AnaEE

Analysis and Experimentation on Ecosystems

Technical and Scientific Description

Version 7.2
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Cover page, from left to right, and top to bottom:
Enclosed growth facility at Højbakkegård, Denmark (© University of Copenhagen)
Inside the Gembloux Ecotron, Belgium (© University of Liège)
Preparing a macrocosm at the Montpellier Ecotron, France (© CNRS)
The Planaqua CEREEP aquacosm facility in Saint-Pierre-Lès-Nemours, France (© ENS – CNRS)
The O3HP open-air manipulation platform at the Observatoire de Haute-Provence, France (© CNRS)
The open-air FACE experiment from Risö fields, Denmark (© Technical University of Denmark)

SHORT DESCRIPTION

AnaEE (Analysis and Experimentation on Ecosystems) is a research infrastructure that brings together a series of state-of-the-art experimental and analytical platforms for ecosystem research throughout Europe. By linking these platforms to modelling approaches, AnaEE advances our understanding of the environmental impacts of ongoing global change and fosters adaptation and mitigation strategies for safeguarding ecosystem services and their economic and societal benefits.

The value proposition of AnaEE relies on the coordination and integration of high technology platforms and data resources, a central access to dedicated services, a portfolio of tools benefitting both users and platform managers, and the capacity to deal with complex projects, while data access is provided via a single interface.

This integrated and comprehensive structure allows for the definition of common goals, priorities, and of a strategy to reach them.

The experimental, future-oriented focus of AnaEE makes it unique in the environmental research infrastructure landscape worldwide and fills a methodological gap in the ESFRI landscape.

AnaEE offers capacities to develop multidisciplinary approaches at the frontiers of life sciences, agronomy and environmental sciences, combining experimentation, analysis and modelling services to answer pressing scientific and societal issues. Specifically, AnaEE offers:

- the experimental capacity to investigate multiple global change pressures acting on ecosystems simultaneously (e.g. climate change, land-use change, pollution, biodiversity loss)
- a high diversity of ecosystem types spanning from modern agro-systems over grasslands and shrublands to forests and aquatic ecosystems, enabling comprehensive and holistic analyses across ecosystem boundaries and allowing to reach context-independent conclusions
- the analytical tools to tease apart multiple interacting ecosystem processes (e.g. the coupling between the carbon, nutrient and water cycle, which are often studied in isolation)
- the spatio-temporal scale to investigate changes across different levels of biological organization (e.g. from individuals to populations to trophic networks to ecosystems)
- the connection of experiments to models through a Data and Modelling Center, which facilitates upscaling, inference, and extrapolation.

Executive Summary

The present section provides a general overview of the project. It can be read autonomously from the rest of the document, which presents the arguments in a more detailed fashion.

Approach and added value

AnaEE adopts an experimental approach on continental ecosystems which combines Manipulation, Measurements, Modelling, Mitigation and Management.

At the core of AnaEE's approach is a network of distributed experimental facilities, through which ecosystems can be exposed to a series of controlled conditions. Results produced within the AnaEE platforms inform predictive models and deliver realistic simulations of global change impacts. AnaEE thus addresses how major biogeochemical cycles, biodiversity and food, feed and fibre production, will change under a variety of environmental drivers and advises society about ways to improve agricultural and ecosystem management practices to secure provisioning, regulating, cultural and support ecosystem services in a changing world.

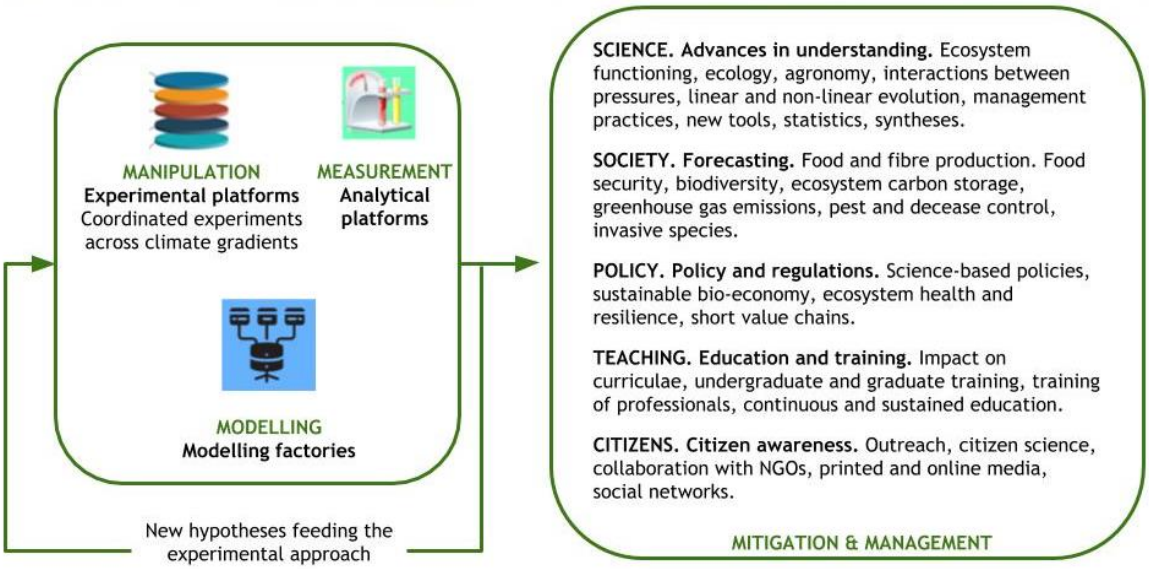
The originality and added value compared to related ESFRI RIs rest with its versatile facilities that can simulate changes in environmental drivers ranging from land-use change, agricultural management practices and systems, pollution, biological invasions, rising atmospheric greenhouse gas concentrations, to climatic changes, including extreme events such as droughts and heat waves.

The experimental facilities are equipped with state-of-the-art instrumentation and use common standards of measurements and analysis. AnaEE provides a nexus between the environment and food domains, by covering the whole span of European ecosystem types, soil and water body types, environmental pressures and other factors in terms of experimentation on terrestrial and freshwater ecosystems.

In AnaEE, the experimental approach will be integrated with modelling to quantify and predict the impact of those current and future global change drivers on ecosystem functioning, to help unravel mechanisms and feedbacks involved in ecosystems' responses, and to test mitigation and adaptation measures.

AnaEE has the potential to look into the future, thanks to the integrative and coordinated usage of its experimental, analytical and modelling facilities. AnaEE will link its facilities with an array of user communities, including scientists, land managers, the agricultural sector in general, the bio-economy industry and policy makers, with the goal to minimize human environmental impact and maximize societal benefits in an increasingly dynamic world.

ANAEE will become a key structure to obtain the knowledge necessary to tackle the complex global environmental challenges facing human societies. It will provide open and easy access to resources and services to a broad user community world-wide to conduct excellent experimental research, foster innovation and provide high-quality information.



AnaEE's experimental approach: Manipulation, Measurement, Modelling, Mitigation & Management

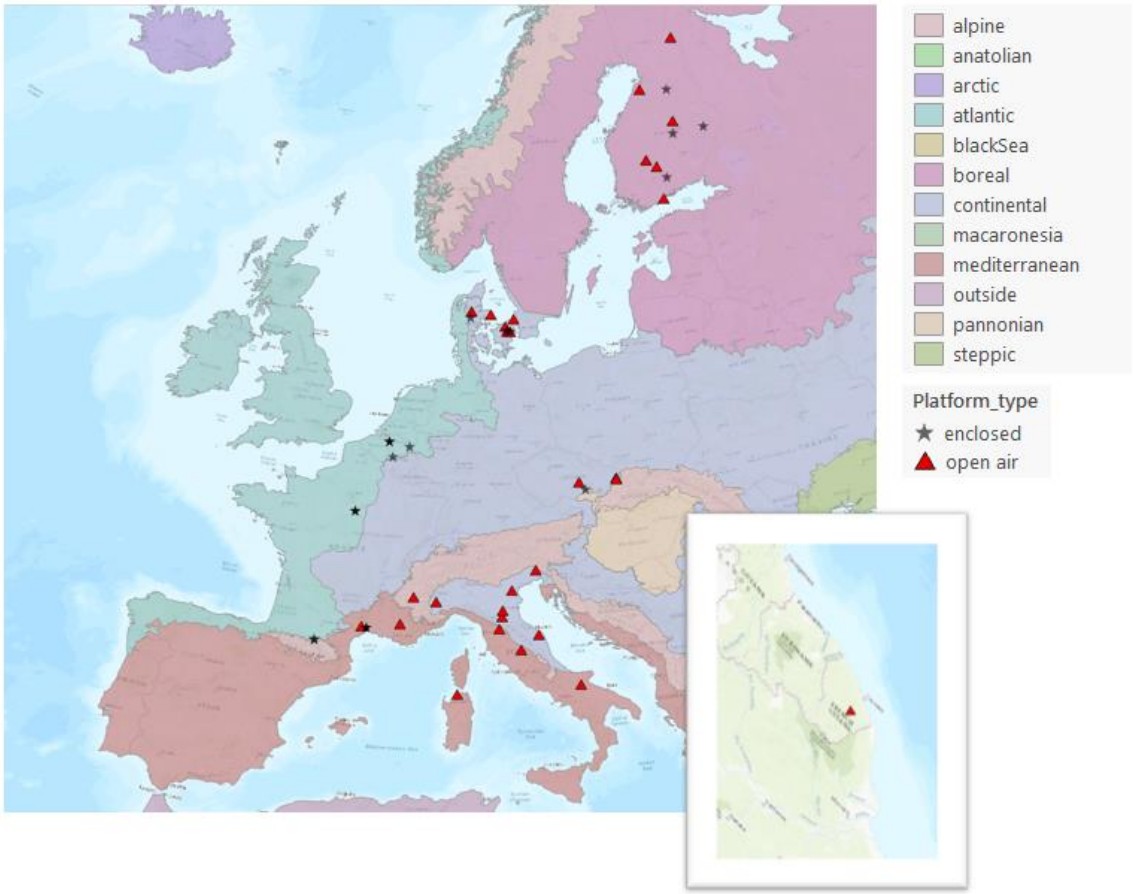
Structure

At the core of AnaEE's approach is the network of advanced distributed experimental facilities, called National Platforms (NP), which are able to study multiple global change drivers, to quantify the role of each of these drivers of change, and to identify their interactions across all European climates.

There are four types of experimental platforms located in 6 countries:

- **Open-air ecosystem platforms** comprise the predominant land use types of European continental ecosystems spanning from managed agricultural to unmanaged, natural ecosystems including terrestrial aquatic ecosystems transecting Europe's climatic zones from the subarctic to Mediterranean.
- **Enclosed ecosystem platforms**, complement open-air platforms by enabling a much higher level of environmental control and process measurement on ecosystems.
- **Analytical platforms** offer advanced biological, physical and chemical analyses for a deeper insight into processes.
- **Modelling platforms** give access to existing, state of the art, numerical models and to advanced software facilities for model development (model factories) that will improve data analysis and synthesis and allow predictions of the responses of ecosystems to global changes.

The contribution of experimental, analytical and modelling platforms of a given country to AnaEE will be organised by operational entities designed as National Nodes (NN).



Geographical location of AnaEE's open air and enclosed platforms, within the various biogeographical zones in Europe. Source of the base layer: European Environment Agency, Biogeographical regions, https://www.eea.europa.eu/ds_resolveuid/9b7911cc33ad4a9c940847a7ff653a40

The AnaEE ERIC will coordinate access to the experimental, analytical and modelling NPs and organize the collaboration with the European user community and stakeholders through the Central Hub (CH) in charge of the overall coordination, and the three Service Centres (SC): The Technology Centre (TC), the Data and Modelling Centre (DMC), and the Interface and Synthesis Centre (ISC).

- The **Central Hub** (CH) will be the unique point of entry to the AnaEE Research Infrastructure. It will ensure the overall management of AnaEE, its communication, and targets to:
    - Increasing visibility of NPs through the web portal
    - Connecting scientists, NPs, and SCs for project incubation
    - Increasing the participation of NPs and national nodes/institutions to EU projects
- The **Technology Centre** (TC) will promote standardisation of procedures and methodology across the platforms, watch and develop new emerging technologies, and will ensure that instrumentation and methods are coordinated. Core activities of the TC include:
    - Harmonizing procedures across NPs
    - Maintaining NPs' technologies at a state-of-the-art level and supporting to their further development
    - Developing innovative technology to serve the agricultural sector and spin off to the industry

- Organising training sessions of the operators and users, either scientific or industrial

- The **Data and Modelling Centre** (DMC) will be responsible for the processing of the data and metadata, the provision of data to the users (either the direct users or the community), and the access to the models and model factories. The overarching objective of the DMC is to create and enable a suitable environment for scientific data to be Findable, Accessible, Interoperable and Reusable (i.e. 'FAIR'). This includes:
    - Preparing and maintaining the AnaEE Data Management Plan
    - Improving data quality and data analysis
    - Ensuring visibility of and access to AnaEE data
    - Facilitating access to a range of modelling solutions and to model factories
    - Modelling ecosystem responses along environmental gradients *via* multi-site experiments.
    - Linking remotely sensed data to model resources.
- The **Interface and Synthesis Centre** (ISC) will be responsible for the overall integration of the results obtained by the AnaEE RI. It will prepare synthesis and opinion papers on behalf of AnaEE, watch for emerging societal needs, and answer to demands from the society, economy, and policy makers. It will be also responsible for the training and outreach. Its tasks comprise:
    - Organising scientific prospective studies and lobbying for research programs
    - Setting-up project building capacity
    - Elaborating outreach material directly related to AnaEE results
    - Organising worldwide ecosystem science syntheses
    - Elaborating societal scenarios and innovation needs beyond AnaEE results
    - Feeding the Interface and Synthesis Centre section of the AnaEE portal
    - Providing recommendations and position papers for policy makers and regulators

The platforms remain the property of their respective country/institution. They will be bound by Service Level Agreements, signed between the ERIC and the host institutions, which will describe the services supplied by the ERIC to the platforms, and by the platforms to the ERIC.

This architecture based on centralized coordination and decentralized implementation will largely enhance the potential of each Node and Operator by providing a common reference and strategic framework, high international visibility, interoperability of service protocols and data collections, and a single-entry point for close connection to the EU Research Framework.

Collaboration networks

AnaEE is engaged in the collaboration with other European RIs, both in the Health and Food domain and the Environment domain of the ESFRI roadmap. In the Health and Food domain, the objective is to study innovative solutions for a sustainable intensification of agriculture by integrating the study of plant phenomics and agro-ecology. In the Environment domain, AnaEE is an active participant of ENVRI, the community of environmental infrastructures.

Beyond academic collaborations, AnaEE aims to offer services to industrial partners in various sectors (such as agriculture, forestry, finance, trade, and health) to find, develop and test climate change adaptation and mitigation measures applicable at continental level or adjustable to specific climates and soils. AnaEE also takes part in ENRIITC, an EU-funded project aiming at establishing a European-wide network of industry liaison and industry contact officers to enhance the collaboration between RIs and the industry.

Services to users

The services provided by AnaEE-ERIC, through the Central Hub and the three centres described above, address four main categories of users. The primary target is the academic community, with services aiming to provide excellent infrastructure and experimental capabilities to researchers. AnaEE-ERIC is also developing services for its own circle of platform members, a condition for the quality of services to the final users. Finally, AnaEE-ERIC develops services to several other types of users: industrial partners, farmers, NGOs, policy-makers, and the general public.

AnaEE's services to academic users:

- a full catalogue of platforms and services
- a single entry point to access infrastructures, as well as information and guidance regarding application procedures and cost structure
- open access to data and metadata acquired by AnaEE RI
- integrated analytical and modelling services
- training for scientists and advanced students

AnaEE's services to its platforms:

- coordination of procedures, quality standards and regulations across platforms
- support to develop, test and implement new instrumentation, processes, methods
- scientific networking and roadmapping (workshops, conferences, exchange network, etc.)
- common procurement
- coordination and support of common projects and applications
- coordination of industrial outreach activities
- communication and marketing
- training of staff

AnaEE's services to private partners and NGOs

- central access point for scientific users from the private sector and NGOs
- tests of new products, new technologies, new management methods for agriculture and nature conservation
- support for innovation activities, including open innovation and living labs
- training for technical users

AnaEE's services to policy-makers and society

- impact assessment
- expert public policy advice on improved management and methodologies for sustainable agriculture and ecosystem management
- coordination and support of platform/national nodes activities in education (schools) and outreach (broader public)
- European wide awareness building and citizen science

Implementation

ANaEE has currently entered its implementation phase in five founding countries (Czech Republic, Denmark, Finland, Italy, and France), one member intergovernmental organization (CIHEAM), and one observer country (Belgium).

The Central Hub is functioning and ramping up. Hosted in France and recently established in its new premises in Gif-sur-Yvette, the Central Hub has appointed its Director General on a competitive basis and the team is being recruited. The Managing Board (MB) is in place. Comprising the heads of the 3 centres, the Director General and key personnel (administrative officers and program managers), it meets every 15 days for the daily management. The Finance & administrative officer will be hired so that he/she will take his position at the very beginning of the legal structure.

The Independent Scientific Advisory Committee (ISAC) has been appointed.

The three Service Centres have been installed in Denmark, Czech Republic and Italy with in-kind resources. The Technology Centre has already completed a full assessment of the platforms, coordinated the set up of a full catalogue of platforms and their services, which is now accessible online through the AnaEE web portal (https://www.anaee.eu/services).

Platform coordination and outreach to users are being organised. A first platform meeting has been organised in November 2019. An information and training session for users is going to take place at the AgroEco 2020 conference (2-3/12/2020) during a dedicated “AnaEE day”. A general Functional Ecology Conference (FEC) is currently being planned to take place in 2021.

Access policy regulations have been designed and approved, as well as cost structure policy. Draft Service Level Agreements are currently being finalised, to be approved by the Assembly of Members (AoM) at ERICs establishment, and signed with each platform (see Appendix 5).

A first version of the proposal portal and of the data & modelling portal (installed by the Data and Modelling Centre) has been developed, with relevant information to help potential users to build their application and find funding.

Outreach to users beyond academia has also progressed considerably, with for instance the collaboration with CIHEAM, providing a bridge with the community of agronomy around the Mediterranean basin.

Finally, a general work programme for 2020-2022 has been designed and agreed upon.

1. Why AnaEE: a key piece of the puzzle needed to address the ecological sustainability challenge for Europe

1.1. A pressing societal challenge: the need for ecosystem research in the Anthropocene era

Evidence regarding the crucial importance of the provisioning of ecosystem services[i] for food security and human welfare is constantly growing. To give but one recent and salient example, the international panel on bio-diversity just pointed out the value of well-functioning ecosystems in the fight against pandemics such as the COVID-19[ii].
And yet, this provisioning of ecosystem system services is currently facing several threats that are caused by anthropogenic activities, resulting in an unprecedented environmental crisis.
The drivers of change which influence continental ecosystems are many, which makes it particularly challenging to study them and understand their interactions: changes in land use and nutrient input; changes in food, raw material and bio-energy production; climate change at global and local scales; loss of biodiversity; pollution, etc. Several of these global change drivers have the potential to disturb critical ecosystem processes, eventually leading to tipping-points and catastrophic changes in ecosystem functioning. As such, they represent persistent threats for sustainable food production, water quality or the global equilibrium of element cycles on Earth.

Moreover, the human population keeps growing and is expected to reach 9.1 billion in 2050: while continental ecosystems are exposed to a rapidly changing environment, an estimated 70% increase of food production is required (FAO[iii]), presenting society with pressing challenges. As pointed out by the Intergovernmental Panel on Climate Change (IPCC) and the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), tackling these challenges requires the combination of several efforts: we need to deepen our understanding of the underlying processes, we need to adapt key behaviours and practices, and we need to change institutional settings. Thus, the challenge is at the same time scientific, technological, social and political.

AnaEE wants to contribute to the scientific and technological part of the problem and create the conditions for deeper, finer-grained understanding of ecosystem functioning. We need to determine their short- and long-term responses, how these feedback to global processes, and how human societies can adapt to and mitigate changes in ecosystem functioning.

[i] A glossary is provided at the end.
[ii] https://ipbes.net/pandemics
[iii] A list of acronyms is provided at the end of the document.

Table 1. Key threats to different ecosystems, key threatened ecosystem services and corresponding fields of experimental research

Ecosystem type	Main threats	Ecosystem services	AnaEE research fields leading to adaptation and mitigation strategies
Agricultural systems (e.g. croplands, agro-ecosystems, etc.)			
	Climate change Land-use change Air and soil pollution Soil erosion Flooding Pests Pollination loss	Food production Food quality Nutrient cycling Carbon storage Soil fertility GHG emissions buffering Stream water Renewable resources	Agronomy Agro-ecology Soil sciences Hydrology Plant biology Microbiology Biogeochemistry
Forests			
	Climate change Land-use change Air pollution Biodiversity loss Biological invasions	Timber/wood production Carbon storage GHG emissions buffering Non-wood products Water cycle Biodiversity Cultural services	Forestry Soil sciences Hydrology Ecology Microbiology Biogeochemistry
Grasslands and shrubland			
	Climate change Land-use change Air and soil pollution Biodiversity loss Soil erosion Biological invasions	Food production Grazing for livestock Nutrient cycling Carbon storage GHG emissions buffering Biodiversity Cultural services	Agro-ecology Plant biology Microbiology Biogeochemistry
Wetlands, rivers and lakes			
	Climate change Habitat destruction Pollution Biological invasions	Water quality Nutrient cycling Carbon storage GHG emissions buffering Biodiversity Cultural services Flood protection	Ecology Limnology Hydrology Microbiology Biogeochemistry

1.2. The need for an experimental approach

Intergovernmental agencies and the academic communities have identified the knowledge gaps that need to be tackled in priority. Amongst those, a very salient gap consists in complementing observational approaches by complex, cutting-edge experimental ones, where researchers can control a series of parameters, and then test hypotheses across various kinds of settings[1,2].

