3DForEcoTech

COST ACTION CA20118

Three-dimensional Forest Ecosystem Monitoring and Better Understanding by Terrestrial-based Technologies

Newsletter #1

OCTOBER 2023

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About

Summary of the Action

3DForEcoTech project aims to establish a strong network of scientists and stakeholders (i.e. practitioners) and sensor manufacturers to synchronise the knowledge, to develop general protocols and algorithms for forest ecosystem state survey and forest functioning, and to make these novel technologies available to a broad audience.

Specifically, 3DForEcoTech will develop protocols for data acquisition, processing, fusion for forest inventory and ecological applications, and will establish open-data and open-source algorithm databases.

01. Introduction from the Chair

Dear **3DForEcoTech** community,

it is already two years since we started the 3DForEco-Tech COST Action project. I already see the huge impact these years have had on me and on many others. When we were writing the project proposal, I had in my mind that the goal should be to create a strong enough motion to shift or move our field.

This approach has inspired many great researchers to join us on this journey. After two years of the project, I see it is really possible. We know that the point clouds created by ground-based technologies are unique in many ways and irreplaceable within the earth observation. The spatial and temporal resolution that we can achieve is, in many ways, magical and challenging simultaneously.

However, we need to convince others. As experts, we play a critical role in translating and standardising these technologies. We have already positively influenced many young researchers through internships, training schools, conferences, and other exciting ways. In the following two years, we will bring many great results to help the community thrive.

Martin Mokroš
Action Chair
Czechia, UK

02. Current leaders and participants status

WG1 Laser- and Image-based Data Collection

Ninni Saarinen
WG1 Leader
Finland

Kim Calders
WG1 co-Leader
Belgium

Louise Terryn
WG1 co-Leader
Belgium

WG2 Data Fusion

Markus Hollaus
WG2 Leader
Austria

Suzanne Marseilis
WG2 co-Leader
Netherlands

WG3 Laser- and Image-based Point Cloud Processing

Carlos Cabo
WG3 Leader
Spain

Arnadi Murtiyoso
WG3 co-Leader
Switzerland

Daniel Girard Mountaut
WG3 co-Leader
Belgium

WG4 Precision Forestry

Stefano Puliyi
WG4 Leader
Norway

Chiara Torresan
WG4 co-Leader
Italy

WG5 Forest Ecology

Emily Lines
WG5 Leader
United Kingdom

Yunsheng Wang
WG5 co-Leader
Finland

WG6 Dissemination, knowledge, gaps, cooperation

Markus Eichhorn
WG6 Leader
Ireland

Krzysztof Stereńczak
WG6 co-Leader
Poland

Kaela Slavik
WG6 co-Leader
Netherlands

Geographical Distribution

Martin Mokroš
Action Chair
Czechia, UK

Yunsheng Wang
Action Vice-Chair
Finland

Eva Májová
Grant Holder Manager
Czechia

Erika Kozamernik
Grant Awarding Coordiantor
Slovenia

Anna Iglseder
Science Communication Coordinator
Austria

Merisa Osmanovic
Social Media Coordinator
Bosnia and Herzegovina

Sunny K. P. Kushwaha
Newsletter Coordinator
India

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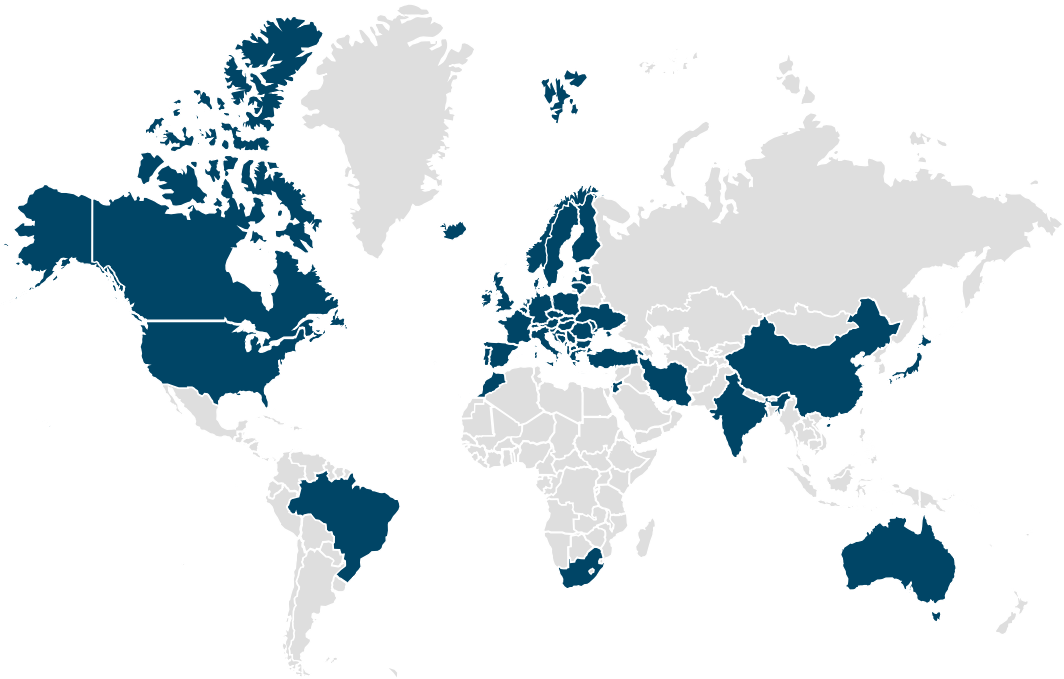

