



# forest 4.0

**CENTRE OF EXCELLENCE: FOREST 4.0**

## **D1.3: CoE's 5-year strategic plan with CoE KPIs and targets**

**WP1: GOVERNANCE**

**Version I**

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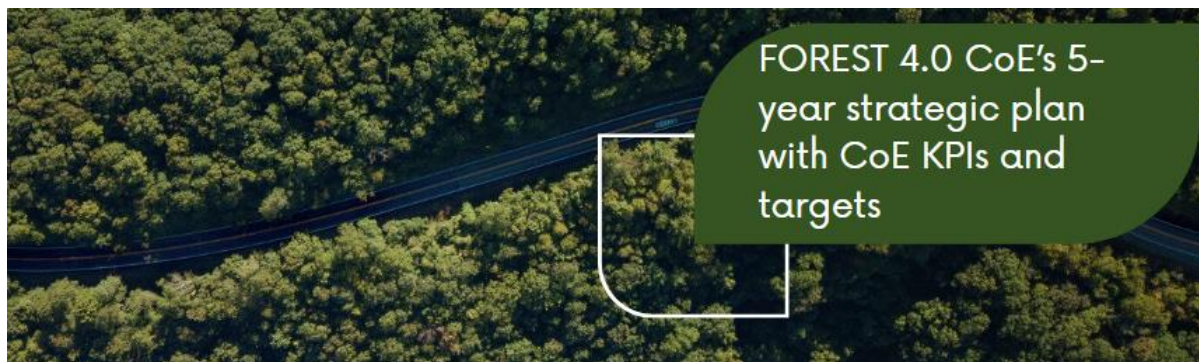
## Document History

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## Executive Summary



The Forest 4.0 CoE strategy deliverable is one of the main deliverables in WP1 Governance. The aim of the created Centre of Excellence (CoE) in forest-related Artificial Intelligence (AI) and Internet of Things (IoT) technologies is to develop and promote innovative data-based solutions to forestry management in the whole value chain, from forest resources management to end-products. FOREST 4.0 aims to contribute to the Lithuanian Smart Specialisation Strategy by developing an innovative forest-based Lithuanian bio economy through the digitalisation of forest operations.

### 1. Introduction

The Forest 4.0 CoE strategy aims to foster innovation and sustainability within the forestry sector to transform the forest environment monitoring, data acquisition, and analysis, and capture value from the collected data. FOREST 4.0 will promote a science-based contribution of sustainably managed forests to the achievement of the EU Green Deal and some of the UN Sustainable Development Goals (SDG), and the transition to a circular and sustainable bioeconomy through the provision of innovative data collection and processing applications.

In essence, a Forest 4.0 CoE serves as a hub where experts from academia, industry, government, and non-governmental organizations collaborate to drive forward the science and practice of forestry. This multidisciplinary approach not only accelerates the transfer of innovative technologies and sustainable practices but also facilitates the training and education of the next generation of forestry professionals. Through workshops, conferences, and publications, a Forest CoE disseminates its findings and recommendations, ensuring that knowledge is accessible to all stakeholders involved in forest management and conservation.

Moreover, the strategy supports the development of policies and standards that promote the sustainable use of forests. By providing evidence-based insights and technological



### D1.3: CoE's 5-year strategic plan with CoE KPIs and targets

solutions, a Forest 4.0 CoE plays a crucial role in shaping both national and international forestry agendas.

## 2. Assessment and Analysis



### SWOT

As a justification for the Forest 4.0 CoE, a SWOT analysis is provided that summarizes the context. This analysis reviews the Lithuanian partners' strengths that they will make benefit of, their weaknesses that they must tackle, and the environmental opportunities that they should cease, and threats that they must be prepared to face.

**Table 1. SWOT analysis**

<b>Strengths</b>	<b>Weaknesses</b>
<ul style="list-style-type: none"> <li>• Good technology transfer capacities</li> <li>• High competence and rich history of AI research in the agriculture sector and digital manufacturing</li> <li>• AI and data analysis specialized study programmes in the universities' strategies</li> <li>• High scientific potential and effective cooperation with foreign universities in smart forestry</li> <li>• VMU and KTU are leading AI and IoT R&amp;D in Lithuania</li> <li>• Already available infrastructure and key experts in smart forestry research and innovation, technology transfer, concentrated in one academic campus</li> <li>• Increasing participation of alumni and business partners in all aspects of AI and forestry</li> <li>• CoE researchers are rated as experts and consultants at national and international level</li> <li>• The university has an efficient science management system, a researcher incentive system, and</li> </ul>	<ul style="list-style-type: none"> <li>• Lack of necessary data for AI-based decisions support tools</li> <li>• Low number of students enrolled in AI studies to satisfy market needs</li> <li>• While Lithuania has research centers for technically relevant areas like chemistry, high-performance computing and mechatronics, there is no center that focuses primarily on AI</li> <li>• Lack of university-wide standards and procedures for the implementation of pro-quality processes in the field of scientific activity, commercialization, support for students, PhD students and academics</li> <li>• Based on Lithuania Bank data, the manufacturing sector of Lithuania allocated only 0.5 % of its value-added to investment in R&amp;I, while the EU countries amounted to 4.4%</li> <li>• Strong dependence of professional forestry on outdated doctrines and command&amp;control forest governance</li> <li>• Research is still much carried out in small and competing groups of researchers, which leads to fragmentation, independence and limited accessibility of research</li> </ul>

<p>digitalisation is applied in all processes of science administration</p> <ul style="list-style-type: none"> <li>The research ecosystem of the CoE is based on the collaboration between experienced field researchers and younger researchers</li> </ul>	<ul style="list-style-type: none"> <li>Low involvement of young researchers in doctoral studies and postdoctoral fellowships</li> <li>Low involvement of researchers in long-term fellowships</li> <li>Insufficient technology transfer and commercialization at international level</li> <li>The number of coordinated international high-level scientific research projects is still low</li> </ul>
<p style="text-align: center;"><b>Opportunities</b></p> <ul style="list-style-type: none"> <li>Strategic government initiatives include plans and recommendations for AI development in industry, finance, community and academic ecosystems</li> <li>Grant funding from the Ministry of Economy and Innovation foreseen for AI projects</li> <li>Government support for national and international cooperation in the area of AI</li> <li>Stakeholders understand the added value of responsible and sustainable AI solutions</li> <li>Contribution to Lithuania's competitiveness and sustainable knowledge-based economic, social and cultural development through transfer of knowledge and technologies created at KTU</li> <li>High specialization of the Baltic Sea Region * in forest-based economy: countries of the region are the major source of wood in Europe (in 2017, their production of round wood, fuel and industrial wood corresponded to 59.6%, 38.4%, and 66.0% of such types of wood produced in the EU-28, respectively); the region also represents around one-billion-euro market of forest-based bioeconomy R&amp;D (according to annual expenditure on R&amp;D within NACE activities A, C16-C18, and C31)</li> <li>Increasing public attitude on processes in and around the forests</li> <li>Increasing role of advanced solutions in forestry due to national and international political processes</li> <li>The link between the green deal policy and the implementation of the sustainable development goals encourages to make comprehensive use of the resources available for the development of new interdisciplinary research</li> <li>The EU's science and studies policy (2022-2027), which focuses on the increased involvement of Eastern European science and studies institutions, offers extra opportunities to develop international project activities</li> <li>The EU and Lithuania's R&amp;D policy encourages investment in activities that create favorable conditions to commercialize their research results, and to create new partnerships with business and other economic entities</li> </ul>	<p style="text-align: center;"><b>Threats</b></p> <ul style="list-style-type: none"> <li>Lack of AI-related research publications and PhD programmes</li> <li>Low confidence in developed AI-based products</li> <li>Uncertainty about data protection in Lithuania</li> <li>Existing areas that are often slow to technological advancement (e.g., agriculture / forestry)</li> <li>High fragmentation of R&amp;I capacities in the country</li> <li>Poor image of professional forestry in Lithuania, often fueled by media and some politicians</li> <li>Escalation of geopolitical situation in Europe and globally results in changing attitudes, financing preferences, mobility</li> <li>Limited experience of VMU in running large scale EU projects</li> <li>Fierce and unmanageable competition between higher education institutions, lack of stability and transparency in the Lithuanian higher education policy</li> <li>The instability, unsustainability and inadequacy of the priorities of the Lithuania's research funding policy hampers the possibility of clear and coherent planning of the scientific activities of the CoE</li> <li>Low researcher image in the national scale limits researchers' motivation and discourages them from pursuing a research career</li> <li>The "brain drain" to national and international businesses and other organizations or institutions reduces the potential</li> </ul>