This is what AnaEE is about: it specifically caters for the need to provide complex experimental settings across a large diversity of ecosystems. As such, AnaEE brings an important piece of the puzzle that has to be put together to address the societal challenges stated above. It provides a single-entry point in Europe to propose a comprehensive research on ecosystems, relying on the relevant infrastructures and engaging the whole span of concerned stakeholders.

The originality and added value of AnaEE lies with the adoption of the experimental method as the backbone of the infrastructure. A guiding principle and core strength is the effective integration of experimental and modelling activities for the overall progress of ecosystem science, particularly with regards to expanding Earth system models[3]: AnaEE adopts the experimental approach on continental ecosystems built around Manipulation, Measurements, Modelling, Mitigation and Management.

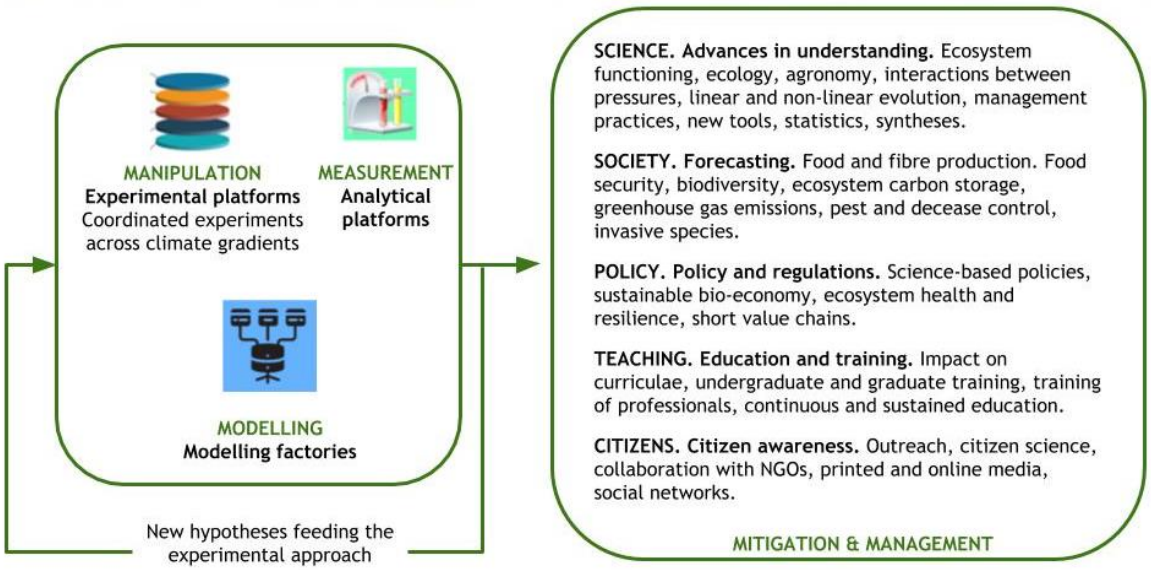


Figure 1. AnaEE's experimental approach: Manipulation, Measurement, Modelling, Mitigation & Management

Within the AnaEE platforms, environmental parameters are manipulated experimentally to simulate the behaviour of the system under various anthropogenic pressures, in order to unravel mechanisms and feedback loops involved in ecosystem responses, and test mitigation and adaptation measures. More precisely:

- it enables manipulation experiments with climatic drivers to predict the impacts of the ongoing climate change;
- it allows the design and testing of innovative management strategies and mitigation measures to improve water management practices, support nutrient efficient farming, optimize carbon sequestration and reduce greenhouse gas emissions;
- it provides the integration of experimental approaches with modelling, which enables quantification and prediction of the impact of global change drivers on ecosystem functioning beyond the specifics of individual studies.

In ecosystem science, this experimental approach has to face demanding issues of reproducibility, scale and complexity. Experiments need to deal with the complexity of ecological systems in

combination with the diversity of global change drivers. For example, the impact of climate change is dependent on management practices. Further complexity arises from the diversity of interaction networks among living organisms, and from the variety of the processes and feedback loops that govern the interaction between biological and biogeochemical processes (e.g. linear and non-linear responses). Ecological research aims to understand and rationalize the complexity of ecological systems in order to explain their functioning and predict ecosystem dynamics and ecosystem responses to global change.

Another type of epistemological challenge comes from the wide range of spatial and temporal scales required to understand global change impacts on continental ecosystems. In spatial terms, results from single site-based research must be scaled up in order to predict processes operating on yearly to century time scales at a continent-scale or even more[4]. In temporal terms, many processes affected by global changes characteristically fully develop over time scales much longer than the duration of most experiments: a coordinated approach is therefore necessary to combine long-term, large-scale global change experiments with process studies and modelling. Those challenges require a more extensive and integrated approach, combining different experiments, at different spatial or temporal scales, and linking the data to models[1].

Many threats to ecosystem functions manifest themselves in a non-uniform and non-linear manner, so that predictions and solutions may vary from one region to another. To avoid context-dependent conclusions, we need experimental facilities that are able to impose multiple treatment levels and multiple pressures in multiple locations. Similarly, adaptation measures and strategies cannot work across-the-board, but must be tailored to specific climate, soil, and water body types, conditions and also to the specific ecosystem structure.

To address the critical need for advanced methods to conduct experimental research, ecosystem scientists thus require collaborative experimental infrastructures, which can provide controlled experimental settings, make it possible to run parallel studies over various ecosystems, and facilitate the combination of analytical tools (e.g., automated sensors) and data to solve interdisciplinary questions[1,2,5]. The AnaEE infrastructure provides the tools to overcome these challenges, improving the predictions of how ecosystems function under complex combinations of diverse environmental pressures, taking into account both biotic and abiotic factors.

1.3. Fostering excellent science, targeting European needs

1.3.1. The need for excellent ecosystem science in a European context

AnaEE complements the many assets of the current European academic fields of ecosystem research: because of its large set of connected infrastructures for experimental research, it paves the way for a more coherent and comprehensive approach. AnaEE provides relevant services to the European research community, with the possibility to replicate experiments and make optimal use of the complementarity of the infrastructures offered by the members.

Ecosystem research has not been performed in coordinated networks until recently, preventing straightforward comparisons across time and space by lack of harmonization and standardization of scientific practices. Efforts have been made in the last decades to develop dedicated observation networks including among most prominent initiatives such as LTER (Long-Term Ecological Research) and TERN (Terrestrial Ecosystem Research Network), ICOS (International Carbon Observation System), or the NEON NSF program (National Ecological Observatory Network). However, these networks are

devoted mostly to observational studies and are therefore not designed for teasing apart cause and effect of interacting global changes needed for accurately predicting the impact of climate change on ecosystems. Furthermore, such observational networks are not solution-oriented as they cannot be used as platforms for developing and testing possible adaptation and mitigation measures and strategies.

AnaEE is a one of its kind distributed experimental RI, covering the whole span of European ecosystems in complementary platforms that allow conducting comprehensive experiments, supported by service centres that further strengthen AnaEE research and increase its impact. Currently, there are no such existing infrastructures in the world. Infrastructures such as ICOS, LTER, CERN, NEON or TERN take advantage of distributed multi-site facilities, but they focus on long-term observation rather than experimentation.
There is a growing awareness worldwide of the need for a comprehensive, multifold experimental facility to improve our ability to predict global change impacts and develop adaptation and mitigation strategies (see details on the section 3.2.3). AnaEE is the only RI ready to fill this gap. As such, it will be a front-runner in a global perspective, filling a need that is currently expressed by numerous researchers worldwide. AnaEE will enable us to move beyond past and current scale- or approach-specific experimental approaches by combining state-of-the-art distributed experimental and analytical platforms with modelling and simulation[6], of direct relevance for the challenges facing European ecosystems.

Key knowledge gaps identified by the AnaEE community

To understand and predict ecosystem responses in a fast-changing world, we must address critical knowledge gaps in global change biology[6]. AnaEE provides the opportunity to achieve major progress in tackling these by combining distributed, state-of-the-art experimental facilities with service centres facilitating modelling and syntheses.

1. There is a paucity of studies into multiple, interacting global changes, especially those combining three or more factors[7]. Several global changes are affecting ecosystems simultaneously, and their impacts are often not additive[8]. Well-designed experiments in controlled environments allow generating multi-dimensional response surfaces, improving impact predictions under various future scenarios.
2. Global change impacts on ecosystem dynamics can be significantly affected by biotic interactions, including changes in plant community composition and the trophic chain[9,10]. Detailed studies on trophic and non-trophic interactions are needed to further elucidate the relationships between biodiversity, ecosystem functioning, and biogeochemical cycles[11].
3. Effects of global change may be different in the short and long term[1], may depend on climate and ecosystem[7,12], and may be felt at some ecological scales but not at others[13]. Cross-scale research is therefore needed, which makes AnaEE, with its distributed nature (multiple climates and ecosystems) and variety of platforms (multiple scales and research foci) especially suited.
4. A tighter connection between experimentalists and modellers is needed, as the goal of experiments is generally not direct extrapolation of the study's findings, but to improve mechanistic understanding and the representation of biological processes in models, so that we can predict outcomes under a range of potential future scenarios[14]. AnaEE explicitly links experiment and model through the Data and Modelling Centre, facilitating extrapolation beyond the specifics of individual studies. Moreover, AnaEE's highly instrumented platforms deliver diverse and high-frequency data, which is indispensable

in modelling.

5. Manipulation experiments are uniquely suited to identify critical thresholds and tipping points of ecosystem responses to global change, but most do not capture the full breadth of possibilities[7]. Experiments that extend beyond current and even predicted ranges of environmental conditions will allow deeper mechanistic understanding and thus improve models and ensuing global change impact predictions[15].

1.3.2. A logic of complementarity with existing infrastructures - notably on the ESFRI roadmap

To ensure that its efforts complement existing structures and prevent duplication of efforts, AnaEE is actively engaged in the collaboration with other European RIs, both in the Health and Food domain and in the Environment domain of the ESFRI roadmap.

Figure 2 illustrates how the epistemological and methodological stance adopted by AnaEE provides new ground, as a complement to other Research Infrastructures in Europe. AnaEE is the unique infrastructure to enable the manipulation of environmental variables to foster future conditions. There is a strong complementarity with the observational approach, which monitors the past and current conditions. Both approaches are needed for modelling the ecosystems.

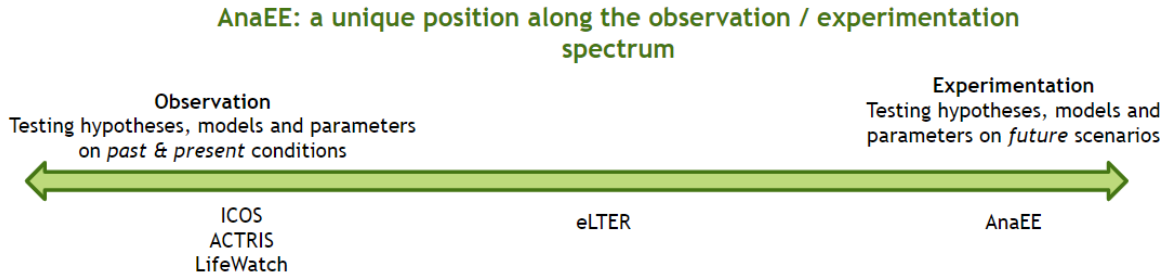


Figure 2. The specificity of AnaEE among other environmental RIs

In the Health and Food domain, AnaEE is collaborating with EMPHASIS. The aim is to bring innovative solutions for a sustainable intensification of agriculture by integrating the study of plant phenomics (EMPHASIS) and agroecology (AnaEE). In a common recent publication[16], three domains for collaboration and synergy were identified: (i) environmental sensors and imaging techniques, especially airborne and in-field technologies, (ii) joint data and metadata standards, and (iii) agronomic modelling, notably combining the genotype performance models of EMPHASIS with the environmental impact models of AnaEE. Synergistic areas between AnaEE and EMPHASIS include field phenotyping where experimental platforms are used to develop methods and sensors for field phenotyping. For example, the CzechGlobe research institute, operating the experimental AnaEE platforms in the Czech Republic, cooperated with several universities and the private company GRYF HB, to develop mobile and stationary infrared thermal sensors for phenotyping drought stress tolerance and spectral sensors based on red-edge spectral band for phenotyping nutrient use efficiency. They were then tested for use in EMPHASIS platforms (PSI). Several AnaEE platforms are also involved in collaboration with breeders (Selgen, Limagrain) in special breeding programmes for drought or heat tolerance using AnaEE experimental platforms (CzechGlobe) and EMPHASIS phenotyping (PSI) platforms. AnaEE also collaborates with ELIXIR to use common solutions and apply common standards for life science data.

In the Environment domain AnaEE is an active participant of ENVRI, the community of environmental infrastructures. We participate in the ENVRI-FAIR project (after ENVRI-Plus), which establishes common standards for the data and metadata of environmental infrastructure in order to realize FAIR access (Findable, Accessible, Interoperable and Reusable). Thanks to ENVRI, AnaEE data will be interoperable with data from other RIs. There are also specific collaborations with RIs in the Environment domain. One collaboration scheme builds on the co-location of our national platforms. AnaEE platforms can be co-located with ICOS facilities and eLTER sites. Not only does this save resources, but observational data from ICOS and eLTER can also be used as input variables or compared with output variables from experiments performed in ANaEE platforms. For example, ICOS data on GHG or VOCs can be used by AnaEE and eLTER, whereas ecosystem level data from AnaEE can help predict future GHG and VOCs emission patterns and decipher local and global mechanisms. In one AnaEE platform (the Hasselt University Ecotron), flux tower data from ICOS are for example used to operate the climate control of an AnaEE enclosed platform with the same ecosystem type, which in turn is linked to field plots of this ecosystem type at a nearby eLTER site to better understand the results of the Ecotron experiment. Figure 3 provides another example of such integration. Figure 4 shows the localisation of the c. 45% of AnaEE's platforms which are collocated with other infrastructures and Table 2 lists the concerned platforms.

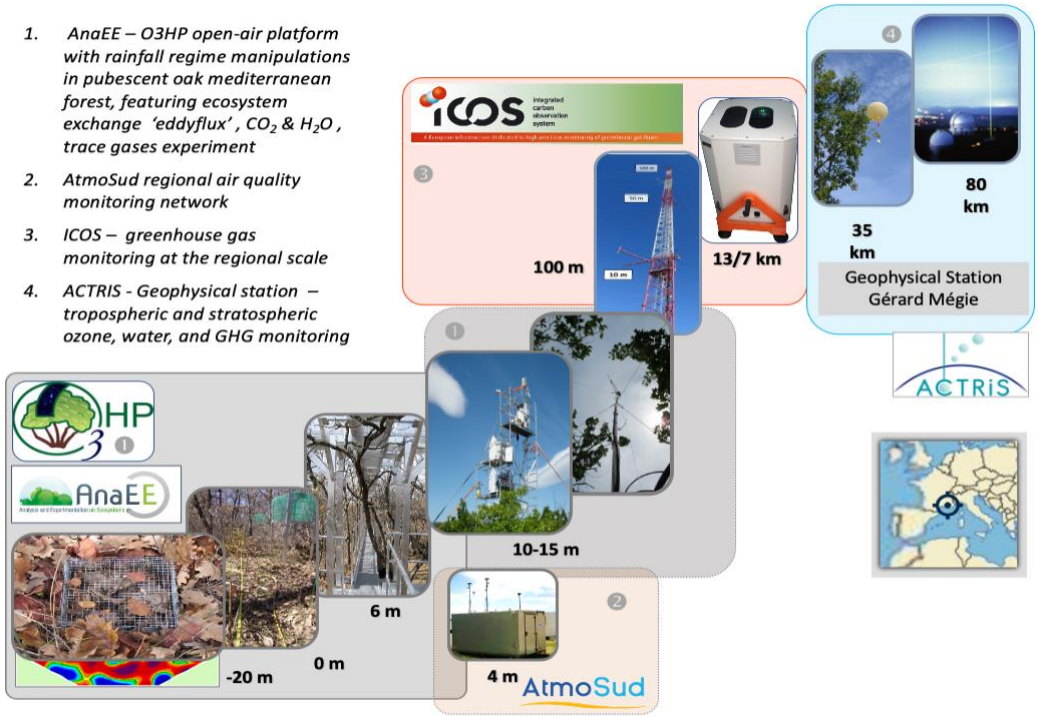


Figure 3. The AnaEE - O_3HP station at the Haute-Provence Observatory (OHP) (© CNRS)

The O_3HP station in France is collocated with an ICOS 100m tower (left of the image), as well as a station from the ARISE project (with NDACC and infrasound networks) and the ACTRIS RI. A station for the measurement of the regional pollution AirPACA network is also located next to the ICOS tower. At the O_3HP station, pollens are identified and quantified using plant phenology under various (manipulated) rainfall regimes. These pollens are potential tracers for the origin of air masses detected by the ICOS tower and the ACTRIS lidar, both on the same site. AtmoSud (formerly AirPACA) has co-located a station of its air quality monitoring network to measure the remote effects of the pollution from the urban area of Aix - Marseille, and disentangle them from the air compounds in a protected area.
The Specnet project links the data that will be acquired by the ESA FLEX mission (part of the Living Planet program), plant fluorescence, with CO_2 fluxes and structural characteristics of the canopy at the O_3HP.
Co-located ICOS Eddy-covariance flux towers and open-air experimental platforms in grassland and agricultural ecosystems in the Czech Republic (CzechGlobe) are used to test specific hypotheses such as separation of transpiration and evaporation measurement from H_2O fluxes, understanding the fluxes and damaging effects of ozone by the flux data or understanding the effects of drought on soil respiration dynamics by manipulation of water availability.

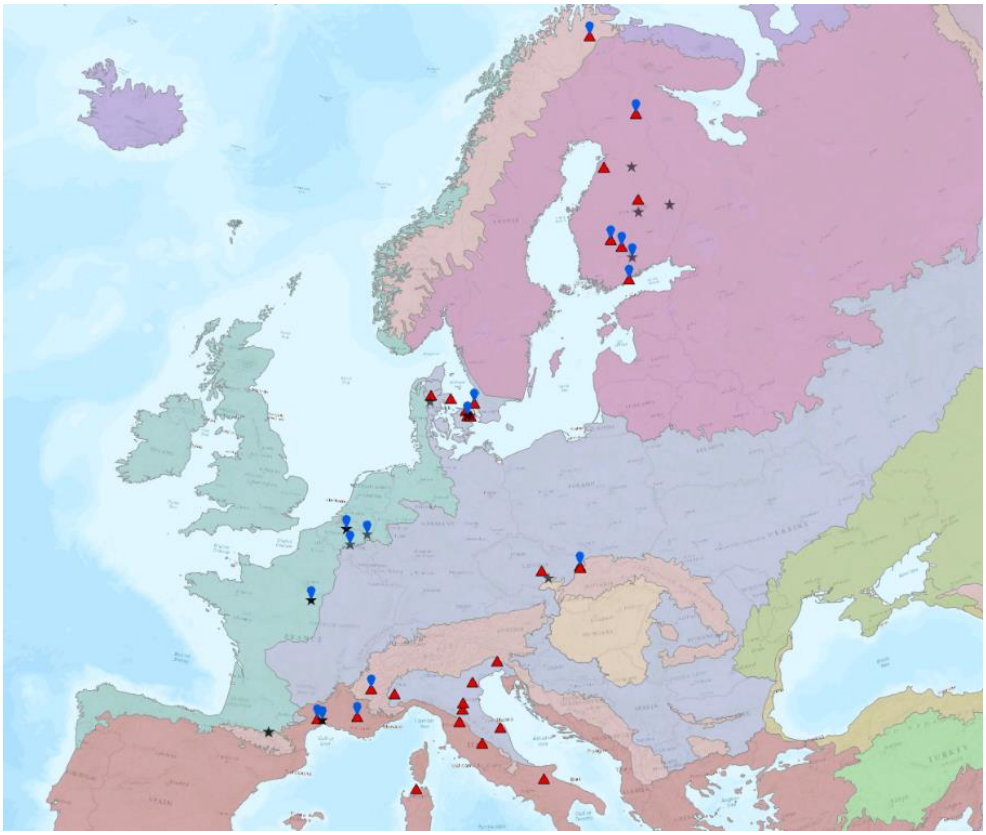


Figure 4. Co-located platforms (blue pins).

Table 2. Co-located AnaEE experimental platforms

ICOS	LTER	INTERACT	ACTRIS	Emphasis
Cultivation Domes / Bily Kriz DTU-Risø Experimental fields ETRS-European Tropical Research Stations Hyytiälä2 (SMEAR II) O3HP (Oak Observatory at the OHP) Puéchabon Station alpine Joseph Fourier Vestskoven Viikki Agricultural Production Laboratory (VAPL) Antwerp Ecotron Ecotron Européen Montpellier Ecotron Hasselt University Ecotron IleDeFrance_2 (Ecolab) EnvironmentIsLife – Ecotron Infrared Heating Systems Antwerp Risø Environmenral Risk Assesment Facility (RERAF)	Hyytiälä2 (SMEAR II) Kevo Subarctic Research Institute Lammi Biological Station Oulanka research station Station alpine Joseph Fourier Vestskoven Viikki Agricultural Production Laboratory (VAPL) Algological Research Laboratory (ALGOLAB) Ecotron Hasselt University	Hyytiälä2 (SMEAR II) Kevo Subarctic Research Institute Oulanka research station	Hyytiälä2 (SMEAR II) O3HP (Oak Observatory at the OHP)	Viikki Agricultural Production Laboratory (VAPL) EnvironmentIsLife - Ecotron

AnaEE also collaborates with the Aquacosm and Danubius projects, as the AnaEE platforms for continental aquatic ecosystems are the natural boundary and transition between the terrestrial and the water domain. AnaEE has also established contact with overseas networks with the same purpose such as the National Environmental Observatory Network in the USA (NEON), the Chinese Ecological Research Network in China (CERN), and the Terrestrial Ecological Research Network (TERN) in Australia.

