), collaboration with socio-economic partners (D/I, Development/Innovation), collaboration with territories, and active scientific interaction with citizens (S, Societal aims). Our region is THE place in France for training in forest and wood sciences from "Bac-3 to Bac+8" and ARTEMIS contributes through several master degrees (including among others ENSTIB and AgroParisTech masters of science in engineering, European Forestry master) and training doctoral students. Rooted in a strong regional forest-wood sector, and at the same time opened to new players and recognized in general fields of research, ARTEMIS offers an original position between forest & wood sciences and more generic plant, economics or environmental sciences, between very specialized research areas and more systemic and interdisciplinary views (see section 7 for description of the mobilizable community), and can have a transformative impact on forest and wood sectors, forest socio-ecosystem management and bioeconomy at European level.

2.2) Artemis agenda

ARTEMIS agenda in Research, Education, Development/Innovation and Societal issues (REDI&S) is driven by the priorities of adaptation of forests and forest-based bioeconomy to global changes. To address these challenges, the strategy of research will be the following:

a) To develop "high level" research on the biology, ecology and biomonitoring of ecosystems (*i.e.*, leading to international scientific leadership and high impact), including biogeochemical cycles, tree-microorganism(s) interactions, and plant/ecosystem responses to disturbances. Such an understanding of underlying mechanisms of ecosystem functioning and resilience is essential to innovative and sustainable management in a context of uncertainty and unknown changing environments.

b) To study adaptation through economic and policy approaches and promote forest questions in all concerned fields of economic sciences (as economics of risk, of environment, industrial economics) at several spatial scales (territories, national, European and global)

c) To integrate results from previous cutting-edge molecular (omics), isotope, soil sciences, biological, ecological and economical approaches into more integrative sciences and techniques such as forest monitoring and planning, silviculture. Such integration effort will require new developments and partnerships on data processing, sensors, and system modeling. It will also request to question, amplify and prioritize the academic capacity of the ARTEMIS community in the areas of decision and policy sciences, for the sake of trajectory design and implementation.

d) To study the adaptation of both forest resources and wood processing systems to new societal requirements (*e.g.*, energy transition). It values some basic researches of section a) for instance to understand the role of microbial actors in wood processing and recycling (detoxication, decomposition). More generally, linking wood techno-system changes to forest ecosystem adaptation is based on the principle that processing a local renewable and natural but vulnerable resource must be designed from/adapted to the soil, ecosystem and system management capacities and not only to the market demand. Moreover, the forest ability to mitigate climate change relies not only on C-sequestration in forest pools, but also on the uses of wood products replacing fossil C-based products. Partners outside forest and wood engineering fields will be necessary for general skills in process engineering, civil engineering, biotechnology environmental sciences (life cycle analysis).

e) The b), c) and d) strategies cannot guarantee solutions to the challenges of forest socio-ecosystems adaptation, consequently conceptual and practical shortcomings must be overcome to understand and activate leverage actions. ARTEMIS ambition is here to bridge them with social and decision sciences (*e.g.*, CEREFIGE, LOTERR, IRENEE and others in LUE communities, ECOFOR, NFZ network or EFI in national and European networks). Lastly, successful innovation requires new approaches of problem solving beyond "technology push" and one-way knowledge transfer from science to practices. To tackle these objectives, living labs and citizen sciences will be developed. They will not only support RDI, but also learning by doing and innovative training.

Interdisciplinarity will be then rationally and realistically fostered at each step. Research developments will be fully integrated with Education, Dissemination and Development/Innovation through active programs linking academic (ORION cohorts and scientific clubs, socio-economic partners and education structures (*i.e.*, LUE, Tous Chercheurs and DHDA).