<ul style="list-style-type: none"> <li>• The growing demand for university-educated and interdisciplinary citizens or professionals with interdisciplinary skills in the modern socio-economic system allows to exploit the available resources in a more efficient way</li> <li>• New international strategic partnerships open possibilities to collaborate with other partner universities and research centers in research and other activities, strengthening the role of the CoE as an international player</li> <li>• The growing role of science and research in society and its confidence in the results of science increases the amount of collaborative research with governments, businesses, social organizations and communities, and their involvement in CoE activities</li> <li>• Dual use technologies development</li> </ul>	<p>of the best researchers to form the CoE</p>
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### 3. Vision and Mission



## Vision

**Forest 4.0 - national, regional and worldwide leader in smart forest innovation society**

## Mission

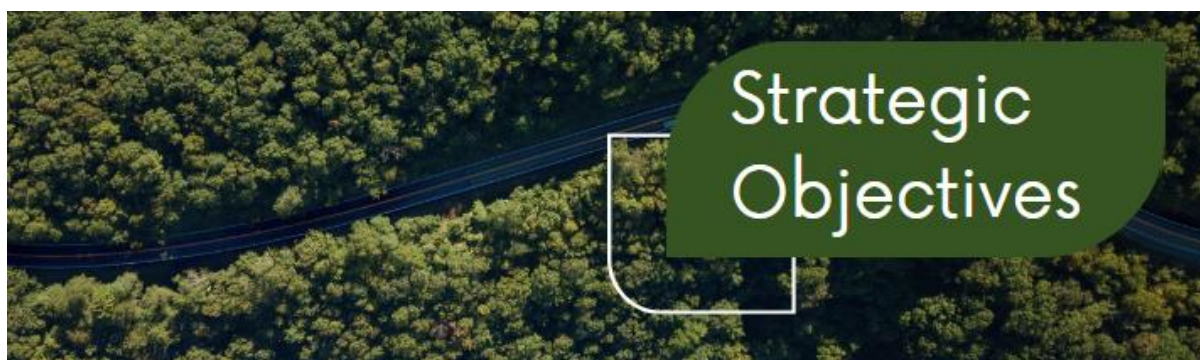
**Development of digital technologies for the forestry and circular forest-based economy**

**Research** Fundamental and applied research for the new and sustainable smart technologies for innovative forest sector solutions

**Education** Education on digital transformation and sustainability of forestry and forest-based economy

- Business**      Creation of methods and tools for smart and sustainable forestry and forest-based economy
- Society**        Engagement and empowerment of society in future forest creation

#### 4. Strategic Objectives



Forest 4.0 aims to contribute to the Lithuanian Smart Specialisation Strategy by developing an innovative forest-based Lithuanian bio economy through the digitalisation of forest operations. Forest 4.0 will promote a science-based contribution of sustainable managed forests to the achievement of the EU Green Deal and the some of the UN Sustainable Development Goals (SDG) on AI and IoT applications promoting a forest-based bioeconomy and the transition to a circular and sustainable bioeconomy through the provision of innovative data collection and processing applications. Project team and Forest 4.0 CoE identified 4 strategic themes: 1) CoE Development; 2) Research and Education; 3) Business development and international outreach; and 4) Ecosystem building and society.

**Table 2. Strategic objectives of Forest 4.0 CoE**

STRATEGIC THEMES	OBJECTIVES
<b>1. CoE development</b>	<ul style="list-style-type: none"> <li>1.1. Setting up operations</li> <li>1.2. Developing CoE resources and processes</li> </ul>
<b>2. Research and education</b>	<ul style="list-style-type: none"> <li>2.1. To establish R&amp;D teams and articulate principal research directions</li> <li>2.2. To advance the technological sophistication of research facilities</li> <li>2.3. To undertake research projects tackling current issues in Forest 4.0</li> <li>2.4. To engage in partnerships aimed at advancing research and education</li> <li>2.5. To enhance the capacity of research teams</li> <li>2.6. To conduct scientific events</li> </ul>

	<p>2.7. To foster collaborations and aim for leadership within professional organizations and associations</p> <p>2.8. To disseminate research findings through publication and presentation at scientific conferences</p> <p>2.9. To foster a culture of scientific understanding in contemporary forestry</p> <p>2.10. To engage early-career researchers in scientific endeavours</p> <p>2.11. To establish postdoctoral opportunities</p> <p>2.12. To facilitate training initiatives for main stakeholders to advance their competencies</p> <p>2.13. To design new academic curricula or courses and engage gifted students</p> <p>2.14. To promote lifelong learning activities</p>
<b>3. Business development and international outreach</b>	<p>3.1. To build team and develop tools for effective marketing and business development</p> <p>3.2. To implement CoE's business model through innovation support services</p> <p>3.3. To integrate CoE into international networks and attract funding from EU and other international programmes</p>
<b>4. Ecosystem building and society</b>	<p>4.1. To increase science and innovation capacities for all actors in the R&amp;I system</p> <p>4.2. To increase the capability of the cluster actors to attract funds</p> <p>4.3. To disseminate research findings to a broad audience and stakeholders</p>

## 5. Target Audience and Stakeholder Engagement



The CoE aims to establish an ecosystem involving multiple public and business stakeholders focused on fostering a culture of innovation to advance AI and IoT solutions in the forest-based sector. Initially, the identification of potential Forest 4.0 stakeholders was conducted. This initiative stemmed from the forestry stakeholders' mapping undertaken within the Lithuanian National Agreement on Forests framework, later updated to include new potential stakeholders, particularly from the IT sector. The alignment with the CoE's objectives was developed through personal communication and expert input from the Forest 4.0 team.