03. What was happening in the working groups?

WG1 LASER- AND IMAGE-BASED DATA COLLECTION

Summer School in Helsinki, 2022

The WG1 primarily focuses on data collection of a variety of terrestrial-based technologies that produce 3D point clouds. The aim is to provide insights and share knowledge on good practices.

We decided that a training school would be a powerful way to start the knowledge-sharing.

Thus, as one of the first activities, the WG1 organized a summer school on three-dimensional forest ecosystem monitoring by terrestrial based technologies in Helsinki, Finland in July 18-22, 2022.

The target audience was PhD candidates and postdocs from any research field with little to no experience with these technologies, but who can see the potential of these techniques and systems in their future research.

We received more than 70 applications from which 16 participants were selected to represent different fields, countries, and genders.

PHOTOS BY MARTIN MOKROŠ

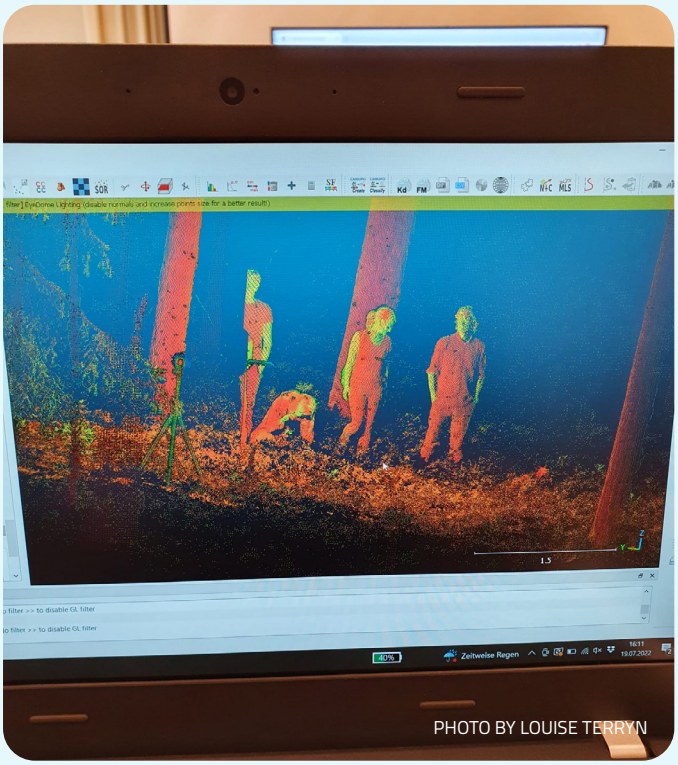

PHOTO BY LOUISE TERRYN

We had five excellent trainers, namely Magnus Bremer from the Austrian Academy of Sciences, Rachel Gaulton from Newcastle University, Antero Kukko from the Finnish Geospatial Research Institute (FGI), Martin Mokroš from Czech University of Life Sciences Prague, and Louise Terryn from Ghent University.

The topics of the summer school covered LiDAR theory, TLS data collection and preprocessing, single tree delineation, TLS data analyses, mobile and UAV laser scanning as well as close-range photogrammetry. The program included both theory, demos, and exercises on the topics.

The teaching materials are available at the website of 3DFoEcoTech (www.3dforecotech.eu/teaching-materials). The idea was to provide materials for anyone wanting to learn about these technologies but also for researchers and teachers who teach about these topics but may not be very familiar with all the details.