2.3) Artemis objectives

The objectives of the ARTEMIS program for the next 10 years are to build a leading consortium on “Forest and Wood Sciences and Education” in France and Europe, and to develop knowledge and methods for designing trajectories for the ecological and energy transitions and to open to new fields of research and to partners on environmental challenges, participating in research on the ecology, the functioning and the transition of forest socio-ecosystems, or to fields where trees are part of innovative and sustainable agro-ecological systems (agroforestry, urban forestry) or represent a revegetation tool to manage polluted soils. To do so, the ARTEMIS Program will: i) develop a top ranking fundamental research in the fields of tree/microorganisms/soil interactions, forest ecology, biogeochemistry, soil sciences, wood sciences and environmental economics; ii) develop integrative multidisciplinary and multi-criteria approaches to model and predict the functioning and evolution of forest socio-ecosystems and forest-based circular bioeconomy, according to more intense and frequent perturbations and necessary ecological and energy transition; iii) accompany and propose innovative forestry management practices and wood processes (including recycling and up-cycling) in a real-time and prospective manners; iv) develop adapted master courses to attract and train the best students and v) develop research programs for and with citizens in the different fields covered.

This ambition will be reinforced through the development between LUE partners of strong connections between scientific challenges and i) higher education (*i.e.*, ORION program: wood and forest bioeconomy and ecology cohorts/clubs), ii) innovation (*i.e.*, SIRIUS program: Forest inn lab and ‘Tous Chercheurs’), iii) citizen sciences (*i.e.*, ‘Science avec et pour la société’ (SAPS) project). One important axis will be to improve the tools and methods modeling the evolution of the forest ecosystems and sector at different scales including uncertainties and then to use such models in projection or foresight approaches. Such improvement requires the accumulation of quantitative and qualitative data, the integration of data covering different scales and exploring more deeply different fields. The integration of new challenges related to green processes and chemistry (*e.g.*, active biomolecules and enzymes), environmental transitions and habitability (*e.g.*, forest management, assisted migration) and forest uses (*e.g.*, forest edges, agroecology, revegetation of polluted soils) at different scales (from local to landscape and territories) will require common efforts and data/recommendation integration of the different partners. Interactions will be established and/or reinforced with partners of the Grand Est region (*e.g.*, Reims, Strasbourg) on different areas such as biomass treatment and environmental biomonitoring.

Through the different dimensions covered and its connections (*i.e.*, ‘gateways’) with the other interdisciplinary programs, the ARTEMIS program will strongly contribute to the LUE societal expectations “Sustainable management of natural resources and the environment / ecological transition” (One Earth), with interactions with others.

2.4) Challenges to tackle

Online with this research strategy, the ARTEMIS program identified 6 operational challenges (OC) to tackle, combining Research, Education, Development/Innovation and Societal aims.

- **Challenge 1 (OC1**): Decipher the biology of the tree-microbiome systems. Integrating omics (genomics, proteomics, genetics, metabolomics) know-how and toolkits to identify major factors controlling soil microbiomes, plant-microbe interactions, plant development, plant functioning and dysfunction, to focus on responses to stresses and disturbances (*e.g.*, climatic extreme events and climate change, nutrient limitations, pests and diseases...),

which are expected to increase in both frequency and intensity.

• **Challenge 2 (OC2)**: Investigate and quantify process responses and ecosystem patterns to short- and long-term environmental changes in forest ecosystems (multi-risks approaches). It is essential to understand and quantify the processes in the atmosphere/tree/soil continuum, in particular the mechanisms of tree dieback and mortality, the interactions between microorganisms and plants controlled by the pedoclimatic environment, and the coupling of carbon, nutrients and water cycles. The scientific basis is urgently needed to develop new decision-making tools in order to analyze the impact of management scenarios accompanying transitions of forests in the context of global changes (drought, heat wave, pest, diseases…) and the increased demand for forest and wood products while preserving the other ecosystem services (carbon storage in the ecosystem, soil sustainability, water quality and biodiversity...).

• **Challenge 3 (OC3)**: Interactively investigate forest resources, wood processes, end-products and supply chains towards a circular and agile wood-based bioeconomy in the territory. A sustainable use of bioresource involves the creation of new processes (thermal/chemical/biological), new products (molecules derived from wood and microorganisms/assembled wooden/construction), diversification of the end uses (new source of biomass, energy production), based on existing and future resource. Linking raw material properties (from the forest and impacted by ecosystem functioning) to efficient processes and 'green' end-products, developing recycling and upcycling, modeling life cycles and environmental performance of supply chains, developing multicriteria assessment of sustainability, is the main focus of this challenge.