While there are additional ministries, subordinate institutions, and other actors not listed among the stakeholders, their role in forest policies is comparatively less significant. A summary of forestry stakeholders is provided in Table 3 with full data available in Annex 1.

The alignment with CoE activities was established through personal communications or by utilizing potential stakeholder profiles. Stakeholders were viewed both as recipients of CoE services and as providers of services and goods to the CoE. The following types of partnerships were considered:

(i) Information sharing, applicable to all potential stakeholders listed.

(ii) Collaboration identification, presumed for stakeholders expressing a willingness to engage with the CoE, often during direct meetings or other forms of personal communication. Collaboration levels varied from a willingness to commission/conduct scientific research from the CoE to mutual consultations, provision/offering of services such as data capture and coding, and participation in other projects and funding applications.

**Table 3. Summary of national stakeholders and their potential interests in smart forestry and linkage to fields of CoE activities (see Annex 1 for more detailed list)**

Stakeholder group	Number of identified and analysed stakeholder organisations within the group	Level of interest based on the share of stakeholder organisations within the group interested				
		<i>Receiver of</i>				
		<i>Information</i>	<i>Scientific research</i>	<i>Consultations &amp; expertise</i>	<i>Services</i>	<i>Partnerships</i>
Policy related to forestry and IT	19	100%	63%	95%	63%	37%
Stakeholders with predominantly economic interests in forestry	33	100%	30%	33%	33%	27%
Stakeholders with predominantly environmentalist interests in forestry	17	100%	18%	41%	35%	59%
Stakeholders with predominantly social interests in forestry	17	100%	0%	6%	6%	6%
Total:	86	100%	29%	43%	35%	31%
Stakeholder group	Number of identified and analysed stakeholder organisations within the group	Level of interest based on the share of stakeholder organisations within the group interested				
		<i>Provider of</i>				
		<i>Information</i>	<i>Scientific research</i>	<i>Consultations &amp; expertise</i>	<i>Services</i>	<i>Partnerships</i>
Policy related to forestry and IT	19	100%	0%	53%	11%	37%
Stakeholders with predominantly economic interests in forestry	33	100%	9%	27%	12%	27%
Stakeholders with predominantly environmentalist interests in forestry	17	100%	12%	29%	12%	59%
Stakeholders with predominantly social interests in forestry	17	100%	0%	6%	6%	6%
Total:	86	100%	6%	29%	10%	31%

All stakeholders can be viewed as both sources and recipients of information exchange. Among the most significant potential clients for CoE research, consultancies, and other services are institutions involved in forestry and IT policy building and implementation, such as ministries and state agencies. Stakeholders primarily concerned with economic aspects of forestry are particularly valuable in terms of their potential to utilize CoE services. Conversely, stakeholders primarily focused on environmental concerns in forestry are not only potential service providers to CoE but also strong candidates for collaborative project partnerships. Stakeholders with a primary interest in forestry's social aspects are important mainly for information exchange.

## 6. Research Plan and Strategy



The research plan and strategy is developed analysing set of studies and meetings with stakeholders leading to formation of the design of the research structure for the Forest 4.0 CoE. The provided table below reveals the context of forestry policies in EU and Lithuania and concentrates on the disclosure of main scientific problems, gaps and conflicts in forestry ecosystem research, open innovations, AI, and digitalization areas. It highlights the main research perspectives, products and services for forest companies in Lithuania and abroad.

**Table 4. Research plan**

<b>Research group</b>	<b>Research topics</b>	<b>Products &amp; Services</b>
IoT and ubiquitous computing for the development of geospatial techniques	Using IoT in forest for environmental management, natural resources management, disaster management, land information system management and visualization; Forest IoT network security; IoT based soft computing-multiagent systems risk evaluation and decision support systems with XAI(explainable AI), creation forest IOT services	Framework and tool for development Forest IoT devices and services; IoT network management tool; Forest IoT network deployment and Service & Resource Orchestration; Forest risk evaluation tool with XAI
Remote sensing for advanced forest data collection	Advanced methods for capturing information on resources for forest estates, landscapes, regions or countries utilizing new finer-resolution data sources and developing new data capture/storage/processing concepts, developing new precision silviculture methods by utilising finest resolution 3D tree level data; advanced frameworks of natural resource inventories based on IoT and remote sensing; exploring spectral properties of vegetation to develop geospatial techniques for climate smart forestry	Advanced imaging missions for assessing properties of trees, forest stands and trees outside the forest; tree mapping using pseudolite driven positioning systems; advanced inventories of natural resources, including modernization of National forest inventories and greenhouse gas accounting; spectral libraries of vegetation; mapping of vegetation properties, including mobile mapping; development and testing new sensors and data collection routines

IoT monitoring and AI prediction techniques for the development of forest management system and the detection of forest threats

Eco-physiological processes in forest ecosystems aimed to build scientific frame of smart forestry (e.g. changes in tree transpiration and fluorescence, photosynthetic activity, development of tree annual rings, together with precise recording of environmental conditions); greenhouse gases over the forest canopies to detect the tree response to environment changes and define the resistance and resilience limits; improvement of models for greenhouse gases and CO<sub>2</sub> footprint; processes in forest soils; forest productivity; decomposition of organic matter; forest vegetation under stress conditions; modelling natural hazards and forest disturbances for decision support; interactions between vegetation and CO<sub>2</sub>, O<sub>3</sub> and N regimes under progressive climate warming and associated feedbacks; fundamentals of precision forestry

Better understanding and enhancing the mitigation potential of ecosystems and sectors based on the sustainable management of natural resources, greenhouse gas accounting according to the requirements of State environmental monitoring program, with the potential to join pan-European ICOS network (Integrated Carbon Observation Systems), full detailed models of C-stocks and flows, process-based eco-physiological models of forest ecosystems, also for existing or new forest projection systems

Crowdsourced forest-based data management and visualization

Data and metadata storage infrastructure, exploratory data visualization for early investigation and decision making, anomaly maps for problematic locations detection, anomaly detection for predictive maintenance, optimization of forestry-related logistic processes

Data curation services, pre-processed data/cleaned data, visual exploratory analytics solutions, anomaly maps for early problematic locations identification, optimization of forestry-related logistics, anomaly detection for predictive maintenance, interactive maps for forestry change simulation, forestry data simulation; forest and forestry data management strategies and tools

AI techniques for cognitive sensing and multi-modal signals processing in IoT-based systems for predictive analytics

Analysis of multimodal forest data (using a fusion of any available data: computer vision, spectrum sensing, tree sensor data, etc.) for intelligent predictive production and maintenance (forest "health care," (re)growth, carbon, fire alerts, and so on); modelling and forecasting of biomass supply chains as a dynamic combination of organizations, human resources, activities, information, and biomass resources (bulk residues, chips, bundles) involved in transferring trackable residues from suppliers to end-users; AI-powered cognitive task analysis to foresee the aims of explicating forest user demands, desires, and cognitive capacities for coping with complicated forest bio-economy chain systems; metaheuristics