Finally, in addition to the aforementioned ENVRI-Plus European funded program, AnaEE also participates in the ENRIITC EU funded project whose aim is establish a European-wide network of industry liaison and industry contact officers to enhance the collaboration between RIs and the industry. Under the leadership of CIHEAM, AnaEE is the main partner of a project of starting communities (sent as a proposal to the INFRAIA-2-2020 H2020 call) in the domain of plant health and agricultural management practices. AnaEE provides its expertise in European projects, transnational access, and all types of platforms.

1.4. Reaping the benefits of a distributed approach

AnaEE is a key piece of the ecosystem research puzzle in which it complements observational infrastructures to deliver the key services required by society, namely prediction of global change impacts, studying and promoting the mitigation potential of ecosystems, designing adaptation strategies and developing adaptation measures (see Table 1). AnaEE can capitalize on platforms that have already been funded, each of which adheres to high standards and offers unique features. Creating such an array of platforms from zero would require huge investment.

As a distributed infrastructure, the main ambitions of AnaEE are to:

- provide easy access to a wide range of infrastructures for the scientists and rely on geographic diversity to access a diversity of ecosystems to be observed;
- offer new services to scientists in terms of data sharing, etc. and organize training and outreach activities;
- design a common roadmap for the future development of infrastructures and coordinate investments.

The distributed nature and combination of experimental, analytical and modelling platforms proposed by AnaEE provides the best organization to respond to the key scientific challenges of global change biology and the societal challenges of the stakeholders.

Thanks to AnaEE, users will be able to run simultaneous experiments across multiple platforms of the same type (for example, open-air platforms across a geographic gradient), synergetic experiments that combine different platform types (for example, enclosed platforms using data from open-air platforms in real-time), and studies with instantaneous feedback between experiment and model (self-steering experiments).
In addition, the AnaEE integrated experimental infrastructure interconnects manipulation experiments with modelling and analytical platforms that will help to understand the impacts of global changes on ecosystem processes and up-scaling the results to a continental or global scales. In addition to modelling platforms, remote sensing platforms or analytical laboratories within AnaEE can for example be used to elucidate climate change impacts across scales (molecular to landscape). AnaEE represents an integrated infrastructure that enables large scale studies across geographic, climatic, elevation or soil gradients that are necessary for successful long-term predictions of climate change impacts for almost all combinations of ecosystem type, local soil and climatic conditions, especially in conjunction with mechanistic modelling.

One of the main added values provided by the integrated experimental infrastructure AnaEE is represented by services for climate change adaptation and mitigation. This is mainly because adaptation or mitigation measures need to be tested against the multitude of climate factors expected in the future (which requires manipulation experiments) and also because the effectiveness of adaptation measures must be verified with the proper experimental design, i.e. compared to the no-action situation (control). This will gradually establish a strong link between ecosystem research and food security to ensure sustainable provisioning of production and non-production ecosystem functions. AnaEE as an integrated infrastructure provides the most efficient way for the agricultural sector and to the industry to find, develop and test adaptation measures applicable at continental level, or also to explore how to adjust them to specific climatic and soil conditions.

For the EU at large, but also at the national level, AnaEE will provide key input regarding the development of long-term strategies and policies aimed at strengthening the role of all ecosystems

in reducing greenhouse gas emissions and enhancing carbon sequestration, but also at addressing current climate change challenges related to reduced food security or declines in non-production ecosystem services. The infrastructure itself and the results provided by AnaEE, together with modelling platforms, will provide policy makers the mapping decision support tools for early detection of the most vulnerable areas and ecosystems, enabling them to take early action.

As a distributed infrastructure, AnaEE provides the unique opportunity to experiment on a wide range of ecosystems across Europe, and to cover climate diversity and heterogenesis at a pan-European scale. This is key in order to scale up results and enrich the scope of predictions, recommendations and mitigating strategies at a European scale.

2. Scope and content of the AnaEE research infrastructure

2.1. A network of high-quality, complementary infrastructures

The network of national platforms

At the core of AnaEE's approach are the distributed experimental facilities that are able to impose multiple global change drivers to quantify the role of each of these drivers of change and to identify their interactions. These platforms, who belong to their respective institutions, have been selected on several criteria:

- State of the art instrumentation, following the AnaEE standards,
- Capacity to perform at least 2 environmental pressures,
- Quality of the data provided,
- Open access to the data and agreement on the standards for data and metadata provided by AnaEE,
- Long term support.

New platforms can be added by the partner countries at no cost at any time of the life of the AnaEE ERIC.

The full platform catalogue is accessible here.

It comprises of four types of experimental platforms:

- Open-air ecosystem platforms comprise the predominant land use types of European continental ecosystems including managed and unmanaged ecosystems as well as terrestrial and aquatic ecosystems transecting Europe's climatic zones (see Figure 5).
- Enclosed ecosystem platforms (such as Ecotrons[5,17], Figure 7) complement open-air platforms by enabling a higher level of environmental control and process measurement on ecosystems.
- Analytical platforms offer advanced biological, physical and chemical analyses of different samples (soil, plant) for a deeper insight into processes (see Figure 8).
- Modelling platforms give access to existing, state of the art, numerical models and to advanced software facilities for model development (model factories) that will improve data analysis and synthesis and allow predictions of the responses of ecosystems to global changes beyond the findings from specific experiments (see Figure 9).

Open-air platforms. One of the key features of AnaEE is to provide access to Open-air ecosystem platforms located along geographic gradients with a large range of climate conditions, in a diversity of ecosystems, and with various global change drivers in order to facilitate global, cooperative experiments (see Chabbi and Loescher 2017 for an overview on this issue). Open-air platforms have

been designed to host long-term experiments lasting at least over one or two decades to decipher long-term trends and slow processes, especially in soils, but also on other terrestrial and freshwater systems. Long-term, open air experiments constitute a major scientific approach in ecosystems with potential to unravel future patterns under realistic field conditions.

AnaEE open-air platforms are exceptional in that they combine manipulation of multiple global change drivers in unique ecosystem types with advanced tools and protocols to characterize ecosystem functioning from organism to element cycles. Such platforms are critical to comprehend long-term changes in ecosystem dynamics, to detect ecological tipping points and to understand the processes determining overall ecosystem resilience to extreme events.

In AnaEE, open-air platforms can operate in different modes: (1) as standalone experimental sites to provide physical access to plots for present-day in depth analysis of ecosystem states, (2) as standalone experimental sites for remote access to samples and data from the past, (3) as a global network of sites to perform coordinated distributed in situ experiments, laboratory analyses of historical samples or meta-analyses of historical data, (4) as providers of long-term global change scenarios data tested against model predictions trained with independent observational data from other research infrastructures or with experimental data from enclosed AnaEE platforms.

Figure 5. Aerial view of the shrubland/grassland experimental platform Brandbjerg (Denmark). 4 x 8 meter rain-out shelters at 3 different levels of precipitation removal intensity cover the experimental plots (© University of Copenhagen)

Figure 6. Domanínek's Czech Globe experimental station with open top chamber facilities

Enclosed ecosystem platforms. When highly controlled conditions are needed that are often difficult or expensive to realize in open air, for example, the experimental simulation of elevated atmospheric CO2, climate-warming, heatwaves, or shifting rainfall regimes, AnaEE offers enclosed platforms.

Such controlled environment facilities are not novel, as ecologists have for example used growth rooms or phytotrons with individual plants in pots for decades, but the AnaEE enclosed platforms are unique in their whole-ecosystem level design and measurement technologies. According to AnaEE criteria, these platforms need to comprise at least 12 individually controllable exposure units, in order to be able to fully cross at least two environmental pressures in a two-by-two factorial design with three replicates. The most advanced category of such platforms, Ecotrons, are equipped to measure multiple ecosystem processes in those exposure units in real-time and in an automated fashion, thus allowing continuous tracking of the ecosystem responses to the imposed pressures (e.g. greenhouse gas absorption and emission in photosynthesis and respiration, evapotranspiration).

In AnaEE, Ecotrons can operate in many different modes: (1) as short-term or long-term exposure environments; (2) as an ecosystem analyser, by bringing whole pieces of ecosystems from open-air or natural habitats elsewhere temporarily into the Ecotron enclosure and measuring ecosystem processes, (3) as one component of two linked platforms containing the same ecosystem type, for example, an open-air platform that supplies microclimate data from the field to drive the climate control in the Ecotron in real-time; (4) as one component of a coupled experiment-model system, where the model continuously feeds back to the measurements in order to optimize the timing and nature of the sampled data, which in turn simultaneously improves the model, in a continuous loop (self-steering experiment). Depending on the requirements, studies can be allocated to either such more advanced controlled environment facilities or to more basic ones, which optimizes the use of the available facilities at a European scale.

Figure 7. View of a chamber in the Gembloux ecotron (Belgium), featuring the full control of the lightning and heating of the mesocosm (© University of Liège)

Analytical platforms represent facilities (independent from other components of AnaEE infrastructure) whose main objective is to provide analytical services unavailable for most experimental platforms (either open-air or enclosed). These platforms bring an added value for the AnaEE community by ensuring a better understanding of the ecosystem processes. They have a high degree of originality, cannot be easily duplicated elsewhere with comparable standards, and have an "open access" status.

The platforms are equipped with state-of-the-art instrumentation and use cutting edge methods closely related to ecosystem and bioeconomy research. The analytical platforms preferentially provide integration of several analytical methods at one place, offering a range rather than individual measurements. Analytical platforms must have sufficient capacity to provide services for the whole AnaEE community and to coordinate standardization of procedures before the analyses, such as sampling, sample storage and transport.

Analytical platforms also contribute to the development of new analytical methods based on the needs of experimental and modelling platforms, and provide training to technical staff, PhD students, and early-stage researchers.

The main criteria for the AnaEE analytical platforms are therefore as follows: (i) state-of-the-art instrumentation and cutting edge methods generally unavailable for most experimental platforms; (ii) added value for the ecosystem and bioeconomy research (such as more in-depth understanding of ecosystem processes on a molecular level or mobile highly instrumented platforms); (iii) sufficient capacity for open-access and long term operability; (iv) standardization of methods with top similar platforms in the world; (v) highly qualified staff and continuous training of technical staff and users.

Based on the survey conducted within experimental platforms, the greatest needs for coordinated analytical services were identified: (i) mobile platforms providing unique in situ measurements (e.g.

PTR-TOF measurements of volatile compounds); (ii) mobile remote sensing platforms (aircraft carriers and drones equipped with hyperspectral imaging sensors); (iii) highly specialized laboratories in all omics fields (genomics, transcriptomics, metabolomics); (iv) process based imaging methods (MRI, NMR, fluorescence, Raman).

Twenty-two analytical platforms have expressed interest to be part of AnaEE, entirely covering the most "wanted" analytical services, and partly also contributing to the extension of capacity for relatively common but not generally available analytical services (e.g. stable isotope discrimination).

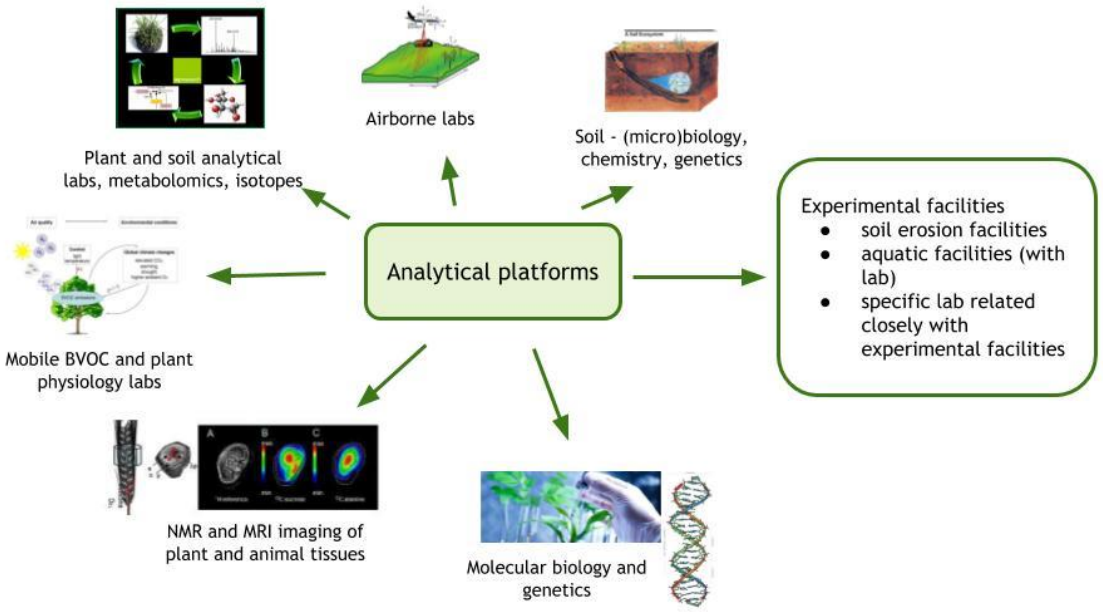


Figure 8. Groups of analytical services that are mostly "wanted" by experimental platforms and provided by AnaEE analytical platforms.

Modelling platforms. A distinctive feature of AnaEE is to provide access to a range of modelling platforms offering quality statistical and biophysical modelling of complex environmental systems. The swift changes observed over the past decades in both climate and animal and plant population dynamics pose a series of complex challenges to researchers and practitioners in the fields of agriculture, forestry management, and environmental sciences in general. The practical difficulties faced in organizing and running large scale field experiments may often not cope well with the rapidly evolving conditions we are witnessing. Numeric simulations, on the other hand, can be a powerful tool to effectively forecast environmental trends and the impact of new management practices, new species introduction, and climate change. Accurate modelling can also allow the detection of anomalies and inconsistencies in the observed field data, providing a further layer of understanding of the complex dynamics of environmental systems. The insights thus provided can in turn help researchers in designing better experiments, planning more effective monitoring activities, and elaborating long term projects. At a more aggregate level, this information can be used by stakeholders and policy makers to better inform decisions.

AnaEE's Modelling platforms give access to existing, state of the art, numerical models and to advanced software facilities for model development that will improve data analysis and synthesis and allow predictions of the responses of ecosystems to global changes.

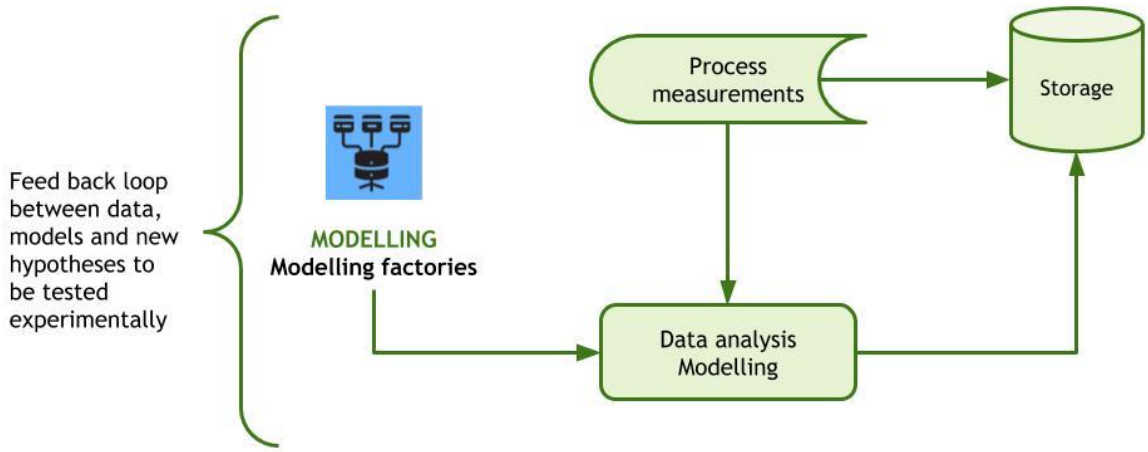


Figure 9. Modelling factories in the AnaEE environment

A large coverage of European ecosystems: As detailed more specifically in Appendix 10, AnaEE ecosystems include all major types of European terrestrial ecosystems, unmanaged or managed, i.e. agro-ecosystems, forests, grassland, shrubland, wetlands, rivers and lakes, across the major climate zones of Europe:

- Agricultural land, which covers 47% of the EU territory. Arable land accounts for the largest share, followed by livestock grazing, mixed crops and various permanent crops.
- Forests and Forestry: about 35% of the EU territory, totalling 215 million hectares (ha) is categorized as forest, representing 25% of the world forest resources[18]. The percentage of unmanaged forests in Europe has overall remained stable at around 3% of the land area.
- Grasslands and shrublands: one of the most versatile ecosystem types in Europe, ranging from monoculture production grassland under frequent management to diverse, extensively managed natural or semi-natural grassland.
- Wetlands, rivers and lakes: There are several million kms of streams and rivers, 73,000 km² of wetlands and more than a million lakes across the European territory (Eurostat). 'Freshwater', including wetlands at the boundary of fresh and salt water, provides for a multitude of ecosystems and ecosystem services, which play a crucial role in European economy and culture.

This allows AnaEE to provide comprehensive assessments and solutions in terms of land-use change, climate change, mitigation, and adaptation.

AnaEE will be the only experimental research infrastructure in continental ecology, distributed throughout Europe, and across all types of ecosystems, including agro-ecosystems. Figure 10 shows the geographical distribution of AnaEE's platform across the ecosystem type in Europe.

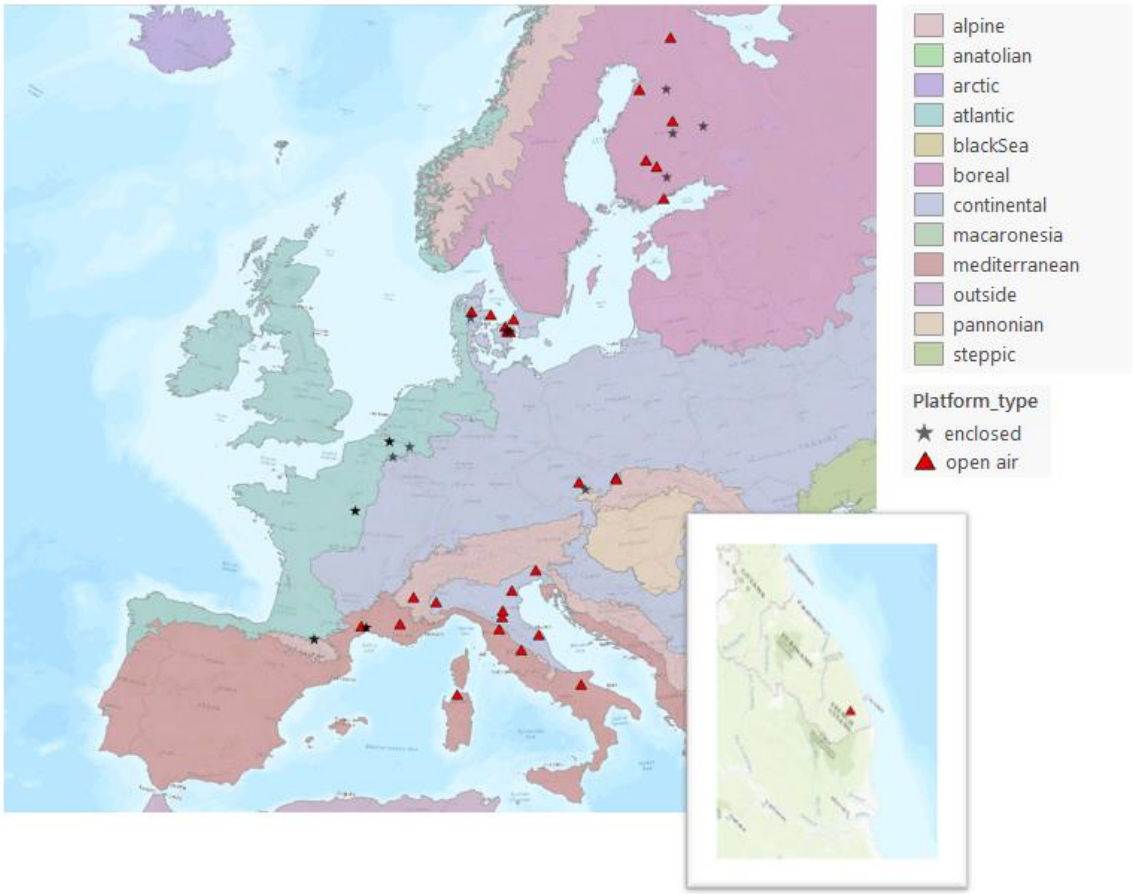


Figure 10. Geographical location of AnaEE's open air and enclosed platforms, within the various biogeographical zones in Europe. Source of the base layer: European Environment Agency, Biogeographical regions, https://www.eea.europa.eu/ds_resolveuid/9b7911cc33ad4a

Associated platforms

As part of our efforts to give the best services to our users, to increase the network of countries involved, and to help new platforms to reach the quality level requested by AnaEE we have established a status of Associated Platforms (APF).