• **Challenge 4 (OC4)**: Imagine, evaluate, model a new set of economic instruments adapted to the risks associated with global changes, for (i) developing new forestry practices and improving multipurpose sustainable forest management in a context of risk and uncertainty (pest, drought), (ii) including forest management in territorial development and European strategies, and (iii) stimulating the forest sector in a local-global bioeconomy perspective. Forest owner and user economic behaviors, payment for environmental services, insurance (hard and soft) instrument, and economic trade-off between increasing harvesting and preserving biodiversity will be investigated.

• **Challenge 5 (OC5)**: Develop integrative researches for forest management and bioeconomy development. Adaptive forest management and sustainable development of forest-based bioeconomy require specific researches in silviculture, resource assessment, life cycle analysis and sustainability impact assessment, long-term monitoring, dynamic forest planning routines, design of new value chains based on innovative products and ecosystem services, and global and territorial forest-based bioeconomy. These researches are based on integrative modeling, specific surveys, field experiments and demonstrators in pilot territories. Often developed in livinglab mode or research action, enrolling students, they are directly linked to innovation and provide support for learning by doing.

• **Challenge 6 (OC6)**: Develop research programs for and with citizens that integrate PhD students and professionals. Forest sustainable management and more generally soil functioning, biodiversity, health risk, wood uses for energy or even tree intelligence or legislation are currently the matter of debates and controversies. Citizen science programs boost research/society interactions and position citizens as actors of research programs and active mediators of the achievements. Enrolled PhD students develop their soft skills. Moreover, we believe that involving forest owners and managers, staff of private companies, or policy makers in such programs will be an accelerator of innovation, by providing them skills in problem-solving by scientific approaches. ARTEMIS ambitions to form new generations (college and high school) to the scientific approach and societal challenges, contributing by the way to a renewal in forest and environmental policy sciences.

Thanks to these achievements, and to the involvement of ARTEMIS community in higher education programs (doctoral schools (member of the SIRENA panel and director of SIMPPE), directors of master courses, of "Ecoles d'ingénieur" AgroParisTech and ENSTIB, innovative projects like ORION), ARTEMIS will contribute to the general LUE strategy concerning training by research, valuing the doctorate as a professional degree for executive careers. The ambition of the ARTEMIS program is to be a major international hub for developing forest sustainability scenarii, forest-related bioeconomy and graduate schools. Expanding this overarching objective will require intense collaboration between academia, education, socioeconomic actors, decision-makers and European partners.