Conceptual framework(s) for self-services such as AI-driven identification and prediction of forest production and maintenance requirements, AI-driven forest "impact" driver reports, automated analysis and evaluation of the effects of external factors such as weather conditions, operator experiences, and/or operator fatigue on forest production and maintenance costs; Modelling and forecasting of biomass supply chains involved in transferring trackable residues from suppliers to end-users; AI driven forest logistics optimization, support with interpretation of remote sensing data; support in geospatial analysis to aid in the AI driven forecasting, detection and identification of anomalies and disturbances in the forest ecosystem/bioeconomy chain

Development of Decision Support Tools (DSTs) to assess forest management practice

Models for strategic and tactical coordination of precision silvicultural methods with the value chain; development and implementation of modern decision support tools for experimenting with alternative forest management models; methods to account for diversity of ecosystem services in decision support for sustainable forestry; incorporation of global climate change and market scenarios in forest management; consideration of climate change effects in forest management decisions; landscape-scale decision support; decision support to account for greenhouse gases in agriculture, forestry and land use sector; new and modified silvicultural management methods devised; social, technological, ecological, economic and political aspects of precision forestry operationalization

Advanced understanding and science to support adaptation and resilience of natural and managed ecosystems, water and soil systems and economic sectors in the context of the changing climate; a general purpose software solutions and know-how for operational forestry to support adaptive forest management, including a set of tools for dendrometric data processing and forest yield modelling; improved forest management decisions, validated and implemented alternative forest management models, fully functional decision support system(s) adopted for Lithuanian conditions, however, compatible with the international needs; modeling infrastructure for the whole forest sector

Life Cycle Assessment (LCA) and bioeconomic modelling tools for the identification and justification of sustainable forest-based business model innovations

Integration of LCA and bioeconomics for the analysis of products and processes in forest resources-based value chains with the aim to improve both environmental and economic performance; environmental sustainability and economic viability of circular economy models applied in forest resources-based business; IoT and AI driven automatization of data acquisition and analysis for the completion of integrated assessments and simulations concerning forest resources-based products and processes; resilient forest value chains under conditions of local and global change, potential consequences of different forest resilience enhancement strategies on the long-term design of value chains, forest and value chain alternatives to enhance the resilience from societal perspectives, institutional adaptations to take advantage of forest and value chain strategies, and road maps for their implementation

Integrated and automated assessment and simulation tools supporting the development of environmentally sustainable and economically viable forest resources-based businesses; matching tool supporting the development of circular economy through industrial symbiosis customized for forest resources-based businesses, municipalities, and consultants; approaches and tools to help forest planners and companies to analyse resilience in their forest-based supply chains, forest and value chain resilience strategies for Lithuania and beyond, proposals and analyses of institutional adaptations

The main approach of CoE is to respond to an increasingly globalised and competitive landscape prompting the dynamic formation of new research priorities and facilitating ongoing improvements in research performance at both national and international level. The initial research plan is based on the Forest 4.0 application, and it will be revised and adjusted yearly according to the needs of researchers and market.

The CoE team will follow closely the developments concerning EU Forest Monitoring Law, European Bioeconomy Strategy, New European Bauhaus, support for emerging research and development topics, such as technologies with dual-use potential.

## 7. Performance Metrics and Monitoring



Forest 4.0 CoE developed the implementation pathways of key performance indicators for 5 years. The results will contribute to the outcomes and towards wider impacts identified below:

- **Increased scientific capabilities / higher participation success in Horizon Europe and more consortium leadership roles**
- Developed and enhanced research and innovation capacities and the uptake of advanced technologies
- Enhanced innovation and **integration of planned processes, services and products** of the centre
- **Strengthened role of the Higher Education sector in research and innovation**
- Development and promotion of **new research strands** in relevant domains
- Stronger **linkages between academia and business** and improved career permeability
- Greater **involvement of regional actors** in R&I process
- Strengthened and mutually benefitting **collaboration with partners** from leading scientific institutions
- Improved **outreach** to international scale for all actors
- Contribution to the achievement of the specific objectives of the supporting national/regional/EU programme as **complementary funding**
- Mobilisation of national and European resources for **strategic investments**

**Table 5. Key performance indicators for 5 years**

STRATEGIC THEMES	Key performance indicators	Measured factor	Annual target by the end of the project	2024	2025	2026	2027	2028
1. CoE development	KPI1. Number of FTE researchers per research group in given year	Critical mass of researchers per research domain	8	3	4	5	6	8
2. Research and education	KPI2. Number of publications per researcher per year	Academic productivity	0.5	0,1	0,2	0,3	0,4	0,5
	KPI3. Number of trained early career researchers per year	Training delivery	25	9	13	17	21	25
	3. Business development and international outreach	KPI4. Targeted share of business revenues	Business support	10	1	3	5	7
KPI5. Number of tested AI system in the sandbox/test labs per economic sector per year		Business support	10	1	3	5	7	10
KPI6. Number of clients for commissioned research per year		Business support	5	1	2	3	4	5
KPI7. Number of patented technologies per year		Intellectual property production	1					1
KPI9. Number of prototypes		Citizen competence transfer	10		2	4	6	10

<b>4. Ecosystem building and society</b>	KPI8. Number of partners in the AI cluster	Cluster development	50	6	10	20	30	50
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## 8. Initiative Prioritization and Roadmap



Forest 4.0 team has discussed the CoE prioritization and roadmap possibilities. One of the key advantages of the CoE is that it can initially be built on a small scale, and then can iteratively evolve and scale up its resources, services, and capabilities.

Building blocks of the evolution of Forest 4.0 CoE are provided in Scheme 1, while Table 6 provides a more detailed roadmap.