APFs are usually not in a member country. They are platforms whose experimental design, heat map coverage (e.g. climate or ecosystem type) and data are of value for AnaEE but do not yet meet the requirements of a fully eligible platform. The platform owner would have the responsibility to provide AnaEE with data and metadata meeting the standard required by AnaEE. AnaEE will make these data public (with a possible grace period agreed between the owner and AnaEE) through the services provided by the DMC, together with the data acquired by AnaEE. This status will result from an agreement between AnaEE and the owner of the data (research institute typically). This status will be granted for 1 year, with possible renewal.

The goal of this status is to allow institutes from non-member countries in helping them to publicize their data, and to engage them in a quality approach to meet AnaEE's standards. In turn, we expect the institution to take the appropriate steps towards its community and government to be in a position to become a member of AnaEE. We believe that this will enhance the services given by AnaEE for the users, and this will be a positive step to nurture new platforms and communities to join AnaEE.

2.2. A series of services coordinated by a Central Hub and service centres

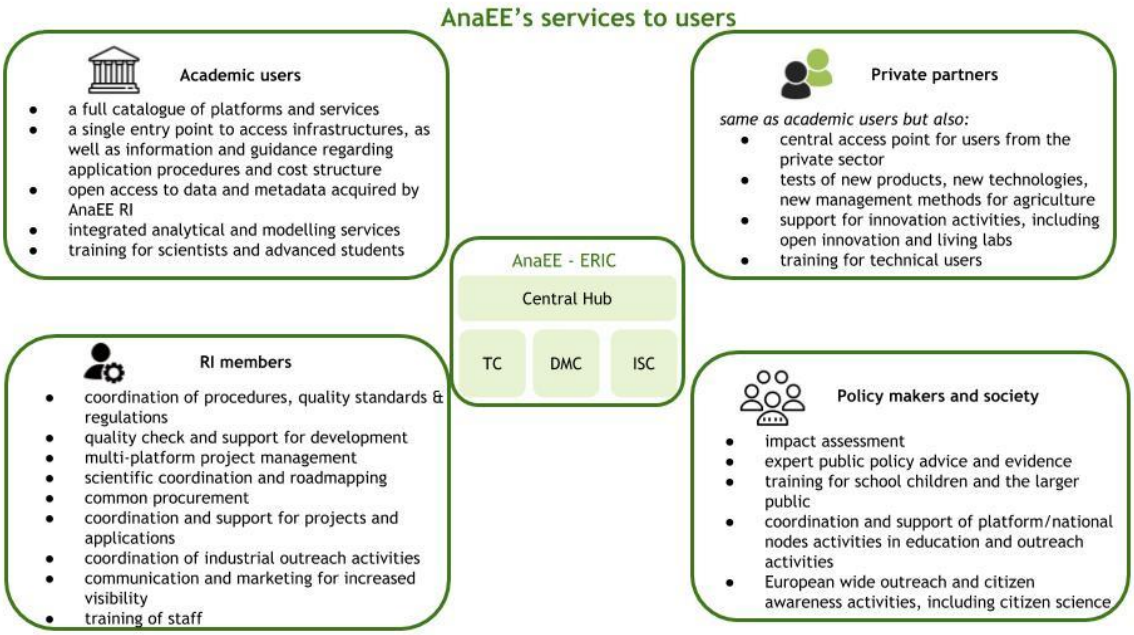


Figure 11. Overview of the services provided by AnaEE's Central Hubs and Service Centres

2.2.1. The role of the Central Hub and Service Level Agreements

The AnaEE ERIC will coordinate and integrate these experimental facilities and will provide key services that facilitate the integration through the Central Hub (CH).

This Central Hub will be the unique point of entry to the AnaEE Research Infrastructure (RI).

The hub features a web portal with access to the platform catalogue, the service catalogue, and a specialized interface to help the selection of services and platforms (see details below section 2.2.1.1.). The hub will ensure the overall management of AnaEE, its communication, etc.

Access to a portfolio of services, either from the AnaEE-ERIC structure or the distributed platforms: AnaEE represents already state-of-the-art experimental infrastructure, covering a wide variety of climate and ecosystem types, with several pressures, either enclosed or open-air. The AnaEE' Technology Centre, Data and Modelling Centre, Interface and Synthesis Centre, are an added value, and ensure consistency across AnaEE. The main services are presented below and the full catalogue of services is provided in Appendix 5:

AnaEE's services to academic users:

- a full catalogue of platforms and services
- a single entry point to access infrastructures, as well as information and guidance regarding application procedures and cost structure:
    - AnaEE portal centralize all users information, the access procedure, and will be a link to the data
    - Users are guided along the process to build their proposal. The procedure to access AnaEE' services ensures that a dialog between the user, the centres, the platform representatives, and independent experts helps to optimize the science output of

the proposal, the selection of the adequate platforms, the synergies with different programs run at AnaEE.
    - Coordination across multiple platforms and the possibility to compare the data acquired on different platforms
    - Accommodation of complex proposals over several platforms
- open access to data and metadata acquired by AnaEE RI (AnaEE will ensure the publication of platform data after the embargo period with a single access point for all platforms)
- integrated analytical and modelling services
- training for scientists and advanced students

AnaEE's services to its platforms:

- coordination of procedures, quality standards and regulations across platforms
- support to develop, test and implement new instrumentation, processes, methods
- scientific networking and roadmapping (workshops, conferences, exchange network, etc.) between platforms operators, engineers and scientists, providing new experimental ideas and projects, technological know-how, etc.
- centralized procurement and capacity of negotiation of AnaEE for new devices
- coordination and support of common projects and applications
- coordination of industrial outreach activities
- communication and marketing: international visibility of the platform thanks to the AnaEE user portal and ISC
- training of the operators and scientists of the platforms
- through the permanent dialog between users, stakeholders, platform operators, and the Central Hub and Service Centres, an innovative procedure to define common objectives and priorities for the research performed in the infrastructure and innovation initiatives can be defined.

As the demand will be growing, we expect to deploy more services within the first three years of operation, and to revise our procedures after this term.

Service Level Agreements (SLAs) will be signed between AnaEE and each platform that will describe the services provided and ensure the long-term funding by the owner.

The principles in the service agreement will be:

- The share of the platform devoted to AnaEE, which will be in any case larger than 30%,
- The proposals will be selected following the centralized AnaEE access procedure (see Appendix 5)
- The platform will follow FAIR guidelines, according to AnaEE standards
- AnaEE will manage the embargo period, which will be by default 1 year. In exceptional cases (i.e. complex experiment, private third party) AnaEE can grant a longer period, but without exceeding what is reasonably needed to perform the project and get the first results, possibly including the valorization
- All proposals related to trans-national access (TNA), will be managed by AnaEE; for AnaEE, TNA is understood as the access by a user that is not a national user from the country of the platform, or, projects that involve platforms located in different countries member of AnaEE
- The SLA will mention the amount of resources available at the platform
- The DMP of the platform will be compliant with AnaEE DMP
- The platform will participate in the activities of AnaEE, especially user training, standardization of process and equipment, discussion on common procurement, etc.

User access policy and procedure

AnaEE platforms are open to all user projects that comply with the technology and number of replicates available as long as they are complementary (or neutral) and not in technical conflict with other ongoing or already planned projects.

Project acceptance and granting of access will require both a scientific evaluation and confirmation of the technical feasibility by the platform owner(s). To this end, AnaEE will appoint a Program Review Committee (PRC) to have independent scientific and technical evaluation of the proposals. Then, together with the PRC and platform operators, AnaEE will support users to optimise the proposal. With guidance and supervision from AnaEE, the platform owners ensure the technical quality of measurements during the execution of user projects and will in turn benefit from user projects to improve their technical and methodological expertise and enrich their platform database.

The AnaEE web portal provides a single-entry point to all platforms as well as administrative support to ease the access. The web portal contains a service catalogue[iv] including the main features of each platform and information about on-going research activities as well as the primary results that have been generated. It also contains a search algorithm allowing identifying the relevant platforms for specific research topics according to metadata collected by the AnaEE Technology Centre. It will be key in the role of facilitator played by AnaEE by enabling potential project leaders to check the technical feasibility of projects, identify which platform best suits their needs, calculate costs and user fees, and access data management plans. The web portal informs users about the main services offered by each of the platforms and service centres and provides a structured way for users to apply for access.

The AnaEE user project procedure follows user projects from the time of the first submission of a pre-proposal via the web portal until final project termination. The procedure was designed to ensure maximum scientific and technical quality of user projects, as well as project reporting to AnaEE and facilitation of open access to project data after potential grace period following project termination. Figure 12 shows how projects are evaluated, improved, executed and terminated. Please refer to the AnaEE access policy document (Appendix 5) for further details and explanations on the principles applied to compute user access fees.

[iv] https://anaee-platforms.azurewebsites.net/

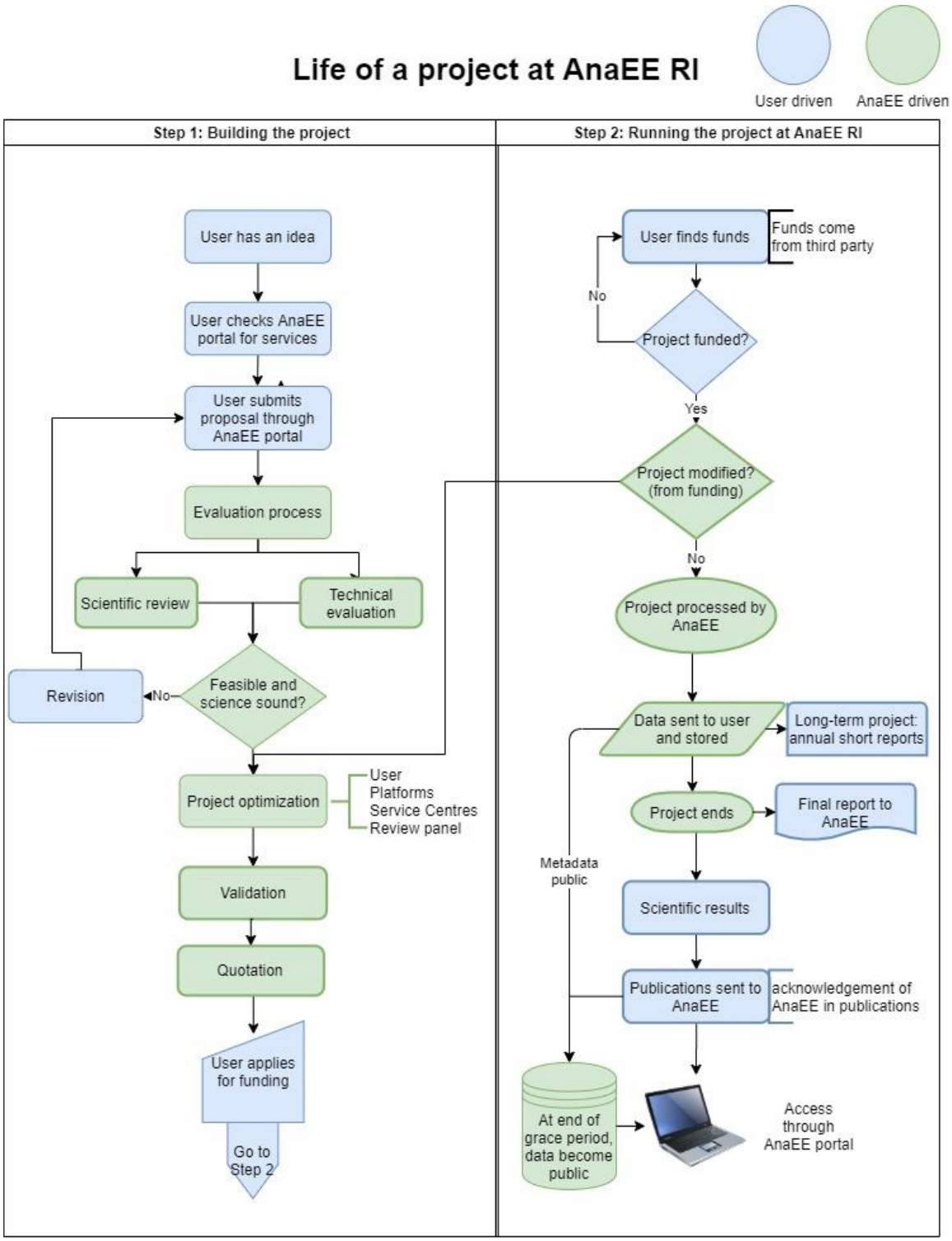


Figure 12. The procedure for user project access to AnaEE platforms and services

Data management, policy and access

It is of paramount importance that in the context of open science, the data from research and experiments performed at AnaEE RI are shared with the scientific community and also with the experts, the agricultural sector and the industry, and more generally with the society at large. This of course includes not only the data, but the tools used to work with and to interpret them.

The diversity of scientific themes addressed by the projects handled at AnaEE, and the multidisciplinary aspect of these researches, lead us to handle a wide variety of data related to the physical, chemical and biological aspects of an ecosystem. This is why it is essential to take data management into account throughout the data life cycle, from the design of the platforms, to the design of the experiments, to the sharing and preservation of the data. The Data and Modelling Centre, as well as the various actors of the infrastructure and project investigators will be involved in the data management process in order to provide quality data and metadata according to FAIR principles.

A key feature of AnaEE, described within the DMP, is the implementation of a process of revision of the data sets before publication. Such a process, which ensures the quality of the data and the ensuing publications and therefore the trust that the academic community can place in AnaEE-produced data, will rely on a combination of automated controls and domain-expert checks.

AnaEE is a member of the ENVRI community and actively participates in the ENVRI-FAIR program. Thanks to the common expertise shared in ENVRI-FAIR, we develop interoperable software and data management systems that can be accessed by other communities. The ENVRI community facilitates the relationships and exchanges with other RIs, such as ICOS, Lifewatch, eLTER, DiSSCo, SIOS and Danubius-RI. AnaEE is strongly involved in the development of services that respond to the common problems of semantic metadata collection and annotation. These developments make it possible to provide data sets enriched with metadata compatible with the semantic web and readable by machines. AnaEE's open and FAIR data policy aims at fostering Data Science in general and the exploitation of research data on ecosystems by Artificial Intelligence methods, therein including Deep Learning, in particular. Therefore, beyond the scale of the project it has been acquired for, the data will be used, in conjunction with other data from AnaEE or other RIs, for advanced knowledge production, and be relevant for studies in the health and food sector, as well as land use planning, as an example.

AnaEE will adopt a decentralized data strategy: data is stored and maintained by platform owners in their own data repositories, while the central data centre only contains meta-data. This model has several advantages, as it saves time and energy for platform owners, who do not have to upload or change the format of their data, nor to retain and sustain several repositories. It also guarantees the continuity in data maintenance and updating, this being done at the level of platforms at the level of their main activity.

The Data Management Plan (DMP) is provided in Appendix 6. It will be available through the AnaEE portal. Users of the infrastructure will be asked to provide their specific DMP when submitting their project.

The AnaEE DMP provides AnaEE platforms with a comprehensive set of guidelines to build their own data management procedures upon, which will be part of the SLA. AnaEE, in compliance with its philosophy of openness and inclusion guides its community towards a higher standard compliance, fostering technology and expertise transfer. In particular, AnaEE will support its platforms in reaching a shared IT maturity level that includes:

- User Identification systems ready for federation with third parties, like the ENVRI community.
- services and data publication platforms open enough to allow metadata transfer towards third party catalogues, like the ENVRI one.
- Service and dataset metadata rich enough to be correctly included and indexed in international and cross-domain catalogues, like the ENVRI catalogue and, in the future, in the EOSC catalogue.

AnaEE will assist platforms that do not possess the means to comply with these requirements by letting them use its IT facilities, including its storage and publication platforms. The usage of such facilities has to be agreed on a project basis within the SLA.

This top-level harmonization effort is necessary in the present situation and its need will become even more pressing in the near future to ensure interoperability with EOSC and other transnational data-centric initiatives.

2.2.2. The Technology Centre

The Technology Centre (TC), hosted by the University of Copenhagen, Denmark, will take charge of the standardisation of procedures and methodologies across the platforms, an essential condition for the quality and added value of AnaEE.
It will then watch and develop new emerging technologies, ensuring that instrumentation and methods are coordinated among the platforms. The TC is also responsible for the spin-off of new technologies developed within AnaEE, as well as for coordinating the training of users and platform operators. The TC will help AnaEE platforms to master new techniques and to stay up-to-date with cutting-edge technologies leading to new understanding of processes.

Technology is at the heart of the experimental approach of AnaEE. The experimental simulations of various levels of ecosystems drivers as well as the measurements of response variables require sophisticated equipment and instrumentation and coordinated standards and processes. It is necessary for platforms to master these techniques and to stay up-to-date with cutting-edge technologies leading to new understanding of processes. Setting up technological watches and developing/adapting specific technologies in collaboration with private companies will help meeting evolving research needs. The AnaEE Technology Centre is in charge of developing and sharing new technology knowledge within AnaEE. It will connect the scientific demand for new technology related to ecosystem science instruments as well as green economy with the supply of innovative ideas.

Keeping the technologies of the national platforms at a state-of-the-art level and contributing to their further development is a task that AnaEE will actively pursue. Technology foresight workshops will bring the Technology Specialists from the science community and from agricultural sector & industry together with specialists from disciplines upstream of the instrumentation used in AnaEE platforms (physics, chemistry, informatics, depending on the type of techniques to be addressed) or from disciplines where such instrumentation is more developed than in our fields and could be transposed to our domain (e.g. medicine, high energy physics, space science, other research infrastructures, etc.).

Core activities of the TC include:

- **The harmonization, standardisation and upgrade of instruments and procedures across AnaEE platforms.** Technology Working Groups (TWGs) will be set up to gather internationally renowned scientists. TWGs will develop experimental procedures and measurements, in order to standardize acquisition methods and data across National Platforms as well as push for and adopt new developments. This will include experimental designs, instrumentation, sampling, measurement procedures and calibrations The TC will provide references for cross comparison calibrations and will ensure that AnaEE procedures are aligned, and even lead, other international infrastructure standards.

One analytical platform which has applied to AnaEE has a recognised expertise in the development of soil biological indicators based on innovative measurement methods of enzymatic activities. Most of these methods are currently mature and standardised (i.e. ISO FDIS 20130) and in situation of transfer to experimental platforms in order to develop soil agroecological diagnostic and advice. Expected benefit is in the development of more sensitive biologically-oriented indicators of soil health which will support improvements in management practices of this important non-renewable resource.

- **The organization of technology foresight workshops and technology sessions**. Technology foresight workshops will bring together TWGs, relevant industries and specialists upstream of the instrumentation used in AnaEE platforms (physics, chemistry, ITC) or other disciplines where such instrumentation is further developed (medicine, high energy physics, space science). Together, they will determine which new technology to develop or adapt to the needs of ecosystems science.
- **The development of innovative technology for the agricultural sector and spin off to the industry**. The Centre pursues both demand-driven innovation (identifying solutions to specific technical needs) and supply-driven innovation (identifying potential users). Technological developments will either be carried out by national platforms or in the labs (physics, chemistry, computer sciences) mastering the fundamental technology, and/or jointly with private companies. Conversely, AnaEE will provide a European-wide testbed for external innovations. The centre will assist AnaEE platforms in supporting innovative local SMEs and start-ups and will take part in negotiating consulting agreements as part of public-private partnerships.

The first demonstration project of the TC could consist in developing and validating a novel soil water sampler/analyser system to obtain continuous in situ measurements of soil hydro-chemical properties to enhance site-based hydrological modelling. This can be done by making innovative use of a new porous steel soil water sampler (from PRENART Equipment ApS) combined with a novel DMR programmable unit fitted with sensors for automatic, in situ soil-water retention curve estimation, followed by plot scale logging of moisture content and potentially nutrient and gas concentrations. The equipment will be installed in a small set of open-air installations varying with respect to climate and soil properties exploiting the distributed nature of the RIs. The aim will be to demonstrate the utility of the novel sensor system for a range of ecosystem and soil types with a proven relationship to ecosystem services/benefits. The societal benefits are improved real-time data of ecosystem properties which influence resilience of vegetation/crops/trees to a rapidly changing water cycle which could provide the basis of early warning systems.

- **The TC will organize training sessions of the users, either scientific or industrial**. Training sessions will include theoretical and practical workshops, seminars, or intensive courses. Training activities will primarily target AnaEE platform personnel. Platform managers will be trained in industry policy, with particular emphasis on Intellectual Property Rights policy.
- **The feeding of the Technology section of the AnaEE portal**. The portal will feature the list of the TWG, their respective activities, and reports (for the public part). It will make widely available AnaEE standards and recommended protocols, calibration procedures, cross-calibrations and reference sensors information. The interactive technical forum will facilitate exchanges between platform personnel so that partner companies and scientists may compare demand and the availability of technical solutions.

2.2.3. The Data and Modelling Centre

The Data and Modelling Centre (DMC), hosted by the Consiglio per la Ricerca in Agricoltura e l'Analisi dell'Economia Agraria in Bologna, Italy, will be responsible for the processing of the data and metadata, the provision of data to the users (either the direct users or the community), the access

to the models and model factory. It will also organize workshops and training for users and AnaEE staff.

The integration of data and modelling services adds value to AnaEE users. Integrated models can be applied to planning experiments in open-air or enclosed platform sites. Conversely, the statistical uncertainties highlighted in modelling exercises may guide experimental schemes. Data inferred from experiments and assimilated into process models will provide a more reliable basis for policy decisions. AnaEE will present users – whether well trained modelers or not – with a one-stop shop for information on and access to a wide range of ecosystems models (through AnaEE modelling platforms) as well as tools to develop new ones (through AnaEE model factory platforms).