03. What was happening in the working groups?

Case Groups

During the General Assembly 2022 in Prague, the participants of the WG1 identified three cases they considered important from the viewpoint of the WG's aims.

- Case 1: Allometric equations (identify existing and needed equations to cover as many attributes, species, and regions)
- Case 2: Mobile laser scanning for which two possible applications were identified, namely urban trees and harvester
- Case 3: Quality assessment framework to consider point cloud quality for different forest applications

An in-person meeting was organized in Zurich on 18-20 April 2023 together with the WG3.

The aim of the meeting was to enable the case groups to meet and workshop their ideas further for more tangible outcomes.

- Merging Case 1 and 2: During the meeting Cases 1 and 2 were merged as they both had had some difficulties in getting started. It was a good decision, as they immediately became a collective: Tree Point Allometry Collective (TPAC). They created a plan about wiki page where they would cover topics related to data collection (e.g. scanner types, scan protocols) of terrestrial, mobile and airborne laser scanning as well as how detailed 3D point clouds can enhance allometric modeling.
- Case 3 had decided to concentrate on occlusion as an attribute to be investigated for a point cloud quality measure. Their plan is to compare and benchmark existing tools and ways to assess occlusion and to recommend the best suitable solution on a defined set of indicators. The output will be a draft of a scientific manuscript. To enhance this, they had searched for a candidate to carry out a Short-Term Scientific Mission (STSM) by the end of the second period of the 3DForEcoTech Cost Action.

Both groups presented the first outcomes in SilviLaser 2023.

Louise Terryn Joins as Co-Lead in COST Action Working Group!

PHOTO BY LOUISE TERRYN

We are thrilled to announce the newest addition to our working group leadership team as Louise Terryn takes on the role of Co-Lead. Louise is currently wrapping up her PhD thesis using UAV and terrestrial laser scanning data for monitoring tropical forests.

She was already actively involved in (the organizing of) several activities of our working group and participated as a teacher in our summer school. We are excited to have Louise on board and look forward to the incredible contributions she will make in driving our working group's success.

Future activities

We are prepared for organizing another summer school with similar topics to the one we had in 2022. It could be organized in collaboration with other Cost Actions.

If you would be interested in hosting a summer school, please do not hesitate to contact the co-leads of the WG1, Ninni Saarinen, Louise Terryn, and Kim Calders.

WG2 DATA FUSION

Report from an STSM

My name is Mattia Balestra, PhD student of the Marche Polytechnic University, Ancona (Italy). I have 3 years' experience in remote sensing and proximal sensing technologies in forestry and agricultural sector. For what concerning the proximal sensing ones, I have done and I am currently pursuing different researches.

PHOTO BY MATTIA BALESTRA

I have been training my skills with photogrammetry and LiDAR surveys, acquiring and processing data by myself with different instrumentations (drone, reflex, GoPro360 and Kaarta Stencil-2, a Mobile Laser Scanner) in different scenarios (forests, urban and rural areas).

During these years I used several software such as: CloudCompare, QGis, 3DForest, R and Agisoft Metashape. These experiences have certainly enlightened me about the technologies which can be used in the agro-forestry and urban green sector. That's why I was determined to apply for the STSM and acquire more knowledges in such field!

The Short Term Scientific Mission was in Leiden, The Netherlands, with the Working Group 2 and the title was: "Data Fusion for the Systematic literature review of data fusion for LiDAR". I started the STSM the 18th February 2023 and it ended the 31st March 2023.

I decided to stay in Leiden till the 20th May 2023 because it was necessary for my PhD (I needed to spend 3 months abroad) and I used that time for the literature review writing process.

So, during this STSM, I collaborated with Dr Suzanne Marselis and Dr Markus Hollaus of the WG2 within the COST action 3DForEcoTech to conduct a comprehensive literature review on the fusion of LiDAR devices with other data sources such as optical and microwave sensors, and in-situ measurements.

To achieve this, I employed specific search terms in the Web of Science database. Our search query is based on words that can be found in the "Topic", which is comprehensive of title, abstract and keywords.

We looked for papers with "LiDAR" AND "Fusion" in combination with a word among "forest OR tree OR canopy" and one among "structure OR height OR inventory".

We focused on scientific papers published in the last decade (2014-2023) that were available as articles or reviews. Out of the 664 papers identified, we screened and selected 153 papers that aligned with our research objectives.