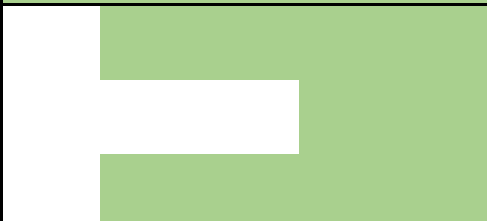
### The evolution of Forest 4.0 CoE



**Scheme 1.** Operational activities of Forest 4.0 Centre of Distributed Activities

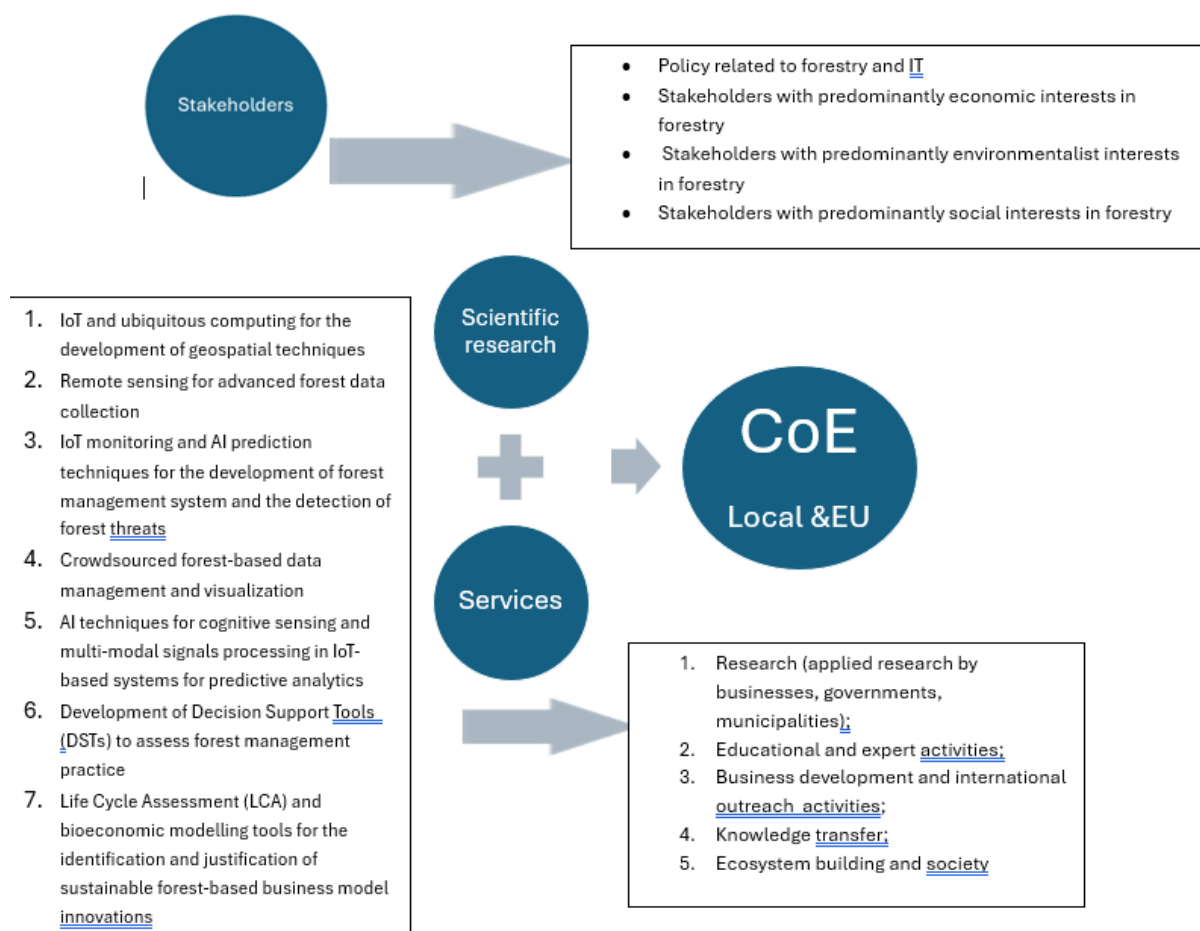
**Table 6. Roadmap for the evolution of Forest 4.0 CoE**

STRATEGIC THEMES	OBJECTIVES	TIMELINE				
		2024	2025	2026	2027	2028
1. CoE development	1.1. Setting up operations	█				
	1.2. Developing CoE resources and processes		█			
2. Research and education	2.1. To establish R&D teams and articulate principal research directions	█				
	2.2. To advance the technological sophistication of research facilities		█			

	<p>2.3. To undertake research projects tackling current issues in Forest 4.0</p> <p>2.4. To engage in partnerships aimed at advancing research and education</p> <p>2.5. To enhance the capacity of research teams</p> <p>2.6. To conduct scientific events</p> <p>2.7. To foster collaborations and aim for leadership within professional organizations and associations</p> <p>2.8. To disseminate research findings through publication and presentation at scientific conferences</p> <p>2.9. To foster a culture of scientific understanding in contemporary forestry</p> <p>2.10. To engage early-career researchers in scientific endeavours</p> <p>2.11. To establish postdoctoral opportunities</p> <p>2.12. To facilitate training initiatives for main stakeholders to advance their competencies</p> <p>2.13. To design new academic curricula or courses and engage gifted students</p> <p>2.14. To promote lifelong learning activities</p>	
<p><b>3. Business development and international outreach</b></p>	<p>3.1. To build team and develop tools for effective marketing and business development</p> <p>3.2. To implement CoE's business model through innovation support services</p> <p>3.3. To integrate CoE into international networks and attract funding from EU and other international programmes</p>	
<p><b>4. Ecosystem building and society</b></p>	<p>4.1. To increase science and innovation capacities for all actors in the R&amp;I system</p> <p>4.2. To increase the capability of the cluster actors to attract funds</p> <p>4.3. To disseminate research findings to a broad audience and stakeholders</p>	

While implementing its objectives, the CoE will aim to respond to the needs of its key stakeholders, developing and providing relevant scientific research and services (Scheme 2).

### Map of Forest 4.0 CoE activities



**Scheme 2.** Map of Forest 4.0 CoE activities

## 9. CoE 5 year Strategy Plan





STRATEGIC THEME		1. CoE development				
OBJECTIVE	1.1. Setting up operations	TIMELINE				
ACTIONS	DESCRIPTION	2024	2025	2026	2027	2028
1.1.1. Setting up governance of the center of excellence	Creating management and governance structure of the CoE, hiring personnel, creating governance teams.	█				
1.1.2. Creating infrastructure of the center of excellence	Purchasing equipment, creating, setting administrative tasks, procedures, policies.	█	█	█		
1.1.3. Setting up business development team	Creating the structure of the business development team, selecting personnel, planning strategy of this team, assigning tasks.	█	█	█		
1.1.4. Creating and developing sales and marketing, research and development, scientific teams	Setting up tasks and goals for the teams, selecting and hiring personnel, creating management hierarchy, setting up procedures and policies for the teams.	█	█	█		

OBJECTIVE 1.2. Developing CoE resources and processes		TIMELINE				
ACTIONS	DESCRIPTION	2024	2025	2026	2027	2028
1.2.1. Human resource strategy development and implementation	Creating the strategy for the human resources, development of the human resources, creating and implementing policies, procedures of all human resources related topics, including employment, well-being, laws.	█				
1.2.2. IT management policy	Create and implement IT management policies and procedures.		█	█	█	█
1.2.3. Standard operating procedures	Create and implement standard operating procedures on all aspects of daily workflow of CoE.		█	█	█	█
STRATEGIC THEME 2. Research and Education						
OBJECTIVE 2.1. To establish R&D teams and articulate principal research directions		TIMELINE				
ACTIONS	DESCRIPTION	2024	2025	2026	2027	2028
2.1.1. Inventory of current research potential at project partners institutions	The research groups will be established improving the available research competences and infrastructure, which will be inventoried and evaluated for the compatibility with Forest 4.0 objectives and development plans.	█				
2.1.2. Building the cores of research groups	The cores of research groups will be formed involving key VMU, KTU and LNU researchers working in the field of Forest 4.0. Preliminary, there are 7 research groups assumed, corresponding to the groups mentioned in proposal, but with the Group 1 “IoT remote sensing and ubiquitous computing for the development of geospatial techniques” split into 2: (i) IoT and ubiquitous computing for the development of geospatial techniques and (ii) Remote sensing for advanced forest data collection, due to availability of good potential for covering wider research tasks.		█	█		
2.1.3. Development of research and education plans for each group	The cores of research groups are responsible to develop research and education plans within the frames of their competences. They are responsible for specification of equipment to be purchased using national part of Forest 4.0 funding. They are also responsible for communicating and marketing relevant Forest 4.0 activities until the corresponding teams at the CoE are established.		█	█		
OBJECTIVE 2.2. To advance the technological sophistication of research facilities		TIMELINE				