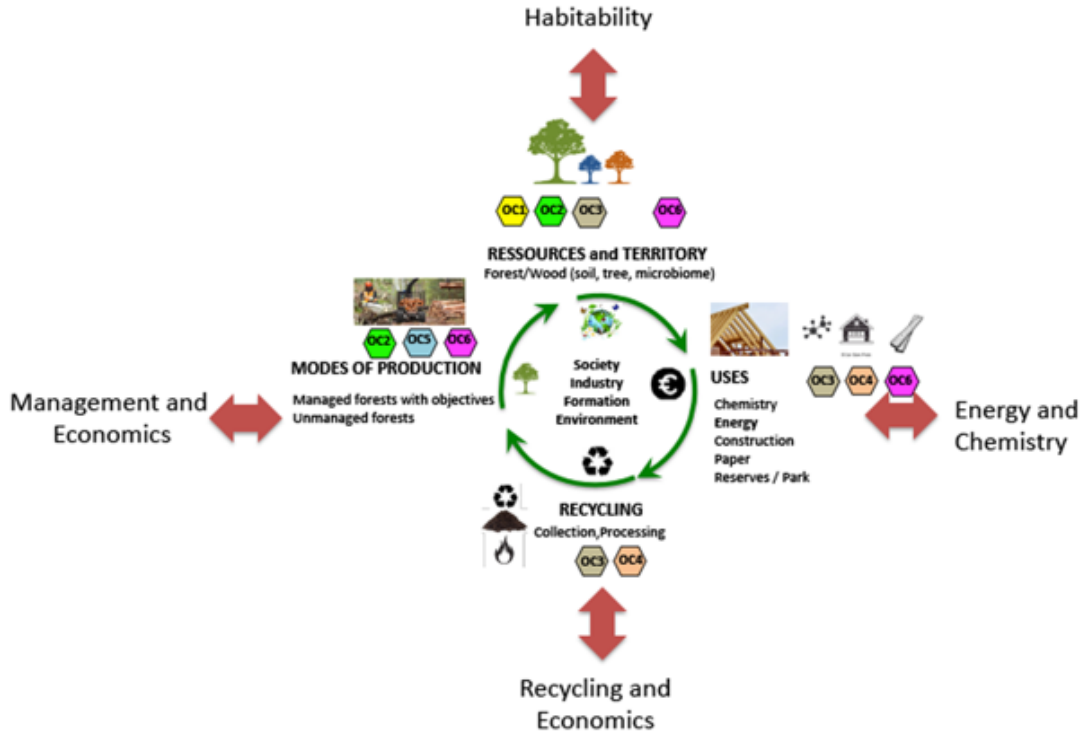

Figure 1: Positioning of the ARTEMIS program in the lifecycle of forest and wood derivatives, including the links with other challenging areas (some corresponding to propositions of interdisciplinary programs to LUE).

3. Programmatic vision:

Our consortium has a strong experience in developing a research, education and innovation strategy plan and to manage multi-partners projects. The organization proposed in the frame of the ARTEMIS program build on this experience and will rely on:

i) A program leader team (3 to 6 scientists) close to the program leader, representing the diversity of approaches from basic research to innovation, from education to participative research, from genomics, (geo)chemistry, ecology to economics, with a systemic view (this program leader will make the link with the LUE and pole strategy);

ii) An international advisory board using existing networks (as NFZ and PMI collaborators);

iii) A strong representation of socio-economic partners and stakeholders in the project governance (scientific board end steering committee) promoting Forest Inn Lab approaches;

iv) An efficient dialog with high education structures (doctorate schools, directors of Master courses, of "Ecoles d'ingénieur" AgroParisTech, ENSAIA and ENSTIB, innovative projects as ORION, and the 'pôles' A2F, OTELO, EMPP...).

To allow emergence of new interdisciplinary projects, a combination of targeted and open call projects will be done. Such dual approach, granting latitude to new incomers, will foster their inclusion in ARTEMIS community. The targeted strategy will emphasize the interdisciplinarity on strategic questions (*e.g.*, climate change, assisted migration, microbiome dimension). The open call for projects will be based on thematic actions (*e.g.*, *Microbial to forest systems, Molecular responses of trees and forests to environmental stresses & disturbances, Identification of plant and ecosystem resilience traits, Monitoring of forest biodiversity (below and above-ground) and links between biodiversity, Ecosystem functioning & Ecosystem services, Wood transformation*) to align the community with ARTEMIS objectives. Meetings will be organized yearly between the program leader team, the different partners and representatives of the different structures of the University of Lorraine (*e.g.*, "Pôles") to determine the dynamics and the strategic thematics to cover.

On the light of the experience gained from the Labex ARBRE and its achievements, and according the ambition of the ARTEMIS program, we determined a programmatic vision based on an annual budget of 800,000 €/year. Funding will be mainly support functioning, subcontracting, salary, and animation. A small part of the funding will be used as matching funds for small equipment's (unit cost above 4000 euros tax free). The essential of the funding

will be devoted to grant actions of Research, Innovation, Education and Formation as well as hybrid projects (*e.g.*, RDI, REF). Based on our experience of animation of the Labex ARBRE, we consider that the first years of the program are critical and its middle stage require stronger input in which broader projects (200 k€ to support functioning, subcontracting and a PhD grant or 12 months post-doc) are necessary to initiate and to boost interdisciplinarity. Along the life of the program, Seed projects (small project: 10 k€) and multi-units project (70 k€ to support functioning, subcontracting and/or half PhD grant or 6 months post-doc) will be granted through an annual call. Small projects permit a good agility and allow initiation of different types of projects (fundamental, applied, education) sometime risky. Multi-units projects requiring inputs from another interdisciplinary program (IP)('Gateway' between LUE IPs) will obtain a specific label and extra-funding (adjustment with the other IPs). International connection will be encouraged and an extra-funding will be considered in the case of join calls *(e.g.*, 100k€ from both sides).