PHOTO BY MATTIA BALESTRA

03. What was happening in the working groups?


PHOTO BY MATTIA BALESTRA

The criteria for deciding whether to include a paper in our review are as follows: i) it must discuss "structure", and cannot be a paper where structure is not mentioned at least in the abstract or among the kind of data that were used; ii) it must relate to forests/trees/vegetation; iii) it must include LiDAR sensors which have been fused with other devices; iv) it cannot be a paper with agricultural and/or urban purposes; v) it must have actually performed data fusion, with the fusion of two different devices (i.e. papers using the same LiDAR device but in different phenological phases have been excluded).

We developed a coding scheme to organize the information extracted from the selected papers. I entered data from the papers accordingly, by reading every paper in detail. The outcome of this process is an excel file which contains all the relevant information for the literature review, which can be easily accessed.

We gathered information on the characteristics of the study area as well as its location, the sensor type and name of the fused devices, and finally the goals of the fusion and the gains obtained as a result!

The results of this STSM will be used as input for a manuscript on the state-of-the art of data fusion techniques for LiDAR data for forest structure.

As a memorable experience during this period, I would like to share with you the opportunity that I had to participate in a research panel composed of the selected writing team for the paper I am currently working on. Indeed, on the 11th and 12th of May, in Leiden, all 10 selected experts in forest-related remote sensing data fusion came together to discuss the findings of my literature review.

This allowed me to expand my research network within a topic relevant to my PhD thesis and significantly enhance my personal and academic growth by collaborating with individuals whose names I had only previously encountered through their fascinating papers.

I believe that STSMs are crucial opportunities for young researchers like myself because they allow you to connect with people that have been conducting research for years and have extensive experience in the field.

This provides a broad perspective on the analysis and research being conducted, enabling a comprehensive understanding of the current advancements.

I would like to encourage other students not to be afraid of challenging themselves with a STMS. New challenges can be daunting, but in the end, the results will be great, and you will be satisfied with your personal and research journey.

All the best,
Mattia Balestra


PHOTO BY MATTIA BALESTRA

03. What was happening in the working groups?

WG3 LASER- AND IMAGE-BASED POINT CLOUD PROCESSING

Joint meeting between WG1 and WG3 in Zurich

In April 2023 working groups 1 and 3 held a joint meeting, hosted by the Swiss Federal Institute for Forest, Snow and Landscape research in Birmensdorf, Switzerland. The meeting was attended by members of both working groups and started with a short seminar with several interesting presentations.

This seminar was intended as a way to share the research conducted by several members of the two working groups. The meeting then continued with separate smaller meetings divided into several smaller groups.

The WG3 meeting discussed three separate things: first, the idea of creating an online queryable database for forest point cloud processing algorithms was proposed.

The database would be attached to the 3DForEcoTech and present information on each of the algorithms identified by WG3.

It was decided to create a search page with the possibility of filtering the algorithms according to various criteria, with the main objective being a gateway for new users in deciding which software is best suited for their needs.

The database will also include information about each software and a document describing its installation and use created by previous STSM and VM. This database will in the future be enriched with information regarding quality of the results, which would be addressed during the 2023 hackathon.

The meeting also discussed the writing of a paper based on previous STSM. The paper will report a synthesis and review of the identified algorithms and act as a basis to the benchmarking to be performed during the hackathon. A second paper was also briefly planned to describe the results of the hackathon. In order to support this endeavor, WG3 also designed a VM to work on data preparation for the hackathon.

03. What was happening in the working groups?

Hackathon

WG3 has organized a hackathon for benchmarking software solutions that deal with forest point clouds.

We selected 13 softwares/algorithms that are publicly available (either commercial, free or open access), that process ground based point clouds from entire forest plots, while providing single tree information.

We made an open call for venues (where the hackathon would take place) and participants (expert researchers that would perform the actual processing).

We selected TU Wien (Austria) as host centre, and 13 participants from different countries and institutions.

We processed 10 different point clouds with all the software solutions in identical conditions (same computers and configurations). Now, we are analyzing the results and comparing them with reference data from the field.

This benchmark hackathon will give very valuable information for potential users about the performance, ease of use and requirements of the different options that are currently available.

We will use the results to improve the information in our 'software database', and will publish a research paper with all the methods and findings.