ACTIONS	DESCRIPTION	2024	2025	2026	2027	2028
2.2.1. Installing the research infrastructure	Following the research plans and plans for enhancement of research infrastructure, installation and starting the new infrastructure, including its integration with the available one					
<b>OBJECTIVE</b>	<b>2.3. To undertake research projects tackling current issues in Forest 4.0</b>	<b>TIMELINE</b>				
ACTIONS	DESCRIPTION	2024	2025	2026	2027	2028
2.3.1. Initiation of research activities in groups	Conducting preparatory research needed both to tune research plans and to prepare for advanced research activities. E.g., depending on research group: testing new IoT tools under forest conditions; testing new remote sensing sensors and imaging platforms; familiarizing with Lithuanian NFI data and data processing algorithms and building open system of tools for dendrometric data processing; elaboration of new sampling scheme for Lithuanian NFI; testing novel forestry data processing approaches involving competences and infrastructure from diverse project partners; adopting already operational forest DSS for Lithuanian conditions; testing forest value chain research methodologies. This research initiation phase is conducted involving VMU, KTU and LNU researchers, supposed to build the cores of research groups. It also includes initial searching for future projects, before dedicated team for project development at the CoE is established.					
2.3.2. Carrying out research and development projects	Carrying out projects by CoE research groups and other researchers, according to the research and development plans.					
2.3.3. Providing CoE infrastructure to outside partners to conduct their projects	Providing infrastructure for other researchers to conduct their projects, based on the conditions for the use of open infrastructure and data.					
<b>OBJECTIVE</b>	<b>2.4. To engage in partnerships aimed at advancing research and education</b>	<b>TIMELINE</b>				
ACTIONS	DESCRIPTION	2024	2025	2026	2027	2028

2.4.1. Concluding partnership agreements with key national stakeholders	Concluding partnership agreements with key national partners, including the State Forest Service, SC State Forest Enterprise, the Association Lithuanian Forest, and the Lithuanian Association of Forest and Land Owners.					
2.4.2. Strengthening international partnerships	Searching for and establishing international partnerships.					
2.4.3. Engaging partners in CoE governance	Involving key stakeholders in the governance of the Center of Excellence (CoE) by inviting them to join the Advisory Board.					
<b>OBJECTIVE</b>	<b>2.5. To enhance the capacity of research teams</b>	<b>TIMELINE</b>				
<b>ACTIONS</b>	<b>DESCRIPTION</b>	<b>2024</b>	<b>2025</b>	<b>2026</b>	<b>2027</b>	<b>2028</b>
2.5.1. Recruiting the research teams	Based on the plans approved by GB, employing researchers to implement the research and education tasks.					
2.5.2. Sharing research infrastructure with external researchers	Developing approaches and providing research infrastructure and CoE resources to external entities, including universities, businesses, and private companies, to facilitate their projects					
<b>OBJECTIVE</b>	<b>2.6. To conduct scientific events</b>	<b>TIMELINE</b>				
<b>ACTIONS</b>	<b>DESCRIPTION</b>	<b>2024</b>	<b>2025</b>	<b>2026</b>	<b>2027</b>	<b>2028</b>
2.6.1. Organization of scientific events	Initiation and continuation of at least one scientific conference a year to summarize Forest 4.0 achievements.					
<b>OBJECTIVE</b>	<b>2.7. To foster collaborations and aim for leadership within professional organizations and associations</b>	<b>TIMELINE</b>				
<b>ACTIONS</b>	<b>DESCRIPTION</b>	<b>2024</b>	<b>2025</b>	<b>2026</b>	<b>2027</b>	<b>2028</b>
2.7.1. Joining international research organizations	Specifying international research organizations and joining/membership them, if approved by GB (e.g. IUFRO).					
2.7.2. Initiating and implementing joint activities	Develop partnerships to initiate, commence, and collaboratively implement innovative projects.					
<b>OBJECTIVE</b>	<b>2.8. To disseminate research findings through publication and presentation at scientific conferences</b>	<b>TIMELINE</b>				

ACTIONS	DESCRIPTION	2024	2025	2026	2027	2028
2.8.1. Preparing and publishing research results	Preparing and publishing research results, following the research topics.					
2.8.2. Taking part in scientific events	Taking part in scientific events and disseminating through publication and presentation at scientific conferences. Build new partnerships through attending scientific events.					
<b>OBJECTIVE</b>	<b>2.9. To foster a culture of scientific understanding in contemporary forestry</b>	<b>TIMELINE</b>				
ACTIONS	DESCRIPTION	2024	2025	2026	2027	2028
2.9.1. Popularizing of smart forestry science	Organization of educational workshops and seminars targeted at forestry professionals, forest owners, policymakers, and the general public to educate them about the concepts, methods, and advantages of smart forestry technologies and practices. Establishment of demonstration sites equipped with smart forestry technologies and field trips. Development of online resources such as webinars, video tutorials, interactive tools, and educational materials that explain the concepts and applications of smart forestry science and the role of CoE. Launching public awareness campaigns through various media channels. Advocating for supportive policies, regulations, and incentives that promote the adoption and integration of smart forestry technologies and practices into mainstream forestry management strategies.					
<b>OBJECTIVE</b>	<b>2.10. To engage early-career researchers in scientific endeavors</b>	<b>TIMELINE</b>				
ACTIONS	DESCRIPTION	2024	2025	2026	2027	2028
2.10.1. Support of the involvement of young researchers in smart forestry	Inventory and permanent monitoring of funding opportunities. Establishment research collaboration networks and consortia led by CoE that bring together multidisciplinary teams of young researchers, senior scientists, industry professionals, and policymakers to tackle complex challenges in smart forestry.					