In term of community management and animation, the ARTEMIS program will organize: i) an annual scientific congress (with presentations of the granted projects/results), ii) an annual doc/post-doc day, iii) regular animations and workshops on strategic and societal topics. The ARTEMIS program will organize an international event each 2 years on strategic areas (*e.g.*, functional ecology and genomics, environmental microbiology, wood sciences and chemistry, ..) with an emphasize on interdisciplinarity and a dimensioning corresponding to the community. Summer schools will be organized on different topics, based on the recognition of the ARTEMIS community. Different topics (non-exhaustive list) can be considered such as: i) Stable isotopes, ii) Microbiome, iii) Soil science/geochemistry, iv) Wood sciences, v) Forest ecosystem services. Members of the ARTEMIS community are organizing each year the summer school "Stable Isotopes in Forest Ecosystem Research" (SIFER). We propose here to extend such initiative and to create new ones.

4. Vision in terms of innovation and interaction with society (Science with and for society)

Numerous studies have attempted to provide answers to policy makers and practitioners to address the main issues and challenges at the heart of the forest-wood sector (bioeconomy development, climate change adaptation and mitigation, forest renewal, citizens; expectations, reconciling ecosystem services). They underline the difficulty of managing an ecosystem of very diverse actors with divergent objectives, and call for testing a variety of methods. The vision of ARTEMIS is to foster a sustainable innovation, based both on technological improvement and on more complex organizational and social processes, integrating all stakeholders up to the citizens. Actually, forests, as common goods, concern all citizens and are increasingly the subject of socio-technical controversies (see the debates on clear-cutting for example). We defend the idea that this user-centred open innovation must integrate non-scientific stakeholders at the very heart of the research and innovation process, on the model of participatory research, which provides useful and relevant tools to (i) raise awareness and understanding of science and the scientific process, (ii) increase the skills and capacity of citizens to tackle the uncertainty and ambiguity of forestry issues. They also contribute to the sharing of expert and lay knowledge, and encourage the construction of new research questions that are closer to the expectations of professionals and citizens, with a view to producing new scientific knowledge and finding innovative solutions.

The strength of ARTEMIS is to be able to rely on two original and complementary initiatives created by the LabEx ARBRE, –the FOREST INN LAB devoted to open innovation and the 'Tous Chercheurs' platform which offers services to researchers and civil society actors to implement participatory research projects–, to produce innovation based on research with and for professionals and citizens (and students). Particular attention will be paid in this process to the training of all non-scientific stakeholders, including citizens, in the research process.

By relying not only on these two pilot devices but also on its analytical platforms, its industrial prototypes, its network of field experiments, its databases and its models, ARTEMIS aims to approach technological innovation in a different way, on subjects as varied as forest monitoring, plantations and natural regeneration techniques, soil management, truffle farming, wood traceability, wood processes, wood materials and molecules, bioenergies, biotechnologies using microorganisms, recycling, economic models of forest management, including insurance and payments for environmental services.

ARTEMIS strategy is fully in line with the dynamics supported by the University of Lorraine as part of its Science with and for Society policy (SAPS), which has been labelled by the MESRI, and contributes to strengthening the second[1] and third[2] components of this policy. ([1] Creation of the school Science&You et [2] Creation of the Participatory research platform base on the 'Tous Chercheurs' design)

5. Positioning in the national to international initiatives, and European to international ambition

Members of the ARTEMIS community are core partners of different national initiatives such as : i) projects related to **forest crisis** (*e.g.,* support of Chantilly forest domain, Doller Valley, Harth Forest, AXA insurance project) ; ii) the **PEPR** ("Programmes et équipements prioritaires de recherche exploratoires") FORESTT on forests socio-ecosystems in transition under global changes that was recently accepted (roadmap under validation). They will also participate to the executive committee of other PEPRs such as FAIRCARBON or SOLU-BIOD. Such national programs will cover different areas related to forest socio-ecosystems and will reinforce the connections between the French partners of Lorraine, Bordeaux, Orléans, Guyane and Montpellier involved in researches on temperate, mediterranean and tropical forests.