AnaEE will also provide users with guidance as the choice of the best models to interpret their results within the more general context of their research project. Models delivered by the AnaEE Data and Modelling Centre will be in form of components, accessible through a well-defined interface to enable the sharing of capabilities between project and codes. Also, discrete model units will be made available via a declarative representation in the frame of the AMEI - Agricultural Models Exchange Initiative, making possible the import and dimperative implementations in different software frameworks for modelling (running examples made already on BioMa, RECORD, APSIM, DSSAT)

The modelling centre, one of the original features of AnaEE, will be also key for the integration and interpretation of data into models from several RIs.

The DMC will create and enable a suitable environment for scientific data to be Findable, Accessible, Interoperable and Reusable (i.e. being 'FAIR'). Core activities of the DMC include:

- **The preparation and maintenance of the AnaEE Data Management Plan**. The Centre will provide national platforms with guidelines and operational tools (thesaurus, ontologies, etc.) to implement metadata and data standardization. Data management plans will be developed for new projects and platforms.
- **Data quality improvement and data analysis**. Data quality will be improved by analyses over larger datasets through National Platforms synergies or by comparing model predictions with new data. The DMC will develop visualization, statistical and data analysis tools and act as a resource centre for data analysis toolkits. Software products developed by the DMC will be made freely accessible. Code will be available in open repositories (e.g. Github) and technical documents will be made freely available. Quality control modules will be extensible for rules.
- **The organisation of training sessions.** The DMC will prepare the users and platform operators to use, and produce data complying to the FAIR principle. Workshops will be organized on a regular basis to exchange experience and gather new ideas in the use of AnaEE data.
- **Ensuring visibility and access to AnaEE data**. A key objective is the full interoperability of experimental datasets collected on AnaEE platforms. Access to data will consequently be centralized and benefit from a user-friendly, single querying tool in the data portal hosted on the master AnaEE portal. Workflows for data publication and mining of DOIs will be created. The model for data will be open access, with a policy to determine the period and conditions for private use of the data by the users at the origin of the proposed experiment (typically 1 year).
- **Facilitating access to a range of modelling solutions and to model factories**. Models are needed to develop and test our understanding of the complex quantitative relationships between processes within ecosystems, as well as their behaviour under various pressures and to generalize from specific ecosystem studies and to upscale results to the scale of interest. The DMC will facilitate access to two types of national AnaEE Modelling Platforms including Modelling Solution Platforms (around a well-established and supported model), and

Model Factory Platforms (an advanced facility offering access to models, model development tools and integrated simulation facilities to its users). The DMC will grant access to recognized process-oriented and other models corresponding to key aspects of ecosystems complexities. Model factories will provide tools to enable the composition of new models through user-friendly linking model components. DMC will provide support for the use of a modelling framework of reference for those who want to start development of model components without previous experience with model development environments.

- **Improving model interoperability and use**. The DMC will define and implement a range of software interface standards (Application Programming Interfaces) to facilitate the interoperation of individual models and across components within modelling factories when there is binaries compatibility, and it will make available declarative representations for model automatized re-implementation in different platforms, interacting with model factories owners.
- **Facilitating the use of models by non-model developers** by ensuring that quality tutorials are available for running the available models, and organizing training workshops on resorting to models to conceive an experiment or interpret experimental datasets;
- **Feeding the Data and Modelling section of the AnaEE portal**. The DMC will particularly address the issue of linking data with modelling solutions using different modelling platforms. Platforms have different architectures and will require specific realisations to access data and to keep the information provided *via* metadata to properly structure output data persistence. The DMC will thus set up demonstration cases to show ways of using modelling to enhance interpretation, upscaling, design of experimental treatments and measurements, etc., as well as the use of measurements and findings to improve models. Cases will be developed in consultation with national nodes and AnaEE advisory bodies, with the aim to encompass a range of systems, questions and challenges suitable for approaching through the integration of modelling with experimental activities. Each case study will be addressed using at least two modelling platforms. Examples currently foreseen are:
    - Modelling environmental gradients *via* multi-site experiments.
    - Linking remotely sensed data to model resources.

2.2.4. The Interface and Synthesis Centre: coordinating scientific roadmaps in the field of ecosystems and advising policy makers

Because it regroups a large community of users throughout Europe around shared methodological approaches, AnaEE is in a perfect position to play two related roles:

- it can act as a place where scientists meet and discuss about further infrastructure and equipment development for a better, more coherent use of resources
- it can be a reference point for policy makers to get public policy advice based on state-of-the-art research.

Organising both objectives will be the role of the Interface and Synthesis Centre (ISC), hosted by CzechGlobe (Global Change Research Institute of the Czech Academy of Science) in Brno, Czech Republic.

The ISC will be responsible for the overall integration of the results obtained through the AnaEE RI. On one hand, the ISC will be accompanying the scientific community to promote their projects results and support them to strengthen their proposals and get fundings. On the other hand, the ISC will be responsible for the training of stakeholders and general public outreach. It will be also responsible

for the training and outreach. A dedicated section of the AnaEE's portal will publish information on relevant events, publications, workshops and provide access to outreach material.

Core activities of ISC will be:

- Organising scientific prospective studies and lobbying for research programs

Major gaps in ecosystem sciences and mobilization of AnaEE platforms will be identified by leading scientists and representatives of international expert panels, such as the IPCC and IPBES. This information will be transferred to research funding agencies by the AnaEE DG together with the head of the Interface and Synthesis Centre, with the assistance of leading scientists. The ISC will actively follow up news on emerging societal needs as identified by international bodies.

- Organising worldwide ecosystem science syntheses

AnaEE will organise data/knowledge syntheses on specific ecosystem science aspects incorporating AnaEE generated and worldwide published data. One of the first topics to be considered will involve the combined impacts of heat and drought on terrestrial ecosystems. Synthesis and opinion papers on behalf of AnaEE will be prepared.

- Setting-up project building capacity for the scientific community

A European project engineer will assist academic consortia in preparing proposals. In particular, the ISC will perform a meta-analysis of the state-of-the-art in ecosystem experimental methodologies, and of the services the experimental and analytical platforms provide for users, in order to determine the status of current scientific and technical capabilities. This will be used by AnaEE to help scientists to prepare large-scale projects combining a range of national platforms.

- Outreach, capacity building and stakeholder engagement

AnaEE's output are not only expert reports, but also maps and graphical portals that are easily understandable. In addition to the scientific papers published by the platforms users, and to the delivery of the scientific and technological data from the other Centres, AnaEE will prepare material to support the needs of various stakeholders, such as policy makers, education professionals and citizens.

One of the main instruments to improve general awareness is stakeholder conferences and training workshops. Experience has shown that direct involvement of actors in moderated discussion and co-creation process is an important initiation step leading to further dissemination of knowledge and motivates concrete actions from the public, agricultural sector & industry and policy makers. Moderated discussion is all the more profitable that it is preceded by a proper understanding of problems and possible solutions in the form of short and condensed lectures by AnaEE experts explaining a particular problem.

In terms of capacity building, an important part of AnaEE's effort targets professionals in the fields of agriculture, forestry, water management, food production, remote sensing services, plant and animal breeding, production of instruments, sensors and technology for these sectors - namely people working with ecosystems on a daily basis. Activities are largely based on demonstration and pilot projects and events such as field days, pilot farms, technology demonstrations, technical workshops that will enable rapid transfer of knowledge into practice, in particular in the field of adaptation measures and technologies, through practical involvement and testing.

Another target of outreach activities is the general public, mainly by NGOs, associations and policy representatives. It is of the utmost importance that the general public better understands ecosystems basics, as well as interrelated issues such as biodiversity, nutrient cycles, soil and water quality, which are key factors in food production and environmental health. Wider familiarity of the public with such concepts will increase the social support towards the implementation of the scientific knowledge generated by AnaEE into policy design and decision processes. The main objective of education in this area is to achieve greater public engagement and better understanding of activities

on enhancing, in particular, non-productive functions of ecosystems. Education for this group will focus on the creation of a web-based educational platform that will demonstrate in a user-friendly way the role of ecosystems in the carbon cycle, nutrient cycling and the importance of individual ecosystem services such as biodiversity, provision of drinking water and others. It will be also a tool to demonstrate the potential of human interventions and activities to mitigate the impacts of climate change on ecosystems, support their adaptation, achieve enhanced ecosystem services and increase the contribution to climate change mitigation.
This process of dissemination is already well-engaged among some of the platforms, e.g. the Ecotron at Hasselt University which already welcomed around 10 000 people in 2019, and proposes didactic online resources for a wide range of public[v].

- Elaborating societal scenarios and innovation needs beyond AnaEE results

Scenario building requires workshops to be organized with policy-makers, relevant professionals and industries. These would be held every 3-4 years or whenever results of major societal significance are made available. Opinion/recommendation papers could be outputs of these meetings. Emerging innovative ideas will be shared with the Technology Centre in case new equipment or methodologies could be developed in partnership with industry.

- Recommendations and synthesis papers for policy makers and regulators

The ISC will address demand from society, economy and policy makers. At the request of relevant stakeholders, AnaEE ISC will contribute to the development of recommendations and perspectives associated with potential solutions to critical scientific and societal issues addressed in its platforms. These include in particular predicting the impacts of climate change on ecosystems, their productive and non-productive functions and ensuring food security. AnaEE will thus provide key information for the design of National Climate Adaptation plans. Several of its members already participate directly in their elaboration and in the development of basic principles, specific measures, support mechanisms and control tools in the implementation of Common agricultural policy on national level.

An example represents the activities in the implementation of Climate Smart Agriculture principles for central and eastern European countries, leaded by CzechGlobe, where several NGOs (e.g. Nadace Partnerství, Ekovín), policy makers, industry representatives were deeply involved in the process of prioritizing challenges and identification the major leverages for speeding up the process of change towards sustainable agriculture, resilient to climate change and providing key ecosystem services including safe food supply.

2.3. Training and education for early-stage scientists

In articulation with universities and other academic partners, AnaEE will develop education and training activities to ensure that students at different levels of education are aware of the production and non-production functions and services provided by ecosystems, with particular respect to their roles in global carbon cycle, climate change mitigation and adaptation. Educational activities will be predominantly planned as proactive, i.e. in practical form with direct involvement of students in the identification of challenges and specific solutions using the principles of active learning and continuous evolution. This approach will ensure systematic and holistic attitude of future experts to ecosystems and their role for sustainable development, which, only in conjunction with the scientific community, will provide effective leverages to mitigate climate change, adaptation and reduction of impacts on key ecosystem functions and services, food security and sustainable development of

[v] See for instance https://www.youtube.com/watch?v=EsCt_xWbV5o&feature=emb_title

society. The next generation of scientists are often lacking “systems thinking” that facilitate landscape level change. The form of teaching will therefore be aimed at clearly demonstrating the functions of ecosystems that are difficult to understand and observe, but which play an essential role for human existence, its sustainable development and for reduction the negative impacts of human activities.

The main targeted group for educational activities of AnaEE is the students engaged in a master or in a PhD, and early-stage researchers. Our training activities will be focused on intensive engagement of students in ecological research, especially on the impacts of climate change on ecosystems, possible adaptations, understanding the role of ecosystems in global biogeochemical cycles and increasing the contribution of ecosystems to mitigate climate change. AnaEE will support specialized higher education and training activities to attract promising young researchers and promote sustained interactions between academics and future economic leaders, smart companies or emerging agro- and eco-friendly businesses and green entrepreneurship. The AnaEE's higher education program will consist of yearly open winter and summer schools for graduate students, early career researchers and professionals across Europe.

These schools will provide practical opportunities to work on their own small research projects, from the definition of hypothesis, methodology to the practical performance of measurements and analysis of results. These schools will teach research and research technology, analytical techniques, data management and models made available by AnaEE thematic centres and platforms, with a specific focus on fieldwork during the summer school and analytical or data management during the winter school. The winter or summer schools will be preceded by popular lectures especially for MSc. students focusing on introduction to experimental ecosystem research, its objectives and benefits for the wider society, including the presentation of the services offered by the AnaEE infrastructure for the implementation of Ph.D. projects and for the solutions of student’s research questions. The aim will be to organize a maximum of winter and summer schools directly on AnaEE infrastructure and ideally also to interconnect different types of platforms included within AnaEE - open air and enclosed experimental facilities, analysers, sensors, instruments, analytical platforms, models. Bearing in mind interdisciplinarity is the most pressing challenge for higher education in ecology and environmental sciences today, summer-winter schools will promote practical learning modules and refer to all environmental, life and earth sciences involved in AnaEE.

AnaEE, in cooperation with experts in didactics, will be involved in creating and publishing motivational teaching materials for elementary and secondary school students that will also actively involve the student in protecting endangered ecosystems and supporting their functions, and will be active in organizing popularization lectures. AnaEE will also actively support and participate in the production of educational documentary films and popularization articles.

2.4. Outreach towards the agricultural sector and industry

AnaEE will pursue both demand-driven innovation (by identifying solutions to specific technical needs) and a supply-push dissemination of innovation (by identifying users for innovation generated internally or externally).

The demand driven innovation will be initiated at the technology foresight workshops mentioned above where the most promising direction for innovative instruments will be determined. Active scouting will be performed to identify components that may fill an empty space in AnaEE technological capacities. The development of new instruments will be done either in national platforms or in partner labs where the technology is mastered and/or jointly with private companies. The technology centre will implement the needed technological developments by establishing

contacts between relevant scientists, laboratories and industries, also in other markets and applications.

Understanding the sensitive interdependencies between ecosystem services and the changing environment is necessary for Europe to develop a sustainable, green economy centred on bio-based products and eco-technologies. AnaEE will encourage industrial collaboration to develop solutions to the challenges of food security and environmental sustainability, with the aim of stimulating the growth of a vibrant bioeconomy. It will act as a "testbed", a "market place", and liaison between scientific needs and the needs from the agricultural sector or industry partners.

AnaEE Industry Policy is entrusted with a double mission: contributing to better research on ecosystems while, at the same time, generating societal benefits such as employment and growth. The value of AnaEE to agricultural sector & industry is the feedback from a large number of state-of-the-art platforms to identify needs and solutions that may lead to innovation. Open access to data from AnaEE will provide further opportunities for industry to reuse data and make innovative analyses. AnaEE will also offer a gate for the industry to touch a wider user's community. Overall, the goals are:

- Improved networking between science, policy makers and industries, sharing knowledge of impacts and dependencies of economic activities on ecosystem services
- Technology transfer resulting in the growth of innovative companies at both regional and international level.
- Test bed for new sensors and methodologies and personnel specialized training

AnaEE will thus provide a European-wide testbed for external innovations. AnaEE platforms already have industrial users (Figure 13), but a core aim of AnaEE is to increase the interaction with AnaEE.

Lastly, an added-value of AnaEE is to combine a pan-European scope with a capacity to specifically address the needs of each territory: beyond its inscription in the network, each of the platform appears as a direct solution provider to the needs of local actors in terms of environmental research and solutions, thus allowing AnaEE to guarantee the continuity between research and concrete problematics of each territory it is distributed upon.

AnaEE will therefore provide conditions to elaborate best practices with users, in a living lab model.

AnaEE open air platforms hold a number of approaches and supporting activities to sustainable agriculture. These include: agroecology, nature-inclusive agriculture, biodynamic agriculture, organic farming, conservation agriculture, climate-smart agriculture, low external input agriculture, circular agriculture, ecological and sustainable intensifications. The main supporting activities examined are integrated farming tools, precision farming, landscape and ecosystems approaches. These approaches and activities are important to cope with food vulnerability manifested by COVID-19[vi] or by pandemic events in general. Currently, the COVID-19 crisis is forcing research to look at short-term solutions, but in the same time, the pandemic opens the opportunity to push forward with long term transformational change[vii] which are possible through developing agriculture functional to building ecosystem quality. In this regard, AnaEE develops and provides innovative solutions to global pressures such as land change (particularly agricultural expansion), direct exploitation of wild species, climate change, invasive alien species and pollution resulted from a long term system experiments. These system oriented innovations support radical transformation of production

[vi] IPES-Food, 2020, COVID-19 and the Crisis in Food Systems, Brussels: International Panel of Experts on Sustainable Food systems. http://www.ipes-food.org/pages/covid19

[vii] McElwee, P., Turnout, E., Chiroleu-Assouline, M., Clapp, J., Isenhour, C., Jackson, T., ... & Waldron, A. (2020). Ensuring a Post-COVID Economic Agenda Tackles Global Biodiversity Loss. One Earth.

methods and make the best use of technologies as well as digital and space based solution to accelerate the transition into new ecosystem driven agricultural and food systems. Additionally, AnaEE gives support to find a common vision for what sustainable agriculture should look like in the future. AnaEE treats crisis as an opportunity to reset the global economy, reversing decadence of biodiversity and ecosystem losses. AnaEE's priority domains to support the transition of agricultural ecosystems into more sustainable systems as well as emerging case studies are reported in the following session 3.1.

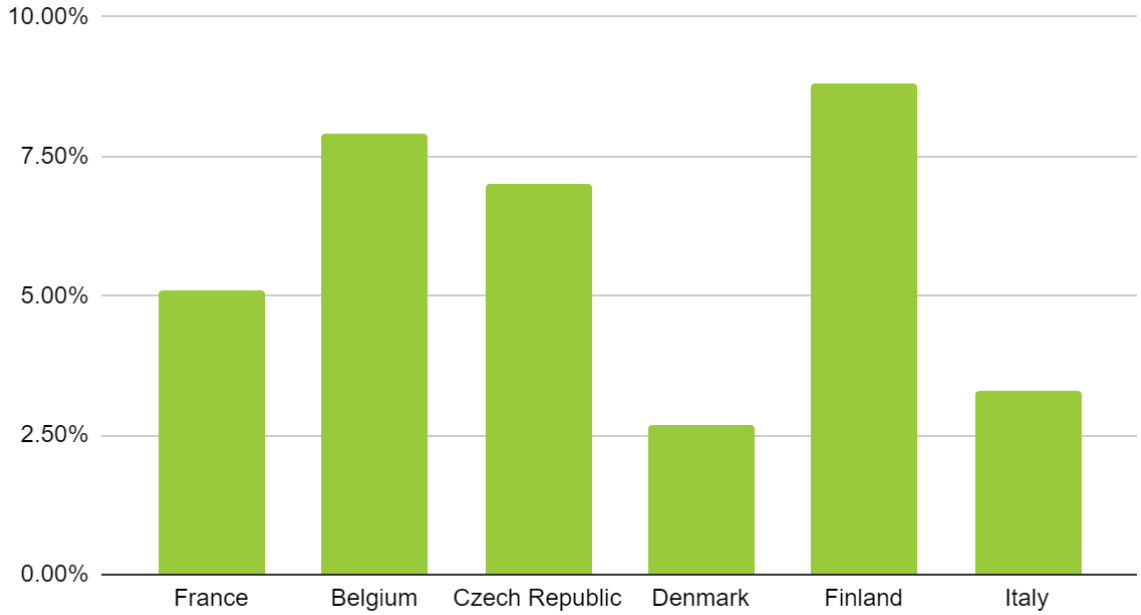


Figure 13. Percentage of projects from industry (including agricultural sector) across platforms. Data from a survey among platforms updated in 2019

The examples below show a few examples of industrial collaborations. Currently, these examples are mostly national, but the aim of AnaEE is to scale them up at an international level. This will be achievable once the network is completely operational, and this is something we already listed as a Key Performance Indicator.

Examples of collaborations

AnaEE platforms in the Czech Republic were used in collaboration with the Czech company GISAT s.r.o. for the development, testing and validation of remote sensing methods on estimating the impact of climatic conditions (mainly drought and heat stress) and nitrogen availability on crops biophysical parameters (chlorophyll content, nitrogen status, leaf area index, above-ground biomass, grain yield, protein content in grain). Developed approaches are based on new spectral reflectance indices, radiation transfer model and machine learning methods. The products are currently used by both agriculture and by the government to increase the use of precision farming technologies, reduce the impact of climate change on agricultural production and reduce the risk of environmental pollution by nitrogen leaching and pesticide residues.

AnaEE experimental as well as analytical platforms in the Czech Republic (Flying laboratory of imaging spectroscopy) were used in collaboration with the Czech company Gryf HB spol. s.r.o. to develop a new type of active on-line spectro-radiometric sensor based on red-edge wavelengths for simultaneous estimation of biomass and nitrogen status. This sensor is independent of the

changing incident solar radiation as it uses a modulated LED light. The prototypes were successfully tested and the commercial production of sensors is ready.
The long-term agricultural experimental AnaEE platforms in the Czech Republic served as testbed for the development of new technologies of Biochar activation and carbon sequestration by biochar application with the Czech biochar industry (company AIVOTEC s.r.o). The technology of biochar composting is currently the most promising method of biochar activation, which provides benefits for growers and mitigation of climate change (carbon storage in soil).
In Denmark, the Brandbjerg experimental platform was used for development and testing of a novel technology, i.e. an automated chamber for both light and dark measurements of greenhouse gas exchange between the ecosystem and the atmosphere. The first prototype came out of the EU-infrastructure project INCREASE, but it was further developed and commercialized by two companies, of which one was a direct spinoff (Larsen Environmental ApS). It is now available through the Danish company DMR+Prenart Equipment (www.prenart.dk/eco2-flux/) and AnaEE Denmark has facilitated its usage now also at two agricultural Danish AnaEE platforms.`
In Finland, the Suonenjoki experimental platform (research nursery) was used to develop and test novel technologies in container seedling production. These developed technologies are now used in Finnish commercial nurseries. The developed technologies included the use of different wavelengths of light in controlling the growth of seedlings and the treatment of seedlings after cold storage in preparing for planting.
In France the SME Cesbron company, which manufactures cold chambers and chillers for the food industry, was engaged in the prototyping and construction of the new climate chambers at the Ecotron Ile de France. Thanks to the expertise gained (four EU patents were registered) and the skills developed, it supplies the horticulture sector with growth chambers.
Lumartix, a company specialized in test benches for the qualification of photovoltaic cells or light appliances for the cinema and events industry, has developed in collaboration with AnaEE-France light appliances for the horticulture sector that can resist in tropical atmospheres, opening a significant market for this company.