03. What was happening in the working groups?

WG4 PRECISION FORESTRY

WG5 PRECISION FORESTRY

WG5 leaders have been successful and there will be a dedicated workshop at British ecological society annual meeting 2023. The title is: *An introduction to close range LiDAR for forest ecology*. Laser scanning is an exciting and rapidly expanding field, but it can be inaccessible to new users. This workshop will provide an introduction to close-range LiDAR scanning, including an overview of its potential applications and data collection methods, with a focus on getting hands on with processing 3D data.

Additionally also a thematic session was accepted and during the annual meeting a thematic session *The three-dimensional data revolution in ecology – sponsored by Journal of Ecology* will be run by Emily Lines an Jesper Erenskjold Moeslund.

WG6 DISSEMINATION, KNOWLEDGE GAPS IDENTIFICATION AND COOPERATION GUIDANCE

Meeting in Cork


PHOTO BY ANNA IGLSEDER

WG6 is responsible for identifying important stakeholders and target audiences at the national, European, and global levels and establishing efficient communication with all parties, in order to disseminate the findings and results. From 31.08 - 01.09.2023, WG6 met in Cork to map and discuss the stakeholders and communication channels and how to link them. The condensed output of the meeting is the following stakeholder-channel-matrix, including identification of already established channels and pointing out the stakeholders we are still missing to reach.

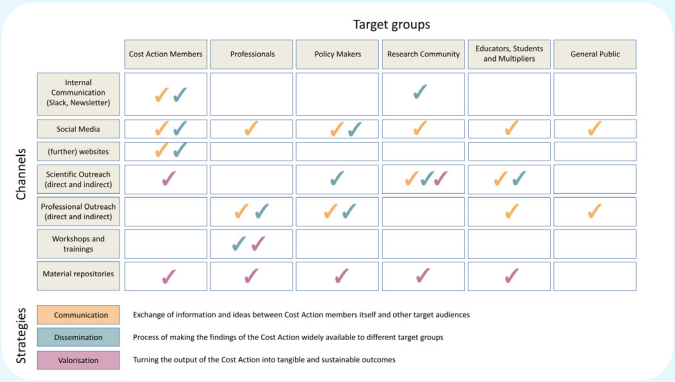


PHOTO BY ANNA IGLSEDER

Further steps of WG6 include a survey related to the objectives of 3DForEcoTech COST Action. The main topic should include answers to questions such as:

- Who is interested in close range photogrammetry technology in forest management and ecology?
- What are the problems faced by end users in applying the technology in practice?
- What are the challenges in implementing close range photogrammetry solutions?

These survey is conducted by a STSM, where the call to find a candidate is still open until October 10th - check it out here: 3dforecotech.eu/news/stsm-open-call/

04. Report from the Super Summer School

Embracing Forest Research interdisciplinary: A recap of the 3DForEcoTech Summer School in Ljubljana

PHOTO BY DOROTHÉE POST

In a celebration of collaboration and knowledge exchange, the 3DForEcoTech Cost Action recently joined forces with the BOTTOMS-UP and PROCLIAS actions to organize an transdisciplinary Summer School in Ljubljana, Slovenia, from July 10th to July 14th, 2023. This first of its kind event, hosted by the Slovenian Forestry Institute, brought together 54 students and 25 trainers and local organizers from universities and research organizations from 24 different countries.

The 3DForEcoTech's core topic of close range remote sensing technologies in forests was greatly complimented by the expertise of the other COST actions on forest multi-taxon biodiversity, and environmental modeling for climate impact attribution. With a strong emphasis on interdisciplinarity, the Summer School served as a platform for connecting the different disciplines, for fostering new ideas and application of different methods and encouraging innovative solutions. To give you an insight to what happened, we want to share the key highlights and takeaways from this event.

1. Welcoming Diverse Perspectives: The Summer School's success was based on the ability to attract students with diverse academic backgrounds, ranging from forestry and environmental sciences to data science and remote sensing.
2. Keynote Lectures: With the given keynote lectures, great introductions to the different disciplines, also highlighting the common research topics, were given. The 3DForEcoTech Cost Action participated with three keynote lectures during the Summer School. Martin Eichhorn (WG6) opened the week with input and hands-on practicals on interdisciplinarity, Kim Calders (WG1) shared advancements in data processing for close range remote sensing in forests, and Yunsheng Wang (WG5) discussed cutting-edge data processing methods. These lectures added valuable insights to the event, highlighting the importance of collaboration and innovative techniques in environmental research.
3. In the field: An afternoon in the forest gave great insights to various devices for gathering remote-sensing based field data – from high-end products from Leica or Geoslam to self-build MLS-devices and the smartphones. Besides the remote sensing data acquisition, also assessment of biodiversity in the field was presented – with the investigation of the soundscape by birds, the occurrence of lichens and plant species richness on plot level.
4. Practicals: In the spirit of learning by doing, the Summer School incorporated practical exercises where students learned how to process and analyze the data collected during the fieldwork. Hands-on workshops on point cloud processing, biodiversity assessment and environmental modeling kept the students busy in the second half of the we. All students were coached from trainers of all three COST actions to be sure to give everybody insights in all the topics. In addition to the keynote lecturers, Emily Lines (WG5), Louise Terryn (WG1), Carlos Cabo (WG3) and Martin Mokroš were present as trainers.