Europe is a relevant scale for the ARTEMIS leading ambition. Members of the ARTEMIS community are regularly involved in European H2020 projects and are currently actively involved in the writing of a Research and Innovation Action (RIA) plan entitled 'European Forest Research and Innovation Ecosystem' EUFORE. Behind this initiative, ARTEMIS core partners have a strong interaction history with the Nancy-Freiburg-Zürich (NFZ) forest.net. Members of the community are also part of ENFIN (NFI European network) playing a critical role in the elaboration of pan-European forest monitoring regulations. Noticeably, common projects have been granted in the last years between the Labex ARBRE and the Swiss Federal Institute for Forest, Snow and Landscape Research (WSL). Regular meetings are performed between members of the network to synchronize agendas and initiate collaborations. The Summer school "Stable Isotopes in Forest Ecosystem Research" (SIFER) organized every year or every two years at Nancy gathered students from all over the world and illustrate the international leadership of the ARTEMIS community on the use of isotopes as a tool for research in forest ecosystems. ARTEMIS members are also actively involved in international collaborations on different areas (Annex 3). The support of the ARTEMIS program will increase visibility and recognition of the Lorraine community and foster collaborations and joined call projects. At last, a specific attention will be paid to an international strategy with other continents, by structuring the networks of our top researchers, especially with North America and China.

6. Interdisciplinary potential and ability to lead beyond the first project ideas that may have been mentioned

The complexity of the forest socio-ecosystems and their position at the interface of various societal challenges, require an increasing integration of new and complementary works of research, innovation, training, and education addressing long-term questions related to forest & wood sciences. The whole history of the Lorraine forest and wood sciences community has been based on the ability to attract new players, including for instance microbiologists in traditional forest sciences as growth and yield studies or soil sciences, or material sciences and chemistry in traditional wood technology studies.

The ambition of the ARTEMIS program is to couple the complementary expertises of its community in chemistry, biophysics, biogeochemistry, environmental microbiology, genomics, bio/eco-computing, genetics, physiology, ecology, ecotoxicology, forest science, monitoring, remote sensing, forest modeling, forest economy, forestry practices, soil sciences, science/society mediation and training to address questions related to: **i) Time**. Compared to other agrosystems exploited/managed by humans, forests are long-living and perennial, require time to grow, giving importance to the management of this resource and especially to anticipation; **ii) Land use**. Depending on the region and/or country, forests are not the same (species, age, management), their history varies (old forest, new forest) as the soil properties (and in particular, the fertility). Some regions have seen their forest capital and their economy increase or decrease significantly. Developing a bioeconomy on a territorial scale becomes essential as well as a relevant legislation system. In addition, forest and agricultural land uses may be found to critically compete with each other in the future; **iii) Production.** Maintaining forest and wood production in changing and stressing periods are real challenges. Forest surfaces are in evolution and forest management is fundamental to value this resource and avoid forest decline. Adapting forest management according to the pedoclimatic and territorial characteristics, favoring forest resilience through good practices and by introducing the relevant tree species are key dimensions to consider; **v) Perception of the forest**. Carbon sink, biodiversity reserve or wood production factory, so many perceptions that must be reconciled.

Improving our knowledge and our anticipation capacity require to know how this ecosystem: i) functions, ii) reacts to environmental stresses (*e.g.*, climate), iii) can be driven to allow a trade-off between environmental and economical requirements, iv) can be exploited to produce wood and derivatives (*i.e.*, green products) and v) can

remain a provider of services (biodiversity reserve, C sink, recreational use). The mobilizable community (see below) is a guarantee of success of such integration effort. In addition, these advances will irrigate other sectors related to agroecology and urban forestry, water management, one health studies, biosourced materials and molecules.