3. Priorities and first steps

3.1. First scientific priorities of AnaEE in the pan-European context

Based on (i) the societal needs as expressed in the Horizon Europe priorities, the EU Green Deal initiative, and the United Nations Sustainable Development Goals, (ii) the specific knowledge gaps listed in section 1.3, and (iii) the capabilities of the infrastructure, AnaEE has identified three priority domains to actively support during its startup operational phase:

- Plant health and ecosystem functioning
- Greenhouse gas emissions in ecosystems, especially in agriculture
- Ecosystem carbon storage

These domains are not exclusive, but indicate where AnaEE could achieve rapid progress with large societal and economic impacts. The aim of the identified priority domains is thus to maximize the effective use of the infrastructure, by mobilizing users.

Two case study project proposals have been identified, REDFOOT and H4PLANT, both consider agricultural ecosystems and described in the text boxes below. REDFOOT focuses on environmental

and climate foodprints of crops in agricultural ecosystems while H4PLANT focuses on a system approach for effective management of pests and harmful alien species in agricultural and forestry ecosystems in Europe.

Case study REDFOOT – Coordinated European research project REDFOOT – Reduced environmental and climate footprint of European agricultural crop production

Aim: quantifying the potential of promising agricultural practices (improved fertilization methodologies, water management, and microbiological-targeted amendments) on crops to improve or maintain ecosystem services delivery (C sequestration, reduction of GHG emissions, maintaining water quality, high quality food production), in EU, and under future climate.
For this, plant productivity, soil C cycle, GHG emissions, and microbial communities need to be monitored and mapped across a wide range of sites differing in crops, soils, and climatic zones in EU. In each site, a number of locally relevant treatments should be tested (amendments, precision farming, post-harvest strategies…), in combination with climate manipulation. This requires a wide and coordinated effort in experimental setup, analyses, interpretation and reporting.

Direct added value of AnaEE to this project: The online web platform catalogue provides an overview of platform services and existing data, facilitating the process of finding the most suitable platforms. Standardized AnaEE procedures facilitate project budgeting. The AnaEE project review committee provides expert feedback and suggestions for potential improvements of the project proposal to maximize novelty and efficient overall usage of platform services and expertise. The AnaEE DMC ensures that data standards are already in place at platforms, and provides standard schemes for their development (for new variables within the project) and oversees the data management plan and data reporting from platforms. The AnaEE ISC facilitates project synthesis work as results come in from platforms and expertise from the AnaEE TC facilitates potential commercialization of new technologies/methodologies developed within the project.

Case study H4PLANT - Coordinated European Research Project H4Plant, Healthy agro-ecosystems for healthy plants

Aim: Year 2020 and 2021 are the international years of Plant Protection. Healthy agro-ecosystems for healthy plants (H4Plant) focus on a system approach for effective management of pests and harmful alien species. The aim of the case study is to ensure a European food security system, which is well balanced with a sustainable agro-ecological transition and ecosystems services while developing practical solutions to predict, prevent and protect agricultural and forestry ecosystems from native and alien pests (introduced in EU Member States) through integrated agro-ecological approach to plant health.

Direct added value of AnaEE to this project: The agro-ecological approach will combine different management strategies and practices into an innovative analytical and surveillance system involving different disciplines, multi-data, multi-functions and multi-actors. Models, which integrate different types of techniques and data, will be developed for the analysis, surveillance, detection and control of invasive harmful pathogens and pests which may threaten the European ecosystems. AnaEE RIs, from open air trials to controlled experiments in ecotron, are used for a better understanding of plant sensitivity to pest attacks and agricultural and forestry ecosystems to alien species arrivals, with the aim of providing models and adapted management solutions for

relevant policies, farmers and environmental / forestry agencies. For example, a specific attention will be given to the Downy oak forest (*Quercus pubescens* Willd.) at the O3HP AnaEE research platform in southern France and its sensitivity to pathogens in a climate change context, with a field sampling in natural and enhanced drought plots coupled to controlled mesocosm experiment in Ecotron. Finally, this case study will also support understanding of relevant epidemic situations or risk in the EU neighbours through the engagement of researchers and RIs of the CIHEAM network of non-EU Mediterranean countries.

3.2. Immediate next steps and further development of AnaEE

As indicated in our specific Work Programme 2020-2022 provided in Appendix 8, 14 Work Packages are distributed into 4 main areas of work that represent the key priorities for a starting RI, covering the end of 2020 and the full year 2021. Several of these tasks are related to the starting phase of the ERIC, while some others are likely to continue in the following years

are likely to continue in the following years

- Work Area 1: Building a sustainable ERIC
  - WP1.1 ERIC implementation procedures
  - WP1.2 Strategy
  - WP1.3 Building sustainable relationship between the ERIC and the Platform network
  - WP1.4 Quality & Monitoring
  - WP1.5 Core IT
- Work Area 2: Towards an operational RI
  - WP2.1 Data Management & Access
  - WP2.2 Modelling
  - WP2.3 Technological developments
  - WP2.4 Platform Access & TNA
- Work Area 3: Building the user and stakeholder communities
  - WP3.1 Technical Training
  - WP3.2 Communication & Outreach
  - WP3.4 Innovation, Industry, Agriculture
- Work Area 4: AnaEE in the international research ecosystem
  - WP4.1 Capacity Building
  - WP4.2 International Cooperation

We provide here an overview of the efforts that are being deployed to: engage users and staff through training (section 3.2.1), engage and enlarge the scientific community of users (section 3.2.2.) and extend the geographical coverage of the infrastructure (section 3.2.3).

3.2.1. Engaging users and staff through training

To ensure the possibility to launch quickly multiplatform experiments studying climate change impacts across geographical, climatic and soil gradients, it is crucial to ensure a fast process of standardization, the implementation of new technologies for the measurement of ecosystem processes and also the extension of the use of new experimental designs based on gradient (regression) type of experiments.

To this end, technical workshops, demonstrations and practical training events will be organized for small groups of platform managers, technicians, users and early stage researchers. Experimental design, measurements of ecosystem processes and technological equipment will be harmonised. To support this training process, technical notes, handbooks and methodological papers will be published to provide users and platform managers with step-by-step support to install and operate the most recent technical equipment.

Specific attention will be paid to the training of users on combining the models and experiments, as well as on the use of new multifactorial statistical tools that will provide a significant shift in the interpretation of large datasets obtained from join multiplatform experiments. The target audience for such training will be platform managers, PhD students and early-career researchers.

Finally, training will also be conducted on the use of the latest analytical approaches in the field of remote sensing, mobile laboratories for the analysis of biogenic volatile compounds, metabolomic, transcriptomic and genomic analyses. The main goal is to present users with the opportunities provided by these analytical approaches to understand the ecosystem processes or for upscaling of data obtained in experiments. The targeted audience will be similar as in the case of modelling and data processing training.

3.2.2. Engaging and enlarging the scientific community of users

AnaEE can build upon the solid user base from the existing platforms.

A survey was conducted in 2019 across 52 platforms meeting the ERIC AnaEE criteria in France, Finland, Denmark, Czech Republic, Belgium and Italy. For open-air platforms, an average of 240 projects run each year, representing more than 1500 users in total. For enclosed platforms, an average of 107 projects regroup more than 300 users in total (Figure 14). On average, and with little variation across countries, 26% of all projects are international. The user community spans many fields of biology and geosciences, including ecology, microbiology, micrometeorology, or biochemistry.

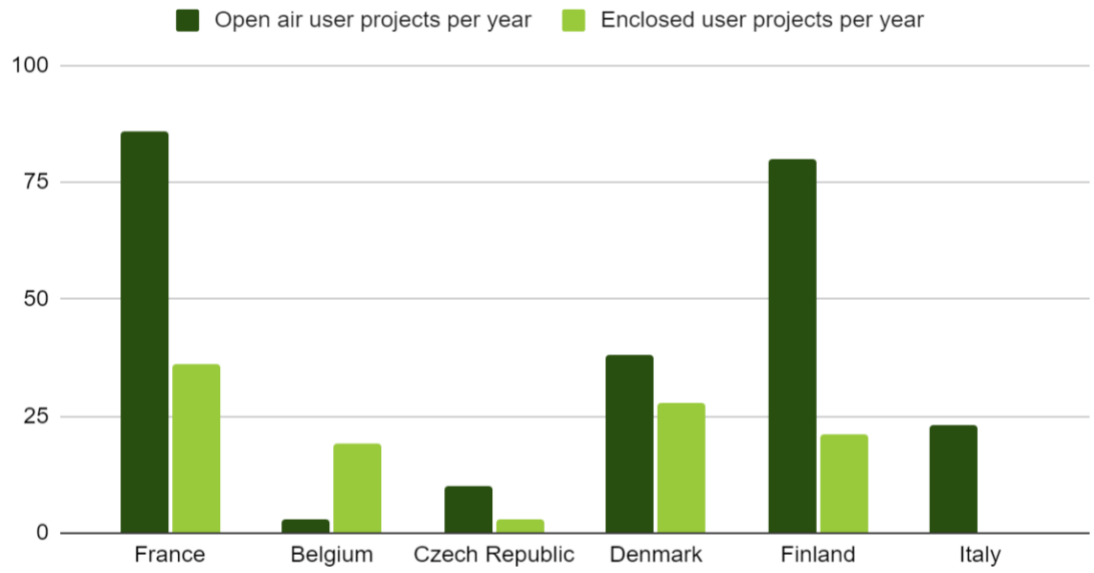


Figure 14. Number of open air or enclosed user projects per year. Source: 2019 platforms survey

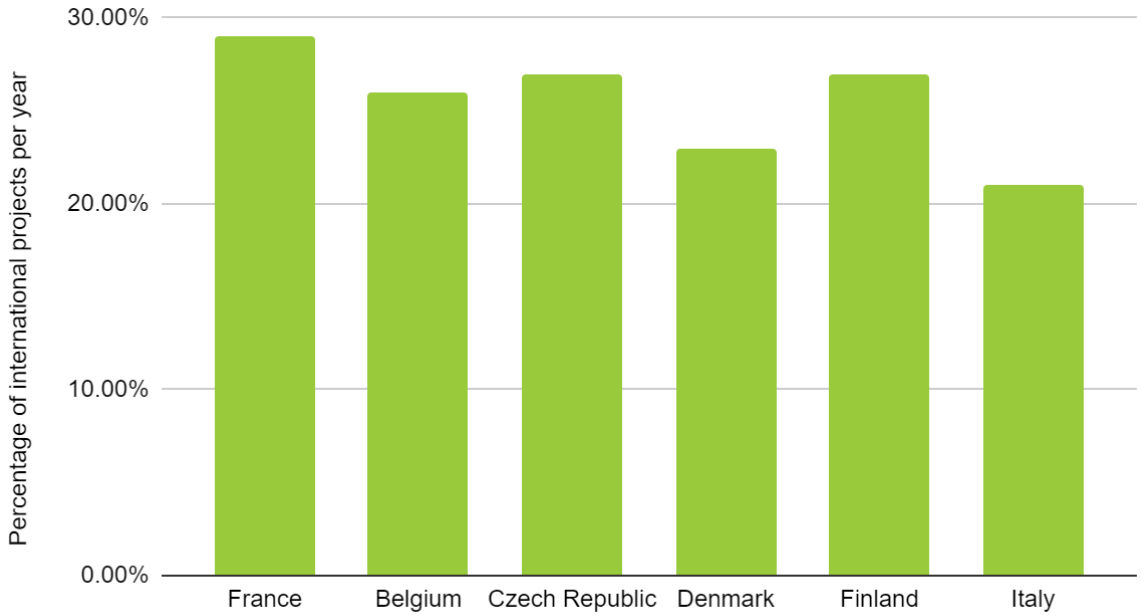


Figure 15. Percentage of international projects. Source: 2019 platforms survey

A major aim of AnaEE is to allow for a significant increase in international projects spanning climatic gradients and ecosystem types in Europe.

Figure 15 shows that there are already international collaborations. However, at the moment, international users tend to make a stand-alone use of platforms: AnaEE will increase not only the number but also the scale of trans-national projects, moving from single-platform to multi-platform international projects.

Such large-scale projects will be a major achievement and added value of AnaEE, made possible thanks to the support provided to scientists to develop multi-platform international project proposals. AnaEE will thus act as a facilitator and will make it easy for scientists to find the right platform, check for availability, assess cost and find relevant partners.

Examples of projects facilitated by AnaEE include the already planned pilot study *The Phytometer project*, where standardized pots with three different plant species planted in either local or standardized soil are grown inside the treatment plots across open air AnaEE platforms in Europe to help disentangle the large-scale climate effects from local-scale variability in e.g. soil type and plant communities.

In general, the national and international user base will grow as the services to the community develop:

- Access to a portfolio of services, either from the AnaEE-ERIC structure or the distributed platforms. AnaEE represents already state-of-the-art experimental infrastructure, representing a wide variety of climate and ecosystem types, with several pressures, either enclosed or open-air.
- Single entry-point. AnaEE portal will centralize all user information, access procedure, and will be a link to the data.
- Support for users to build their proposal. The procedure to access AnaEE' services ensures that a dialog between the user, the centres, the platform representatives, and independent experts helps to optimize the science output of the proposal, the selection of the adequate platforms, the synergies with different programs run at AnaEE.

- Coordination of multiple platforms, to ensure that they keep at the best level of facilities, the comparison of the data acquired on different platforms, the accommodation of complex proposals over several platforms (either geographic and type).
- Use of mobile technologies (large, or costly, instrumentation) across multiple platforms to make more efficient use of investments in equipment and gain more data across larger climatic scales with the same equipment.
- Common procurement that will help negotiate prices to acquire the best available instrumentation and associated parts, and will be a tool to reach standardization of equipment across platforms.
- Capabilities of the AnaEE' Technology Centre, Data and Modelling Centre, Interface and Synthesis Centre.

3.2.3. Extending the geographic coverage

During the first years of AnaEE's operational life, it will be paramount to enlarge the geographic coverage of AnaEE. This is not only a means to acquire more resources and improve sustainability, but also to enlarge our community of users, provide new services and more generally improve the relevance of the studies performed on the platforms, because of:

- an improved representation along the European climate gradient with open-air facilities in the different climate zones (sub-Arctic, Humid Oceanic, Humid Continental and Mediterranean, including semi-arid);
- a greater number of enclosed facilities, especially large Ecotrons, simulating a larger parameter-space of environmental pressures;
- a larger set of management methods and ecosystem types available for testing in both open-air and enclosed facilities;
- a wider array of measurement possibilities and analytical facilities;
- a larger community of modellers, theorists, and numerical scientists working on the data from AnaEE with modelling factories.

When approaching countries to broaden the geographic coverage, each country is a specific case, but some patterns are clear (see also section 4.1.2 below).

For countries that have an established community with large, up-to-date, facilities (e.g. Germany, Estonia), we need to cope with the lack of awareness and networking inside the country, in order to facilitate the crucial step of approaching the institutional authorities. In such cases, we propose a visit of the Management Board for a one- to two-day scientific workshop, and, whenever needed, a contact with the appropriate administrative authorities. This approach has been started with Germany, Lithuania, and Estonia.

For other countries, the main obstacle to direct integration to AnaEE lies in the size of the community or the level of the equipment. This is the case in particular with Mediterranean Countries (with of course notable exceptions). In such cases, AnaEE will also develop a capacity-building approach, aiming at helping the country to enlarge its community of users and experimental scientists in ecology, and to find the means to upgrade existing facilities or new ones. From this perspective, the collaboration with CIHEAM (cf. 1.3) can prove extremely powerful, notably on both sides of the Mediterranean territory.

Quite evidently this is just a sketchy picture, as some countries may present a mixed template. It is also quite possible that external circumstances (e.g. the political situation, or financial considerations) prevent the membership of a country.

The annual Functional Ecology Conference, as well as more specialized workshops and training, or doctoral/postdoctoral schools are also part of this strategy.

4. Organization and governance

4.1. The legal entity

AnaEE-ERIC will be a European Research Infrastructure Consortium (ERIC). This will facilitate the coordination with all facilities distributed in the member countries. AnaEE-ERIC will also adopt procurement procedures that conform to the European rule. This will ease the dissemination of standard, state-of-the-art instrumentation, lowering the prices for all facilities, while AnaEE-ERIC will stay the sole owner of the hardware that it buys.

The other advantage of the ERIC status is that it facilitates the participation of the infrastructure to European calls, as well as other national, regional or international calls. AnaEE can indeed represent the overall facilities on common proposals of generic importance. A good example of it is the participation of AnaEE to the INFRAIA-2-2020 call on starting communities together with CIHEAM. While we currently need all the signatures of the different institutes resulting in a large administrative load, the participation of AnaEE to this call would have been much simpler with the ERIC statute.

The headquarters of the legal entity are in France, on the premises of the CNRS Campus in Gif-sur-Yvette, near Paris.

4.1.1. Founding members

The founding members of the ERIC are:

- France (host country)
  - Centre National de la Recherche Scientifique (CNRS)
  - École Normale Supérieure de Paris (ENS), Paris Sciences Lettres University
  - University Grenoble Alpes (UGA)
  - University of Rennes (UR)
  - Centre de Coopération Internationale pour la Recherche Agronomique en Développement (CIRAD)
- Czech Republic
  - Global Change Research Institute of the Czech Academy of Sciences (CzechGlobe),
- Denmark
  - University of Copenhagen (UCPH)
  - Aarhus University (AU)
  - Technical University of Denmark (DTU)
  - Roskilde University (RU)
- Finland
  - Natural Resources Institute Finland (LUKE)
  - University of Helsinki (UH)
  - The University of Turku (UTU)
  - The University of Oulu (UO)
- Italy
  - Consiglio per la Ricerca in Agricoltura e l'Analisi dell'Economia Agraria (CREA)
  - Consiglio Nazionale delle Ricerche (CNR)
- The International Centre for Advanced Mediterranean Agronomic Studies (CIHEAM-IAMB, Intergovernmental organization)
- Belgium has requested the statute of Observer, which it has been granted for two years. At the time of writing this document, a proposal was submitted to the Belgian authorities to become a full member (answer expected by beginning of 2021). The partner institutes in Belgium are:

- The University of Antwerp
- The University of Hasselt
- The University of Liège (Gembloux)

4.1.2. Other prospective members

As explained in section 3.2, we actively seek to enlarge our community of users and members. In addition to the specific case of Belgium described above, we have approached several other countries, and we hope that they will apply for membership in the short to mid-term.

- Sweden: this country has an impressive set of facilities and it is well structured through the SITES consortium. Discussions for membership have started, after a visit in October 2019.
- Portugal: this country has a high level of expertise, though the community is small. We have started discussion with them. The visit, initially delayed because of the pandemics, is being planned.
- Spain: discussions have taken place but the community lacks a common structuration. Some Spanish institutes have participated in the EUPHORISC INFRAIA proposal that is led by CIHEAM with a strong support of AnaEE, and we plan to resume discussions ASAP with a specific concern for creating the conditions for a common approach.
- Israel: there was strong support from the academic community in Israel for AnaEE, and an engagement, but the political situation has prevented this country from taking any commitment. We hope that the situation will clarify in the coming years.
- Lithuania and Estonia: both countries have added AnaEE on their national RI roadmap. Unfortunately, the funds are not available yet. Visits were planned, but cancelled because of the current pandemics. We think that both countries may become members of AnaEE during the first years of the operational phase.
- Germany: positive contacts have been taken with partners in Germany, which has a strong tradition in experimental ecology. We plan a visit ASAP. German institutions are also partnering the above mentioned EUPHORISC proposal.
- Bulgaria: contacts have intensified over the Summer, leading to Bulgaria formally signifying its interest to the Assembly of Members in November 2020.

4.2. Organization

4.2.1. Organization principles

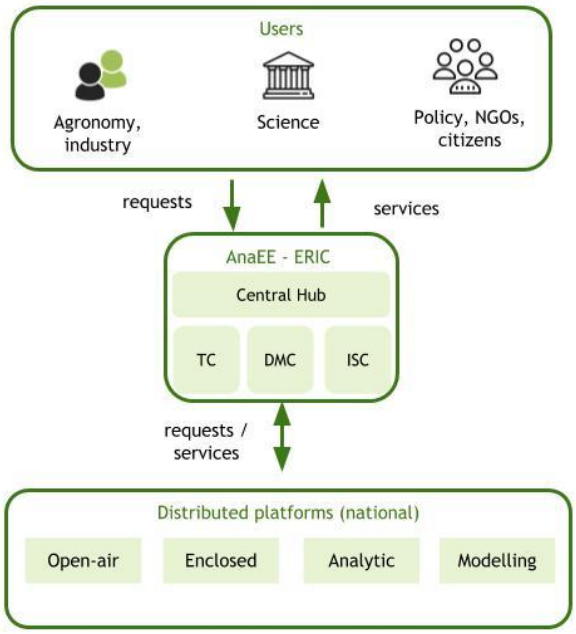


Figure 16. The organization of AnaEE. The ERIC will be the interface with the users, with an integrated offer of services, and receiving requests.

The ERIC will be of the *distributed* type (Figure 16). The legal structure will consist of the Central Hub (CH), in charge of the overall coordination of the ERIC, and of three service centres - the Technology Centre (TC), the Data and Modelling Centre (DMC), and the Interface and Synthesis Centre (ISC).

Platforms remain the property of their respective country/institution. Each platform will be linked by a specific Service Level Agreement, signed between the ERIC and the host institution, which will describe the services given by the ERIC to the platforms, and from the platform to the ERIC (see 2.2.1).