<p>2.10.2. Establishment of training and mentorship programs for young researchers</p> <p>2.10.3. Applying for extra PhD positions from Lithuanian Research Council</p> <p>2.10.4. Applying for funding students research from Lithuanian Research Council</p> <p>2.10.5. Involving talented students in research</p> <p>2.10.6. Providing opportunities for short term scientific missions</p> <p>2.10.7. Summer school for PhD students and young researchers</p>	<p>Development of training and mentorship programs tailored to the needs of young researchers entering the field of smart forestry. Provision of opportunities for hands-on experience, professional development, and mentorship from experienced researchers and industry practitioners.</p> <p>At least one application is prepared each year starting from 2025 by each research group.</p> <p>At least two applications are prepared each year starting from 2025 by each research group.</p> <p>Each year starting from 2025 5-10 students are employed as research assistants for several months to get familiarized with the running activities in Forest 4.0, get trained with specific equipment of data collections/processing techniques with the option to join them research groups later.</p> <p>Organizing short-term scientific missions in Forest 4.0 to facilitate knowledge exchange, collaboration, and skills development among researchers, practitioners, and stakeholders. At least 1 STSM a year starting since 2025.</p> <p>Organizing summer schools for PhD students and young researchers in to provide opportunities for learning, networking, and skill development in interdisciplinary field of Forest 4.0. It is planned that each research group organizes at least one summer school by the end of project.</p>					
<p><b>OBJECTIVE 2.11. To establish postdoctoral opportunities</b></p>						
<p><b>ACTIONS DESCRIPTION</b></p>		<p><b>2024</b></p>	<p><b>2025</b></p>	<p><b>2026</b></p>	<p><b>2027</b></p>	<p><b>2028</b></p>
<p>2.11.1. Applying for post doc positions from Lithuanian Research Council</p>	<p>At least one application is prepared each year starting from 2025 by each research group.</p>					
<p><b>OBJECTIVE 2.12. To facilitate training initiatives for main stakeholders to advance their competencies</b></p>		<p><b>TIMELINE</b></p>				

ACTIONS	DESCRIPTION	2024	2025	2026	2027	2028
2.12.1. Develop learning platform with specific training topics and course programs	Developing approaches and tools to educate and train stakeholders in Forest 4.0 solutions, which are implemented, validated, and delivered by the CoE. Additionally, conducting training sessions on new technologies implemented in the CoE.					
2.12.2 Organize workshops/seminars/courses	At least one event per project implemented at the CoE to external stakeholders.					
<b>OBJECTIVE</b>	<b>2.13. To design new academic curricula or courses and engage gifted students</b>	<b>TIMELINE</b>				
ACTIONS	DESCRIPTION	2024	2025	2026	2027	2028
2.13.1. Assessment of currently running study programs for the potential links with Forest 4.0	All currently running study programs at VMU are checked for the possibility to include new subjects or new topic in available subjects, related to Forest 4.0.					
2.13.2. Modernization of already running study programs	Based on the assessment, already running study programs are modified. Special focus is made on the II and III level programs. E.g. II level study program Forestry may be supplied with opportunity to have a specialisation related to smart forestry, timber industry, etc.					
2.13.3. Development of joint study programs	Explore possibilities to develop joint study programs with partner universities, other universities.					
2.13.4. Development of joint courses	Explore possibilities to develop 1-2 joint courses.					
<b>OBJECTIVE</b>	<b>2.14. To promote lifelong learning activities</b>	<b>TIMELINE</b>				
ACTIONS	DESCRIPTION	2024	2025	2026	2027	2028
2.14.1. Promoting lifelong learning in smart forestry	Develop and offer continuing education programs, workshops, and short courses tailored to the needs of professionals working in smart forestry. Creating online learning platform or e-learning modules that provide flexible and accessible opportunities for individuals to acquire new knowledge and skills in Forest 4.0.					

STRATEGIC THEME		3. Business development and international outreach				
OBJECTIVE	3.1. To build team and develop tools for effective marketing and business development	TIMELINE				
ACTIONS	DESCRIPTION	2024	2025	2026	2027	2028
3.1.1. Creation of the core team for marketing and business development	Providing market insight to inform marketing decisions; implementing marketing and communications strategy to increase awareness of and engagement with the CoE world-changing research, and campaigns that range from digital marketing, PR, media relationships to promoting the community engagement event; identify and approach new prospects and close sales deals with them; support the services developed in task 5.3 to find clients; planning of marketing activities.					
3.1.2. Continuous market research and participation in relevant networks	Identification of potential customer/partner/client needs, problems, both in general and specific, tied to the particular customer; establishing main stakeholders' forum to collect needs and visions of the forest industry in Lithuania (further, in other countries as well); involving main forestry partners to the project, including State Forest Service, Ministry of Environment, Registry Center, State Forest Enterprise); identifying possibilities to distribute other partners' digital technologies to forest industry; participation in relevant networks; R&D cooperation network/cluster establishment.					
3.1.3. Developing Customer Relationship Management (CRM) system	Creating profiles of the customers, creating CRM database.					
OBJECTIVE	3.2. To implement CoE's business model through innovation support services	TIMELINE				
ACTIONS	DESCRIPTION	2024	2025	2026	2027	2028

3.2.1. Design and provide innovation support services	Identification of exploitable results from research projects with potential for market uptake; support research teams to engage in innovation activities; creation and attraction of ICT business expertise through joint infrastructure utilisation, end-user involvement in research, skills transfer through training of industrial actors; implementing network of suppliers, customers, and stakeholders; provision of innovative services; development of Smart Forestry solutions; grant preparation.					
3.2.2. Develop and manage the start-up incubator	Preparation of Overall Design of the Acceleration Programme and Planning (D6 by M10); Incubation Design and Implementation Plan (D11 by M24); facilitating the co-creation of disruptive and breakthrough solutions, business ideas and opportunities for supporting innovative, smart forest management methods; strengthen the generation of new data driven business opportunities while harnessing the entrepreneurial potential of Lithuania; providing access to infrastructure, mentoring, and providing support services during the start-up phase.					
3.2.3. Develop and operate the technology transfer/intellectual property right management office	Preparation of IPR management plan (D21 by M48); put in place an IPR management office in charge of providing a tool for advanced intellectual property rights (IPR) analysis of research projects and guidelines for IPR policy framework in the implementation of the CoE; enable pooling and exploitation of existing innovation knowledge and increased IPR-based cooperation opportunities (out-licensing, in-licensing and also underdeveloped university technology transfer).					
<b>OBJECTIVE</b> 3.3. To integrate CoE into international networks and attract funding from EU and other international programmes		<b>TIMELINE</b>				
<b>ACTIONS</b>	<b>DESCRIPTION</b>	<b>2024</b>	<b>2025</b>	<b>2026</b>	<b>2027</b>	<b>2028</b>
3.3.1. International networking 3.3.2. Project development to attract funding from EU and	Participation in target international networks to build CoE's global reputation. Research and innovation funding grant preparation for EU and other international programmes.					

other international programmes						
STRATEGIC THEME		4. Ecosystem building and society				
OBJECTIVE	4.1. To increase science and innovation capacities for all actors in the R&I system	TIMELINE				
ACTIONS	DESCRIPTION	2024	2025	2026	2027	2028
4.1.1. Create a Lithuanian AI and IoT cluster to implement a Lithuanian Smart Forestry Strategy and promote the CoE abroad	Organise the Lithuanian forest bioeconomy R&I community as a cluster connected to international networks (European Digital Innovation Hubs, European Forest Institute, International Network of Forest Scientists "IUFRO", Bio-based Industries Consortium "BIC", etc.) and Lithuanian private and public stakeholders (DigiTech Sector Association "INFOBALT" and its Digital Innovation Hub, Forest Owners' Association of Lithuania, State Company "Lithuanian State Forest Enterprise", Association "Lithuanian Forest" that represents manufacturing companies, Vilnius Tech Park, etc.). This should start as soon as the CoE operations begin.					
4.1.2. Engagement and empowerment of society in future forest creation Forum	The empowerment of society in participating in future forest creation forum is crucial in order to meet all innovators, ideas and share experience of practice of variety of stakeholders from forest owners to the start-up developers, from researchers to entrepreneurs and potential users.					
4.1.3. Citizen science & education	Participation in external citizen science events (Science Festivals, the European Researchers' Night, or the Science is Wonderful! Initiative).					
OBJECTIVE	4.2. To increase the capability of the cluster actors to attract funds	TIMELINE				
ACTIONS	DESCRIPTION	2024	2025	2026	2027	2028
4.2.1. Support science based policy and programme making	Set up a smart forestry and regional policy programme supported by the European Regional Development Fund (ERDF). The ERDF funds will be used for capacity building. It will help Lithuanian ICT businesses improve their AI methods and forest industry improve their operational forest planning practices that will result in better business outcomes.					