7. Estimation of the critical mass mobilized / mobilizable around the proposal, by making a distinction between research forces, training forces, socio-economic and societal partnerships

The community identified to date includes 13 Research and Research and Development units, but we intend to attract researchers from other units. On the issue of forest and wood, whatever the dimension considered, a minimum of 260 researchers, engineers and technicians will be able to participate. This number includes academic (INRAE, IGN/ENSG, ANSES, AgroParisTech), socio-economic partners (ONF, CRittBois, CNPF, IGN (NFI, observatory of forests)) and education structures (*i.e.*, LUE, Tous Chercheurs and DHDA). In terms of research and training, this number can go up to 400 when post-doctoral scientists, PhD students, Contractual engineers and technicians, Masters, BTS and IUT are included. This number will increase when considering researchers whose study focus is not forestry, but whose approach or technique will contribute. Many of the researchers are lecturers/professors or involved in students training in different class levels (IUT, license to Master, Engineer school). The area covered by the ARTEMIS program corresponds also to different doctoral school of Lorraine University (*e.g.*, SIRENA, SJPEG, SIMPEE).

ARTEMIS core = labs where forests ecosystems and organisms, forest sociosystems, or wood products and processes, are very significant (and historical) objects

- UR 1138 Biogéochimie des Ecosystèmes Forestiers (BEF);
- UMR 7522 Bureau d'Economie Théorique et Appliquée (BETA);
- UMR 1128 Dynamique des Génomes et Adaptation Microbienne (DYNAMIC);
- UMR 1434 Ecologie des Ecosystèmes Forestiers (SILVA);
- UMR 1136 Interactions arbres microorganisms (IAM);
- EA 4379 et EA UL/USC INRAE Laboratoire d'Etudes et de Recherche sur le MAtériau Bois (LERMAB)],
- RDI ONF Département Recherche, Développement, Innovation de l' Office National des Forêts ;
- CNPF/IDF Institut pour le Développement Forestier (Institut Technique de la Forêt Privée);
- (CRITT-Bois) Centre Régional d'Innovation et de Transfert de Technologies des Industries du Bois ;
- (LNPV) ANSES / USC INRAE Laboratoire National de la Protection des Végétaux;
- IGN/UPR LIF 201423823N RNSR /USC INRAE Laboratoire d'Inventaire Forestier.

ARTEMIS new actors = labs where teams or individual researchers already bring complementary expertise on specific projects. ARTEMIS aims to foster strengthened and structured collaborations.

- Ecology, Environment :

UMR 7360 CNRS/UL Laboratoire Interdisciplinaire des Environnements Continentaux (LIEC)

- Material sciences and process engineering

LRGP : Laboratoire Réactions et Génie des Procédés ; Institut Jean Lamour (campus ENSTIB)

- Applied maths, computer sciences, automatics, sensors

LORIA Laboratoire lorrain de Recherche en Informatique et ses Applications est une Unité Mixte de Recherche (UMR 7503) (ADAGIO team, others) ; GeorgiaTech Dream lab ; ICL Institut Elie Cartan

- Innovative systems

EA 3767 Equipe de Recherche sur les Processus Innovatifs (ERPI) Laboratoire de Génie Industriel spécialisé dans l'étude des processus d'innovation

- Social sciences

CEREFIGE Centre Européen de Recherche en Économie Financière et Gestion des Entreprises
IRENEE Institut de Recherches sur l'Evolution de la Nation Et de l'Etat (EA7303)
LOTERR Centre de recherche en géographie

8. Brief presentation (short CVs) of the principal investigators

BIO Dr. Stephane UROZ

Dr Stéphane UROZ
- UMR1136 UL/INRAE Tree microorganisms interactions
- UR1138 INRAE Biogeochemistry of forest ecosystems
- US1371 INRAE Labex ARBRE
Centre INRAE Grand Est Nancy
France