4.2.2. Central Hub

Under the leadership of the DG, the Central Hub is the main entry point of AnaEE, responsible for the services provided both to external users, platforms operators, and AnaEE' staff. The infrastructure operates through its own Service Centres, the platforms, as well as specialized bodies.

The Central Hub is responsible for the overall consistency of the action of AnaEE, and for impulsing its action and strategy.

It is also responsible for the communication actions toward the user communities and stakeholders. As part of this effort, the Central Hub runs the AnaEE web portal, the single access point for all AnaEE related activities and services. The web portal features an information section, for the users and the general audience; a platform catalogue, with an advanced query system; the proposal system; the access to the data (provided by the DMC); a link to the national node web portals; and any other relevant sections.

Finally, the Central Hub is warranting the quality of AnaEE services and products, and ensures that quality is a main driver at all stages.

To reach this high level of integration, coordination, and dedication among AnaEE's staff, the Central Hub will also convene internal meetings, events, training and communication actions among all AnaEE staff, Central Hub and Service Centres.

The Central Hub will:

- Conduct the implementation of AnaEE and its strategic development
- Implement AoM' decisions in cooperation with the Service Centres
- Make proposals to develop new platforms in order to address emerging research needs,
- Assess the performance of National Platforms and service centres,
- Implement the overall management and quality plan of the ERIC
- Convene, and organize the logistics of AnaEE bodies,
- Prepare and implement AnaEE's communication plan
- Manage the day to day tasks (financial, HR, etc.)

The CH will be located at the headquarters of the ERIC, in Gif-sur-Yvette, France.

4.3. Governance and management

The **Assembly of Members (AoM)** is the main governing body of the AnaEE-ERIC. It comprises two representatives per member, one having a scientific, and one having administrative expertise. The AoM appoints the DG and takes all decisions related to the AnaEE strategy, governance and scientific development.

The **Director General (DG)** is the chief executive officer of AnaEE and its legal representative. The DG is appointed by the AoM and has authority on all services of the AnaEE. He has full autonomy within the statutes and the framework decided by the AoM. He will prepare the main decisions and propose the strategy of the ERIC for decision by the AoM. He manages directly the CH services, and supervises the three service centres (TC, ISC, and DMC). He appoints the heads of the Service Centres and delegates the day to day operations to them. The appointment of staff members will follow the guidelines approved by the AoM (cf. Appendix 5). This will be the case also for procurement and also main tasks from the DG and CH. A Program Manager has been recruited as an in-kind resource before the start-up of the ERIC, and will then become part of the staff. The Finance and Accounting Officer (FAO) will be among the first staff members recruited by the ERIC.

Under the supervision of the DG, the **heads of the 3 service centres (TC, ISC, DMC)** are responsible in their domain of the provision of services provided by AnaEE. They participate in the Management Board (MB) that advises the DG for executive affairs.

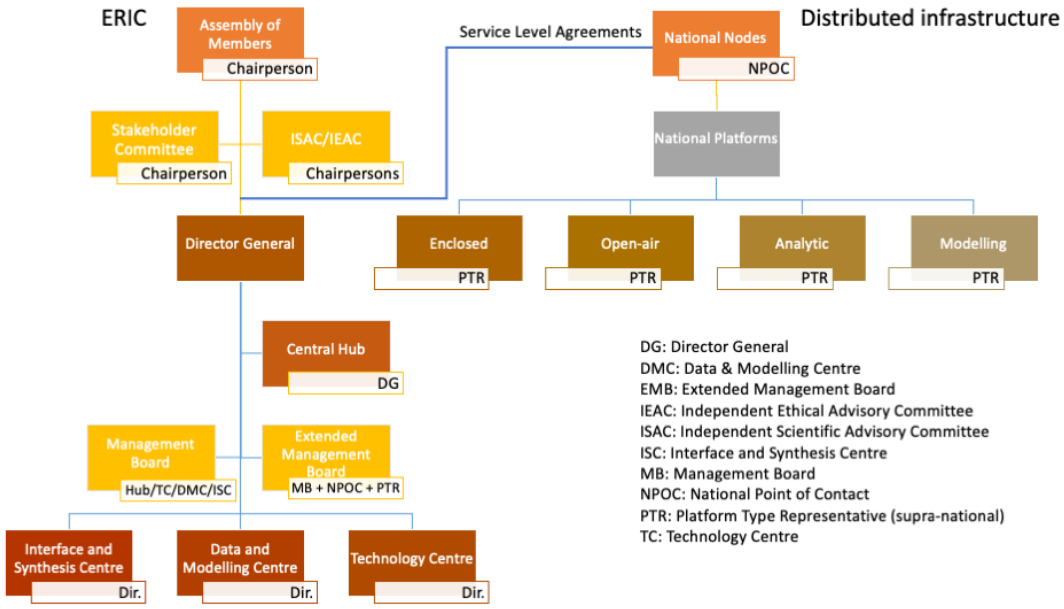


Figure 17. The functional chart of AnaEE-ERIC

Several statutory subsidiary bodies will be appointed to support AoM's and DG's work - and their composition is being prepared by preparatory committees so as to be ready to start. The statutes provide for the Independent Scientific Advisory Committee (ISAC), the Independent Ethical Advisory Committee (IEAC), the Stakeholder Committee (SHC), and the Management Board (MB). In addition, the AoM may appoint any subsidiary body as required by the circumstances.

- The Independent Scientific Advisory Committee (ISAC) is composed of 5 to 10 scientists chosen for their expertise in the fields covered by AnaEE. It is appointed by the AoM. It provides advice on the criteria for the acceptation of platforms, on the strategy, on the collaboration with other infrastructures and bodies, it analyses the activity reports and provides recommendations on the work programme and long-term strategy, and gives foresight on ecosystem sciences and the links with food security and the bio-economy. An initial ISAC has been already appointed by the preparatory AoM before the establishment of the ERIC.
- The Independent Ethical Advisory Committee (IEAC) is composed of 3 to 10 members appointed by the AoM for their expertise on ethical issues in ecology and life sciences. It will advise the AoM and the DG on ethical issues to be considered by the ERIC or the national platforms in their activities, or issues arising from specific programs proposed for consideration by AnaEE.
- The Stakeholder Committee (SHC) will be composed of representatives of the bodies and institutions that have an interest in the services and results delivered by AnaEE. The members will come for the scientific user community, the agricultural sector, the industry, administration or governmental bodies, jurists, NGOs, and the media. Its number will be between 10 and 20. It will advise AnaEE on the work programme and strategy, user accommodation, collaboration with other structures, and the communication plan. The members of the SHC are appointed by the AoM.
- The Management Board is a committee composed of the DG and the heads of the service centres, which is already up and running in this preparatory phase. It advises the DG on all matters related to the day to day life of the ERIC, as well as in the preparation of the budget, the work programme and all matters of consideration for the DG. In its "Extended"

configuration the MB (EMB) comprises the representatives of the national nodes and platform types. The DG can invite experts to attend the MB and EMB if the need arises.

Other subsidiary bodies can be established by the AoM as needed. We foresee that a Finance Committee will be established, with representatives of the AoM, in order to make a link with the DG and Central Hub services, and to promote the discussion for the financial report and preparation of the next budget (either annual, and update of the pluri-annual projections).

Working Groups (WG) are appointed by the DG as needed. Working Groups are lighter structures than subsidiary bodies, with more focussed terms of references and whose lifetime may vary from few months (to solve or provide advice on a specific problem) to a few years, e.g. in the case of an advisory working group for the service centres. At this time, we can foresee:

- Working Groups on the request of the SHC, established for specific user category problems: outreach, connexions with management practices in agriculture, evidence-based policy, etc.
- Working Groups connected with the DMC/TC/ISC for the advice of the heads and staff of these centres.
- The User Working Group (UWG) to provide feedback and advice from the users. This is intended for scientific (either public and private) users (or engineers in the case of partnership) accessing the experimental facilities. However, the SHC will provide feedback from the various communities involved, and specific user committees can be appointed, should the need arise (under suggestion from the SHC).
- Proposal Review Committee (PRC, see access document; the question of having a WG or body may arise later), in charge of the scientific evaluation of proposals.
- Working group on Human Resources (in charge of the elaboration of the strategic HR plan, recruitment, training, policy).

5. Budget and resources allocation

5.1. Budget

The DG (CH) will handle the overall budget of AnaEE-ERIC.

Budget is decided for a period of 5 years, starting from the ERIC's constitution, and revised after this period. Unless approved by the AoM following the appropriate rules, members' contribution remains unchanged during the 5-year period.

New members will contribute in addition to this budget. Exceptional contributions may be accepted, and AnaEE can receive specific contributions associated with additional services.

AnaEE-ERIC will also apply for contributions and grants from several bodies including Europe, structural and regional funds, national funds, private partners / donors.

One year before the end of the 5-year period, the DG will propose to the AoM a contribution plan and draft the budget (including expected external funding) for the next 5-year period, including new members contributions.

A finance committee, appointed by the AoM, will monitor the budget execution, and will work with the DG, AnaEE staff, and AoM for the elaboration of guidelines and prospective budget.

Every year, the DG presents the work plan and the associated budget for approval by the AoM. The accounts will be independently audited and certified at the end of each financial year. Some services will be outsourced, such as payroll, accounting and auditing.

5.2. Cost structure

A 10-year costs projection is provided in Appendix 9, with an initial 5 years ramp-up period. This projection will be adjusted after 3 years to take into account the experience gathered in the early operational life of the ERIC.

The projection is based on the assumption that the ERIC starts mid-2021. Members have agreed to pay a full year membership for 2021, which allows for building up a provision to cover the ramp-up period, during which we expect new countries to become members and grant applications to be accepted.

Operational costs are supported by members. Supplementary operations, such as common procurement, will be covered by exceptional contributions. Grants and revenue from the ERIC services will cover additional expenses.

With these assumptions, operational costs grow from 480k€ in 2021, to 1258k€ in 2025 and then 1443k€ in 2030. Inflation and other variations such as seniority have been accounted for.

During 2021, 10 employees will be hired, representing 3.8FTEs and 330k€ because of the progressive start and procedures. In 2025, we will reach 15 employees (12 FTEs - 999k€) and in 2030 16 employees (14.5 FTEs - 1188k€). For the same period, the external administrative costs will represent respectively 34k€, 88k€ and then 84k€; procurements 22k€, 20k€ and 17k€ (platforms are directly supported by their home institution); running costs 20k€, 32k€ and 36k€. Communication and outreach will represent 35k€ each year (with the addition of a communication officer recruited after year 2). Travel will ramp up from 35k€ to 85k€.

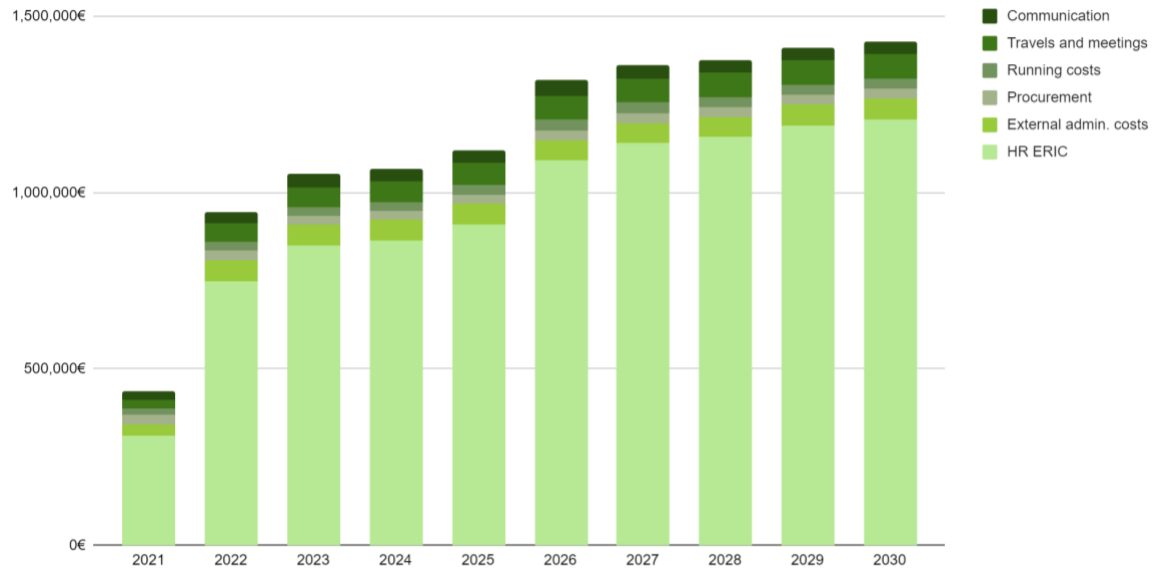


Figure 18. The evolution of the budget (expenses) of AnaEE over the next 10 years.

The structure of the budget reflects the importance of the share of Human Resources, which is typical for ERICs and required to support the activity of a pan-European infrastructure.

However, if we take into account even a limited 20% share of the grants and other income sources, devoted to HR, then HR will represent two thirds of the overall budget, which is a reasonable objective.

5.3. Funding model

The revenue of AnaEE-ERIC will come from:

- Members' contributions: members will contribute to the ERIC following a model that depends on a basic fee, plus a variable part related to the GDP and number of facilities it brings to AnaEE (see statutes).
- Host premium: countries that host one of the AnaEE central facilities (i.e. CH in France, ISC in the Czech Republic, TC in Denmark, DMC in Italy) are expected to contribute for a total amount equivalent to the budget.

Therefore, the total budget from the members will be the membership fee plus the host premium.

Other revenue includes:

- EU research and R&D grants e.g. from Horizon Europe, or any relevant EU call
- Infrastructure and structural funds at regional or national level
- International or national research or R&D grants
- Service provision
- Industry partnership
- Partnership with NGOs, authorities, or relevant bodies for specific studies, including policy studies, assessment of impact, etc.

A substantial amount has already been granted to specific platforms or national nodes in the view of their participation in AnaEE-RI.

The sustainability of AnaEE-ERIC will be achieved by increasing the number of members (countries), therefore reducing the impact of a possible withdrawal from one member, and reinforcing the interest for non-member and member countries of AnaEE. AnaEE-ERIC will also apply for grants from the EU Horizon program, as well as other programs of interest. It can, either directly or through its national nodes, candidate for support from regional infrastructure funds or even national grants. A synthetic view of the revenue from AnaEE is presented Figure 19.

Income projection, based on member fees, grows from 858k€ in 2021 to 1206k€ in 2025 and 1421k€ in 2030. The provision decreases accordingly from 377k€ in 2021 to 10k€. Note that member fees have been approved by the founding members and are written as an appendix of the statutes.

In addition to the budgetary lines drafted here, AnaEE will develop a systematic and ambitious plan of grants application to European and national/regional funds, and will develop links with the industry. Our objective, after the ramp-up period, is that 30% of the revenues of AnaEE will come from grants, partnership, and service provision (from the figures we have, it is on order of 8% for the national facilities today).

As shown in Figure 13 there are already between 5 and 7% projects from the industry that are processed at AnaEE platforms. A realistic objective for the mid-term (5 years), is to reach, in the short-term, a 10% share of the industry. The integrated structure of AnaEE will make its offer particularly attractive, as it can propose experimentation in open-fields, in enclosed facilities, analytical tools and modelling support. This is obviously an added value compared to the present situation where most of the industrial projects are run on single platforms.

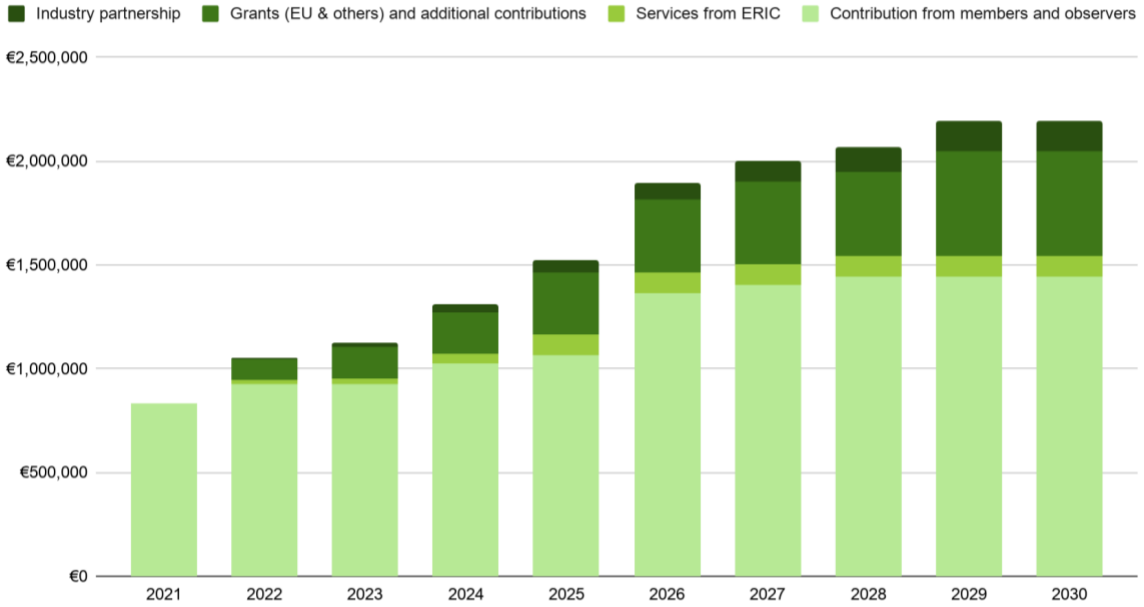


Figure 19. Synthetic view of the AnaEE revenue forecasted between 2021 and 2030.

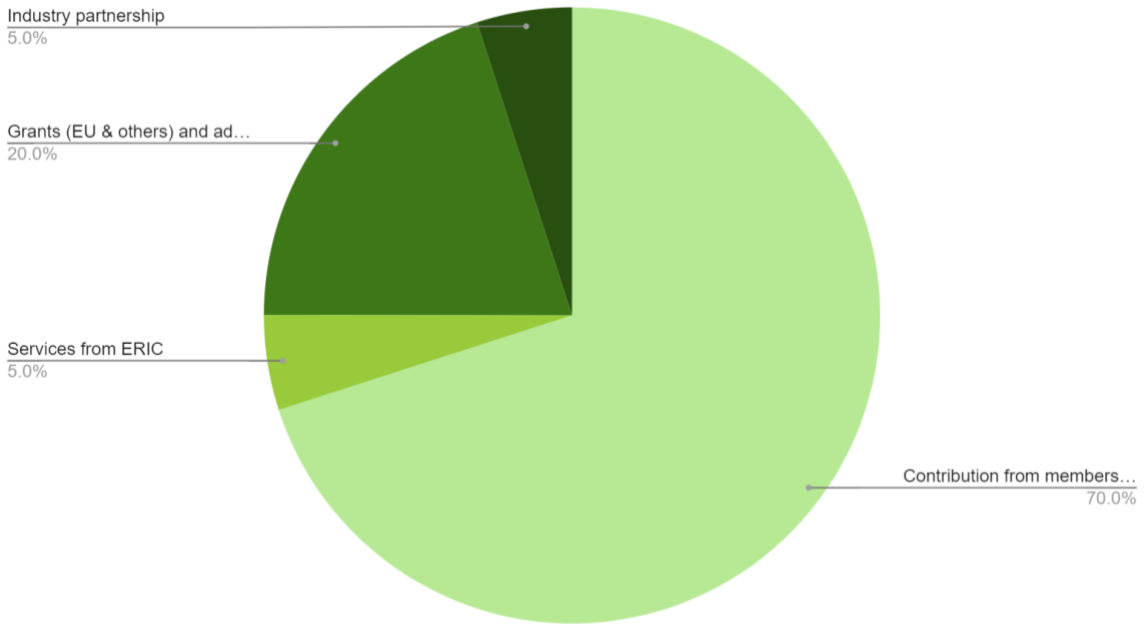


Figure 20. Revenue structure of AnaEE, projected for 2027.

5.4. Human resources

The evolution of payroll and headcount is presented Figure 21.

AnaEE-ERIC will be an equal opportunity employer. As an organization it promotes equal opportunities and diversity. The only way to achieve scientific excellence is by considering every person on the basis of merit, ability, competences, and qualification. AnaEE-ERIC promotes respect, dignity and fair treatment for all and it will not tolerate discrimination or any kind of harassment, abuse of power and violence. AnaEE-ERIC will not tolerate any discrimination on whatever basis, origin, gender, sexual orientation, belief, etc.

AnaEE-ERIC will strive for a gender balance in its positions of students, staff, and key personnel. User proposals will be treated to avoid biases based on gender or personality, according to the best practices.

Female candidates will be promoted for all new positions established or funded by AnaEE-ERIC.

Staff members, including in-kind personnel, will be recruited on a competitive basis according to the principle enunciated above.

In order to maintain the excellence of its services, AnaEE-ERIC will have a strong policy for capacity building and talent attraction. This means attractive packages, opportunities for training, leadership for EU projects. Each staff will meet the DG yearly, and its direct supervisor in between (heads of SCs) to precise the key activity areas, the objectives and tasks. A development and training plan will be designed for each employee.

The employment policy is presented in Appendix 10.

We have made provision for scientific officers, early career researchers, that will be in charge of the support of the users at all stages of their proposal/accepted project, of the proposal review committee, for the technological or methodological development, for monitoring the data and synthesis, and for the support of the data and modelling access.

We believe that these young scientists should be able to stand a strong research program, which should not be in conflict with their scientific duties at AnaEE. Albeit the norm is rather 30% in other IR of all types, we consider that a share of 50% duties / 50% original research is more appropriate, and allows to establish a lively interaction with a host scientific institute that will support their research.