OBJECTIVE	4.3. To disseminate research findings to a broad audience and stakeholders	TIMELINE				
		2024	2025	2026	2027	2028
4.3.1. Preparing and publishing research results	Prepare and disseminate research findings in mass media and social media to reach broad audience.					
4.3.2 Taking part in scientific events and disseminating through publication and presentation at scientific conferences	Participate in variety of national and international events with presentations to broad audience.					
4.3.3. To use for the initiation and development of new projects and the deepening of concepts	Participate in national and international project proposal development together with different stakeholders and project partners					

**Annex 1**

**List of key national stakeholders and their potential interests in smart forestry and linkage to fields of CoE activities**

Stakeholder's name	Receiver of*					Provider of**				
	Information	Scientific research	Consultations & expertise	Services	Partnerships	Information	Scientific research	Consultations & expertise	Services	Partnerships
<b>Policy related to forestry and IT</b>										
President of the Republic of Lithuania	+		+			+				
LR Seimas (Parliament of Republic of Lithuania)	+		+			+				
Government of the Republic of Lithuania	+		+			+				
Political parties	+		+			+				
Ministry of Environment	+	+	+	+		+		+		
State Forest Service	+	+	+	+	+	+		+		+
State Service of Protected Areas	+	+	+	+	+	+		+		+
Environment Protection Agency	+	+	+	+	+	+		+		+

Environment Protection Department under the MoE	+	+	+	+		+		+		
Lithuanian Geology Service under the MoE	+	+	+	+		+				
National Land Service under MoE	+	+	+	+		+				
Environmental Project Management Agency	+		+		+	+		+		+
Ministry of Education, Science and Sport	+					+				
Ministry of Agriculture	+	+	+	+		+		+		
Ministry of Economy and Innovation	+	+	+	+		+				
Ministry of Transport and Communication	+	+	+	+		+				
Chamber of Agriculture of the Republic of	+		+		+	+		+	+	+

Lithuania										
PI Lithuanian Agricultural Advisory Service	+	+	+	+	+	+		+		+
State Data Agency	+	+	+	+	+	+		+	+	+
<b>Stakeholders with predominantly economic interests in forestry</b>										
SC State Forest Enterprise	+	+	+	+	+	+	+	+	+	+
Lithuanian Association of Forest and Land Owners	+	+	+	+	+	+	+	+	+	+
Association of Forest Work Contractors	+	+	+	+	+	+		+		+
Wood Processors Association	+	+	+	+	+	+		+		+
Association of Wood Processors and Exporters of Western Lithuania	+					+				
Lithuanian Biomass Energy Association LITBIOMA	+	+	+	+		+				

Association of Lithuanian Forest	+	+	+	+	+	+		+		+
Asociacija Investors' Forum	+					+				
Association of Wooden Packaging Manufacturers	+					+				
Association of Timber Houses Producers	+					+				
Lithuanian Association of Impartial Timber Scalers	+	+	+	+	+	+	+	+	+	+
Lithuanian Association of Forest Mushroom and Berries Businessman	+					+				
Association of Private Forest Owners	+					+				
JSC MMC forest	+					+				
JSC "Stora Enso"	+					+				
JSC "Juodeliai"	+					+				
JSC "Timbex"	+					+				

JSC Civvita	+	+	+	+	+	+		+		+
JSC HD Forest	+	+	+	+	+	+		+		+
JSC Greengold Management	+		+			+				
JSC „Klasmann-Deitman Lietuva“	+			+		+				
JSC Žaiboratai	+					+				
JSC „Smilgius“	+	+	+	+	+	+		+	+	+
JSC Dzūkijos mediena	+					+				
JSC „Dzūkijos miškas“	+					+				
JSC „Bangenės miškas“	+					+				
VMG Group	+					+				
JSC „Likmerė“	+					+				
JSC „Šilalės mediena“	+					+				
JSC „Renostera“	+					+				
JSC „Liforina“	+					+				
JSC Fudo	+					+				
Lithuanian Association of Water	+					+				

Suppliers										
<b>Stakeholders with predominantly environmentalist interests in forestry</b>										
Lithuanian Center of Arboriculture	+									
Lithuanian Ornithological Society	+				+	+				+
Green Policy Institute	+		+		+	+		+		+
Nature Research Centre	+		+		+	+		+		+
Lithuanian Research Centre for Agriculture and Forestry	+	+	+	+	+	+	+	+	+	+
Institute of Forestry	+	+	+	+	+	+	+	+	+	+
Lithuanian Fund for Nature	+	+	+	+	+	+		+		+
Association "Gyvo Žalio"	+					+				
Ancient Woods Foundation	+		+	+	+	+				+
Baltic Environmental Forum Lithuania	+					+	+			+
Foundation for Peatlands Restoration and	+			+	+	+				+

Conservation										
Lithuanian Entomologist Society	+					+				
Center for Environmental Policy	+					+				
NGO Sustainable Development Initiatives	+					+				
Nature protection organization "Baltijos vilkas" ("Baltic wolf")	+					+				
Lithuanian Dendrologists Society	+					+				
JSC NEPCon LT	+		+	+	+	+				+
<b>Stakeholders with predominantly social interests in forestry</b>										
Lithuanian Countryside Tourism Association	+					+				
Federation of Forestry and Forest Industry Labour Unions	+					+				

Lithuanian Foresters Union	+					+				
Union of Lithuanian Landscape Architecture	+		+	+	+	+		+	+	+
Confederation of Lithuanian Labour Unions	+					+				
Lithuanian Campsite Association	+					+				
Association of Local Authorities in Lithuania	+					+				
Lithuanian Tourism Association	+					+				
National Tourism Business Association	+					+				
Association of Lithuanian Tourist Information Centers	+					+				
Lithuanian Tourism Chamber	+					+				
Lithuanian Hunter And	+					+				

Fishermen Association										
Lithuanian National Travel Guides Association	+					+				
JSC "Ornitostogos"	+					+				
JSC "Baltic Bike Travel"	+					+				
PI "Taurus Siekis"	+					+				
Lithuanian Folk Medicine Association	+					+				