Dr Stéphane UROZ is a Research Director at INRAE (France) hired in the ECODIV division at the interface between two Research Units: i) The “Tree microorganims interactions” (IAM, UMR1136 INRAE/Univ Lorraine) unit and ii) the “Biogeochemical cycles in forest ecosystems” (BEF, UR1138 INRAE) unit. He served as Head of the “Ecogenomic of interactions” team in the UMR1136 IAM (from 2020 to 2022; 40 members). Since 2022, he is the Scientific and Technical Director in charge of the Clusters of Excellence ARBRE (Forest under climate changing; US 1371). He is internationally recognized for his research in environmental microbiology and genomics applied on forest soil bacterial communities and on their role in mineral weathering, nutrient cycling and tree nutrition, and the recent proposition of the mineralosphere concept. He has published over 90 papers in international peer-reviewed journals such as Science, Nature Communication, Trends in Microbiology, Trends in Plant Sciences, Environmental microbiology, Applied and Environmental Microbiology, Soil Biology and Biochemistry, New Phytologist, Scientific Report. He has coordinated/ partnered several projects funded by National (EC2CO, ANR), European and International (France-Berkeley) international agencies. He is editorial member of the *journals Frontiers in Soil Sciences* and *European Journal of Soil Sciences*. He currently has 8598 citations with an h-index of 43.

BIO Professor Mathieu Pétrissans

Pr Mathieu Pétrissans
- USC LERMAB
Technological Institute of Epinal
Université de Lorraine
France

Professor Mathieu Pétrissans is an Exceptional National Class Professor at the University of Lorraine, France. He served as Vice-President of Research at Nancy 2 University (from 2010 to 2012, 19000 Students), and then as Research Officer in charge of the Clusters of Excellence. He have been the coordinator of the "Scientific Counseling Committee" in Lorraine (France, 2500 researchers, 2014-2022), Dean of the Technological Institute of Epinal (450 Students, 2014-2022) ; currently Director of the Technological Collegium (8000 students) and Co-Director of the Scientific Council of the « Cluster of Excellence ARBRE » (Forest under climate changing). He's an international expert of biomass and wood thermal behavior, focusing on the thermal treatment of biomass. His main scientific achievements are the demonstration of the connection between the severity of the treatment and the inhibition of fungi attack, and also the description of the thermodegradation chemical pathways of wood biopolymers. These results have been integrated in a tow-step kinetics model. He has published over 70 papers in international peer-reviewed journals. He is the editorial member of the journals *Wood Material Science and Engineering* and *Forest*. He currently has 5839 citations with an h-index of 36. For his career accomplishments, he received the "2 Medals of knight and officer in the order of the academic palms" by the French Minister of Education and Research.

BIO General Engineer Myriam Legay

Myriam Legay
- UMR 1137 SILVA
AgroParisTech
Campus de Nancy
France

Myriam Legay is a General Engineer of the “Ponts, Eaux et Forêt” civil servant corps. Graduate from Polytechnic and

ENGREF (now AgroParisTech) schools, she served as a forest manager from 1992 to 1999 in the French Forest Service ONF), being in charge of the forest management planning, and then of the forest management of Fontainebleau forest, a large, prestigious and highly multifunctional forest (17000 ha, 60 km from Paris). After that she reached the Research, development and Innovation unit of the French forest service, which direction she took in charge in 2014. From 2019, she has been in charge of the AgroParisTech campus in Nancy, the main site in France for the training of the future executives of the forest sector (higly selected engineer, masters of science and doctors). She is also involved in several governance bodies of the forest sector (scientific committee and governing body of the ONF, governing body of the Forest National Park…). From 2005, Myriam Legay has been working on climate change adaptation, through the integration of scientific results for implementing climate adaptation strategies, in the framework of the ONF, but also within the collaborative consortium AFORCE, to the creation and governance of which she contributed from 2008 to 2019. She has published or contributed to about 30 articles, mainly in technical reviews, and coordinated the development of the ClimEssence plateform (https://climessences.fr/en), for supporting species choice under climate change. For her career accomplishments, she was conferred the distinction of “knight of French Agricultural Merit” and “knight of the French Legion of Honour”.