To get an even better impression of the summer school, check out the video that was created on our Youtube Channel. Watch out on social media for more content about the summer school!

05. Recap of STSMs

Until the end of the second period, a total of thirteen STSMs (Short Time Scientific Missions) were successfully completed. These exchanges are central to the COST Actions productivity.

Young researchers are invited to another research group and have the time to dedicate their focus fully to a distinct research question in the scope of the COST.

These are the STSMs so far:

PERIOD 1 (2021/22):

Working Group	STSM Grantee	Topic	Main Organizer
WG1	Barbara D'hont	Terrestrial and mobile photogrammetry as a low-cost solution for forest inventory	Martin Mokros
WG2	Zennure Ucar	Metadata database	Suzanne Marselis, Markus Hollaus
WG3	Jaz Stoddart	The compilation and testing of existing public algorithms/ software/implementations for pointcloud processing in forestry	Carlos Cabo
WG4	Julian Frey	CNN species classification on RGB images for TLS applications	Stefano Puliti
WG4	Covadonga Prendes Pérez	Extending the use of very-high-density UAV-LiDAR in forest inventories: a case study in the dolomites	Chiara Torresan
WG5	Mengxi Wang	Three-dimensional forest structural complexity from TLS or UAV data	Emily Lines

PERIOD 2 (2022/23):

Working Group	STSM Grantee	Topic	Main Organizer
WG1	Lennart Klinger	3D Occlusion mapping as a tool to assess point cloud quality	Benjamin Brede
WG1	Monica Herreror	Digital forestry by 3D point cloud plus radar info	Kim Calders
WG2	Mattia Balestra	LiDAR Data Fusion. Systematic literature review of data fusion for lidar.	Suzanne Marselis
WG4	Justin Holvoet	Generating a new allometric equation for commonly exploited forest species in Switzerland using MLS technology	Daniel Kükenbrink
WG5	Jonathan Terschanski	Forest structure from terrestrial LiDAR & microclimate temperature	Jonathan Lenoir
WG5	Alice Penanhoat	Impact of storms on individual trees: assessment of architectural changes in pure and mixed coniferous stands using LiDAR	Emily Lines
	Tom Verhelst	Advancing traditional biomass allometries with close range remote sensing	María Menéndez-Miguélez

If you are interested in going on an STSM or hosting an STSM, watch out!
New calls are coming up continuously!

3DForEcoTech

Description of the Action

Forest ecosystems across the world are facing high pressures due to climate changes. In many areas, they are in a transition to adopt the changes. However, many are damaged in this process. It is crucial to make forest ecosystems more resistant to face these challenges, through resilience strengthening and close-to-nature forestry. Implementing such approaches and monitoring their progress requires accurate knowledge about forest ecosystems that rely on a forest in situ data at high spatial and temporal resolution.

Novel terrestrial-based technologies will play an important part to face these challenges. Such technologies have experienced a fast development in recent years. The forests can now be observed and monitored in a very high spatial and temporal resolution that was not possible even a few years ago. Researchers and practitioners are facing a unique opportunity to deepen the understanding of forest ecosystems and to change the forestry to adopt the climate, environment and industrial changes. Various research groups across EU and beyond are testing such technologies or developing processing algorithms for precision forestry and forest ecology. But further cooperation is strongly required.

3DForEcoTech project aims to establish a strong network of scientists and stakeholders (i.e. practitioners) and sensor manufacturers to synchronise the knowledge, to develop general protocols and algorithms for forest ecosystem state survey and forest functioning, and to make these novel technologies available to a broad audience. Specifically, 3DForEcoTech will develop protocols for data acquisition, processing, fusion for forest inventory and ecological applications, and will establish open-data and open-source algorithm databases.

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Action Details

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