We consider that young scientists will be in positions to start a strong, original research program, that will allow them insertion in the community, and be hired elsewhere. They will be also in position to establish a strong network with the community of users (either scientists and industry) that will help them for the future.

Some of them will also be able either to join the industry, or to found a start-up company for the spinoff of the AnaEE products that they will have contributed to build. In that respect, AnaEE will consider carefully the possibility of industry/public funding schemes for PhD students, such as the CIFRE in France, the industrial PhD program in Denmark, or the appropriate schemes in other countries.

For AnaEE, no need to say that this will be a tool to build a community of scientists, engineers, and business founders, that will be invaluable for the long-term sustainability of AnaEE, and warrants the evolution of its scientific objectives and performance.

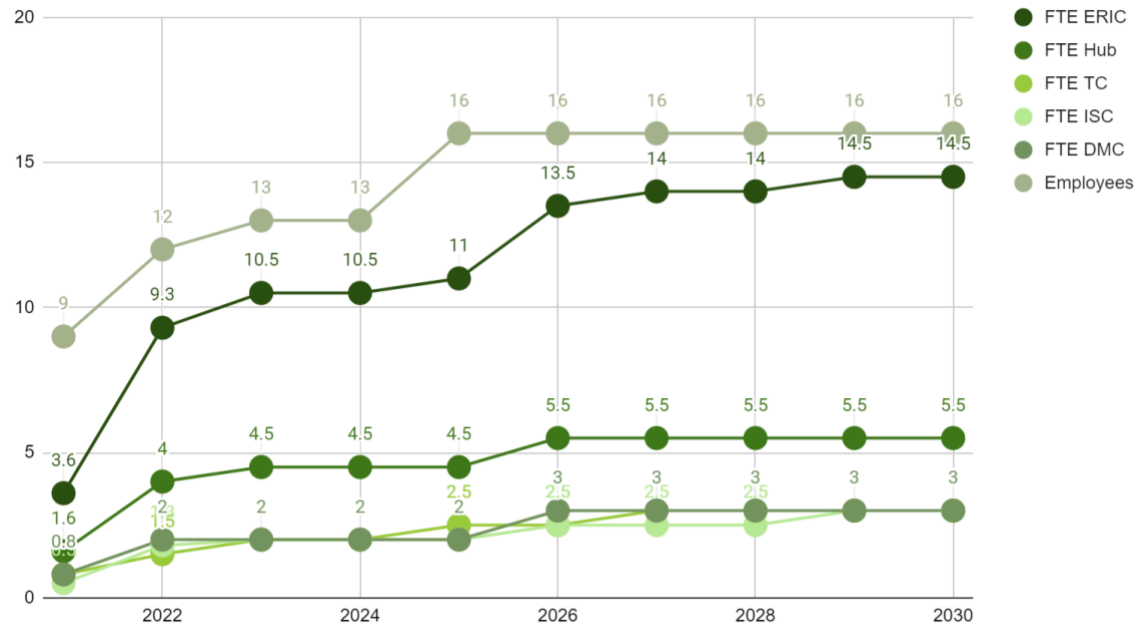


Figure 21. Evolution of the number of FTEs and employees for AnaEE.

6. Monitoring, key performance indicators and risk management

6.1. Key Performance Indicators

Key Performance Indicators (KPIs) are used to appreciate the progress of AnaEE towards its objectives.
We have followed the approach recommended by the ESFRI monitoring group on monitoring[19] and adapted the indicators to AnaEE.
KPIs will be collected and maintained by the Central Hub, and reported both to the executive management and to the AoM on a regular basis. They will be part also of the evaluation made by ESFRI.

We consider that the global and reasoned use of the set of qualitative as well quantitative indicators proposed here can help to monitor the achievements of AnaEE over the 5-year evaluation periods and be a useful guide for the overall strategic management of the infrastructure. We have aligned the KPIs described below to the objectives of AnaEE, and we have applied the RACER (relevance, acceptability, clarity, easiness, robustness) criteria.
Because of the distributed nature of AnaEE, the local platforms belong to local or national institutions. For some KPIs it is possible to distinguish between the local and trans-national achievements, based on the agreement between AnaEE and its platforms. Other indicators may be intricated, as the local impact may benefit the global infrastructure (which is by the way one of the added-value of AnaEE). Whenever possible, both situations have been distinguished.

Indicators are distributed within three categories: short term (< 3yrs), medium term (3yrs – 5 yrs), and long term, as many of the program and activities of AnaEE will produce results over periods that

span years. Data will be collected from the start, but in some cases, we expect the trends to be meaningful after a few years.

6.1.1. Short-term indicators

These indicators reflect the day-to-day activity of AnaEE, and its efforts to attract a large community.

Table 3. Short-term indicators

KPI #, S/D	Description	Unit / time	Comment
Achieving Scientific Excellence			
1	Number of user projects submitted	Number, annual	This number reflects the community interests in AnaEE. The trend reflects a growing awareness among the community, and a positive perception of the added value.
2	Number of projects accepted and scheduled	Number, annual	Connected to the previous objective, reflects the quality of projects submitted, and the capacity of the infrastructure to serve the community. Close to KPI #3 from report
Education and training			
3	Training sessions to people not RI staff	Person.hour	This comprise the training of NP managers, provided that this training is in the interest of AnaEE (e.g. upgrade of NP to meet AnaEE standard, use of new equipment, etc.). Includes also people trained to use AnaEE, or any external training. Needs proper tracking of efforts.
Outreach			
4	Outreach through printed, web social media, etc…		Outreach in external media
5	Direct outreach activity from AnaEE via web site and social media	Statistics from web-based tools	RI engagement in social media (FB, twitter, youtube, etc.) and impact of AnaEE web site
Trans-RI collaboration			
6	Number of co-location of facilities	Number	Per site, mentioning each co-located RI. This is not only a smart use of resources, but also triggers trans-RI work.
Optimising management			
7	Revenues	€, nature	Sources of revenues, and their respective contributions to investments and operational costs

6.1.2. Medium-term indicators (3-5 years)

Table 4. Medium-term indicators

KPI #	Description	Unit / time	Comment
Achieving Scientific Excellence			
8	Number of international users	Number annual	Same as KPI#2, but Outside Europe, quantifies the international impact of AnaEE.
9	Number of publications from AnaEE projects	Number, annual	Taken from recognized databases. Reflects the capacity of the users and of AnaEE to publish science from experiments. Trend shows growing impact. As many programs are based on mid-long-term experimentation this number should be interpreted with some caution. It also needs a strong policy to make sure the users acknowledge AnaEE, and can be work consuming.
Education and training			
10	PhD students using AnaEE	Number, annual	Number of students that use AnaEE for their work, i.e. leading to publications and/or contributing to thesis work.
Transnational collaboration			
11	Number of AnaEE Members	Number	Of particular relevance is the evolution of this number during the first 5 years of AnaEE's life
12	Share of users and publications per member country	Number/%	
Facilitating economic activities			
13	Share of industrial users, including academic scientists contracting with industry, and publications	%, Number	May be difficult to get reliable numbers, at least at the beginning.
Optimising data use			
14	Number of publicly available data sets	Data sets in OA, annual	As identified by DOIs
15	Access of public data	Users/annual	Data access through AnaEE portal, counting number of downloads, and/or individual users

Provision for Scientific Advice			
16	Participation in policies	Number of invitations and/or contributions	Number of participations in policy related working groups, committees and advisory boards. For national, or often even trans-national, bodies, it is expected that experts will be invited on a national basis. However, their expertise will be based on results and knowledge gained across the whole AnaEE RI, hence it should be counted.
Facilitating international cooperation			
17	Number of non ESFRI countries member of AnaEE	Number	
18	Number of projects involving RIs outside ESFRI countries	Number	Together with the country of origin.
Trans-RI collaboration			
19	Number of projects involving 2 or more ESFRI RIs	Number	Applications, and approved projects, mentioning explicitly the use of 2 or more RIs, or the use of data from 2 or more European RIs
Optimising management			
20	Extent of resources made available to users	TBD	Number and AnaEE share of NPs (including type) and datasets made available to users. The units and the way to measure this AKPI should be elaborated.

6.1.3. Long-term indicators (> 5 years)

Table 5. Long-term indicators

AKPI #, S/D	Description	Unit / time	Comment
Achieving Scientific Excellence			
21	Citation count	Number, annual	Normalized number (excluding auto-citation) of citations from papers based on work performed through AnaEE. As much of the work is interdisciplinary, defining top 10% base may prove to be difficult. Citation counts evolve over a period longer than that of the publication itself.
Provision for Scientific Advice			

21	Citations in policy related publications	Number	Is the RI, or staff, mentioned in policy related publication? One concern is that for a given country only the national node, or NP, is cited, while use of AnaEE-wide work has been made (e.g. a study across several climate zones solely attributed to the Wonderland node).

Quantitative indicators always require contextualisation, which will be provided by a series of qualitative indicators. They are related to:

- Scientific excellence.
    - Appreciation over the attractiveness of AnaEE. This narrative will be based mostly on quantitative KPIs. Other evidence may come from evaluation by independent committees such as the ISAC. The trend will be evaluated over a period of 5 years. Because several projects will be pluriannual, when this will be possible, we will evaluate the trend over a period of 5 and 10 years.
    - Added value of AnaEE. Evidence taken from quantitative KPIs, as well as from invited papers in major conferences, invitation of AnaEE-related speakers, etc. The trend will be evaluated over a 5 year period.
- Collaboration with other Research Infrastructures.
    - Common work performed at collocated platforms with other RIs. This narrative will evaluate the impact of the collocation of platforms with those of other RIs. This will be especially useful for the AnaEE roadmap in common with other RIs. Topics will include the scientific relevance (publications involving data from several platforms), common projects, but also the benefits (instrumental, financial, political, HR) of the strategy of collocation.
    - Joint research infrastructure roadmap. Participation to the clusters in the Food and Health and in the Environment domains. We will also discuss the establishment of closer links (MoU, SLA) with specific infrastructures.
- Engagement plan for Industry and Agricultural sector and related resources. This indicator will be built during the first operational phase, in order to provide a more refined assessment of industry needs, with a focus on trans-European scale.
    - Technology transfer. Technologies transferred by the Technology Centre to the industry. National nodes should transfer through AnaEE when they have used process, instrumentation (or even AnaEE platform share in NPs), or data from AnaEE. One aspect to evaluate is whether transfer of technology at the national level benefits from belonging to a European RI like AnaEE.
- Education and training.
    - Scientific and technical training. Will include the quantitative KPIs, and also scientific schools based on AnaEE results and projects. Should include remote training and teaching.
    - Public outreach. Will discuss quantitative KPIs, but also the consistency between national/local events and AnaEE wide outreach. Outreach development plan.
- Data use optimization.
    - Data management plan. Existence and quality of the DMP will be discussed and assessed.

- Compliance with FAIR and OA standards. Compliance of the available data and of the DMP with FAIR and Open Access (OA). Check whether a single access point is available, easy to use. Sustainability and ease of access will also be assessed. EOSC connectivity, and integration, provision for sustainability of data that can be distributed at NP level

- Scientific advice and impact on policies. Demonstrated impact on policies, regulations, standardization, using case studies. Participation of AnaEE staff as well as national staff to committees (supposing that national impact is reinforced by AnaEE international impact).
- International cooperation. Appreciation of the scale, quality and relevance of internationalisation strategy.
- Optimisation of management.
  - Social responsibility. Corporate social responsibility system, including gender balance, conflict solving procedures, corporate ethic charter; and compliance with EU rules (including for young researchers).
  - Effective safety and risk management. Check on the agreed risk management and safety procedures agreed with NPs.
  - Sound financial management rules and accountability system. Efficiency and quality of the processes regulating: budget design & execution, milestone follow-up, planning, correcting course when deviations happen, transparency of the processes & decisions.

6.2. Risk analysis

Table 6. Main risks

Risk #	Description of risk	Probability	Impact	Proposed risk mitigation measures
Management, financial, conflicts				
R1	A member wants to withdraw its participation	Low	High	Members are committed for a 5-year term. Communication with members is continuous so as to anticipate any problem and discuss reasons for the wish to withdraw. Possible financial causes may be discussed with other members. The demonstration of added value of AnaEE, and especially success in proposals may limit this probability to low. But in case a member decides to withdraw, the accretion of new members will alleviate the impact.
R2	An institute/University in a member country wants to leave the collaboration	Low	High	Though this is internal to the country, it may lead the member to withdraw its participation. Institutes will be committed for 5 years. In case an institute wants to retire, negotiations will be held to program a progressive retirement. Demonstration of added value of AnaEE, and especially success in proposals may limit this probability to low. A larger member base diminishes the impact of the withdrawal.
R3	A member wants to	Low	Low	The contributions from member states are fixed for a 5 year term. If the number of platforms has

	reduce the number of platforms within AnaEE to reduce its contribution			a (weak) impact on the contribution, the reduction of platforms during the 5 year term does not impact the contribution until the end of the term. Also, the addition of new platforms by a member does not impact its contribution until the end of the term, introducing a virtuous mechanism.
R4	Difficulties in accreting new countries	Medium	Medium	Demonstrated added value of AnaEE will encourage new members to join. Success in getting funding will also encourage prospective new member countries. The status of "observer" allows new countries to see the advantages of full membership. It is also an opportunity for countries to prepare their NPs to the level requested by AnaEE.
R5	New country interested but difficulties to get NPs at AnaEE level prevent from membership	High	Low	Some countries may want to join AnaEE but might hesitate because of the high standards required for AnaEE platforms. In this case a nurturing process will be put in place with a work plan and specific timeframe to acquire the needed level of expertise and instrumentation, including IT competences. AnaEE centres will monitor the progress and give specific advice, possibly with the help of other, more advanced members. The "observer" status can be also seen as a mid-term engagement for the time being necessary to comply with AnaEE full requirements. Finally, “associated platforms” may be a way for an institution to establish links with AnaEE and to build a capacity in experimental ecology, before the country applies for membership.
R6	Conflict between members	Low	High	Prior to the validation of the statutes, the members of AnaEE had to agree on key issues dealing with resources, rights and duties, governance and processes. We are therefore confident that the basis is sound. To prevent conflicts from building up, management is attentive to identify possible misalignments early on and to enforce frequent communication and discussion between members. Should nonetheless a conflict arise, mitigation and mediation procedures are in place to enable a quick solution and prevent the conflict from paralysing the structure.
R7	Conflict between one or more members with management	Low	High	AoM will ultimately decide. Management should have an open attitude and understand criticism, but management is also responsible for the execution of decisions from the AoM, and to enforce respect of rules. The president of AoM will be involved in conflict resolution,with additional advice from SAB or possibly EAB if it involves a scientific dispute. Finally, an independent arbitration procedure is the last option if previous remediation fails. An internal communication officer will be hired to ensure proper communication within AnaEE reducing this risk.

R8	Internal conflict within AnaEE staff, or staff with management	Low	High	Managers will follow training in conflict resolution. The appointed DG has proposed that an ombudsperson be appointed by AnaEE. As the size of AnaEE does not call for a full-time ombudsperson, it can be shared between RIs having similar needs. AnaEE management will prevent conflicts by a permanent dialog with the staff, regular meetings, and open-door attitude. Management will ask and be open to reports of possible inappropriate attitudes, such as harassment. After investigation, if proven, appropriate actions will be taken by the management. See also employment policy.
R9	Ineffective collaboration within the core centres (Hub, TC, DMC, ISC) or with NPs	Low	Medium	The DG and directors of the 3 centres are in place. The management board meets every 2 weeks. Every month the MB meets together with platform type representatives and national node representatives. Minutes of each meeting are produced and disseminated quickly. This ensures a good level of coordination within the structure. Should the problem arise, a discussion within the extended management board, possibly involving the AoM president will take place. The DG has expertise in management, and will follow training specific to RIs.
Scientific and technical risks				
R10	Not enough projects submitted	Low	High	AnaEE is already attending specialized conferences to attract attention. Case studies already show the interest of having platforms in different areas, or of different types, with integration with modelling and analytical facilities. The large number of national users and of already active international projects, as well as the commitment of national nodes for AnaEE ensures that quite a lot of users will be interested in pursuing research using more experimental facilities that will be more integrated. The quality of the projects submitted, as well as their scientific output will leverage a large number of users. AnaEE will also organize conferences and workshops in its specific domain, with published proceedings, or together with another RI.
R11	Few publications and/or few citations of these publications	Low	High	The combination of short and longer term experiments implies that results will be published progressively. Apart from experimental studies, we expect to publish perspectives and methodological papers in the short term. Moreover, the use of already existing data from the NPs, which will be made available to the community by AnaEE, will also facilitate publications early on. In the longer term, modelling and meta-analyses/ syntheses papers are expected, facilitated by the centres.
R12	Platform(s) do not meet	Low	Medium	SLAs enforce that the standards of platforms meet the AnaEE requirements.

	AnaEE standard			Platforms belong to the AnaEE RI only if they meet the agreed standards, following a procedure overseen by the TC. We will monitor periodically that the platforms comply continuously with standards. If this is not the case, a recovery procedure will be agreed with the platform manager, with a precise work plan and timeline. If still there is a problem, then the platform will be descoped (note in this case this is the responsibility of the member, not of AnaEE, hence the contribution won't change.
R13	Delays in implementing a project due to overload	Low	Low	Develop tools to optimize scheduling at platform and AnaEE level. Select alternate platforms: role of support scientist.
R14	Delays in implementing a project due to weather or other external reason	Low	Low	Having more platforms in a given climate zone allows for a rescheduling of an experiment over different platforms delivering the same service.
R15	Difficulties in deploying new technologies on platforms	Low	low	New technologies will be tested first by the TC, and deployed after advice of the EMB. A specific procedure for deployment will be agreed, with check points and monitoring. If delays are experienced, an evaluation will be performed to understand the cause that can be linked either to the technology (unforeseen difficulties), or to the platform. In the former case, new studies will be performed by the TC (if needed with the provider), in the latter case, the difficulties of the platform will be identified, and a plan agreed to overcome them and deploy the technology. New technology will be used concurrently with existing instrumentation as long as needed in order to alleviate the risk of a discontinuity in data calibration, issues with the new technology, etc. Technology (instrumentation) strategic plan.
Data acquisition and management				
R16	Delays in getting data from stations	Low	Medium	SLAs and support from TC and DMC will alleviate this risk. Encourage remote, (near) real-time acquisition of data. Possible wireless connections of instrumentation and control/command of facilities. Real time pre-processing of data and standardization to comply with AnaEE standards, under control of DMC.
R17	Problems in the sustainability of data from platform and/or national node	Low	High	SLA will enforce data sustainability. Sustainability of data management, quality and archiving by national nodes and platforms will be checked and monitored by DMC. Duplication of data using standard tools will be encouraged, if not enforced. Use EOSC services. Mirroring at CC IN2P3 to avoid catastrophic events.
R18	Problems in the FAIRness	Low	Medium	SLA provision. Platforms are committed to deliver data complying with AnaEE rules, that are FAIR. If a problem is identified, DMC will propose tools to

	of data from platforms			remedy the issue. DMC has already developed tools to enable data to become FAIR.
R19	Problems of open access to the data from platforms, or user unwilling to comply with the OA standard	Low	Low	The platforms have agreed to provide OA data. Rules are defined in the binding SLA. Users are committed to follow the rules (eligibility). The aperture of data (i.e. after the embargo period) will be done by the platform, not the user, under supervision of the DMC. If a platform does not comply with the rules, the issue will be first discussed between AnaEE management and the national node, then eventually by the AoM; The platform can be descoped in case it persists (resulting in no change of the member contribution).
R20	Problems in implementing standards interoperable	Low	High	AnaEE is contributing within the H&F domain (ELIXIR, EMPHASIS) and ENVRI community on agreed interoperability standards. This is especially important given the diversity of the community and the users. Until now we do not see any issue here.
R21	Problems in centralized access	Low	High	Problems may arise from different causes: access provider, database access, software tool, etc. In the case that internal AnaEE resources are not enough, a specialized IT services provider will be sought. Provisions have been made in the budget.
Private users (industry, agro-business, etc.)				
R22	Low interaction with private users	Medium	Medium	Although the primary target of AnaEE is the academic community, with the aim to understand the drivers and long-term impact of global change, interaction with private partners will be encouraged, since the use of experimental platforms (indoor or outdoor) will be of interest to them. Methods, tools and strategies for agriculture might also spin off from AnaEE. The attractiveness for the industry will depend on the intrinsic attractiveness of AnaEE, but also from policies that can enforce industry to conform to specific standards. AnaEE will hire a communications officer that will be in charge of discussing with industrial partners and lobbying for common research. AnaEE will also participate in specialized meetings, fairs, events of prime interest for industries. Engagement of researchers, especially young researchers, to build new businesses from their research will be encouraged. Finally, several platforms are already engaged in collaborative actions with industry. It may be an opportunity for them to have their products tested in more climatic zones, or type of ecosystems.
R23	Conflict of interest between industrial activities and expertise	Low	Low	AnaEE will act as an expert body for policy makers and regulators. To ensure that Industry oriented activities do not create conflicts of interests for AnaEE and its staff, strict deontology procedures will be applied - in particular with respect to the choice of projects and access of users to the platforms. AnaEE will monitor the resources from

				private partners in order not to be in a situation of global conflict of interest. In other words, private resources should be limited according to usual rules for ERICs (essential resources will come from member states), and will be diverse, to prevent a specific partner gaining disproportional leverage over AnaEE or its staff. Specific procedures will be enforced under the advice and supervision of the Ethical Advisory Committee to avoid conflict of interest. This will be part of the SLA with NPs. AnaEE or NP staff will not be allowed to become experts when a possible situation of conflict of interest may arise. A declaration will be signed and the links between AnaEE staff and industry will be monitored.
Expertise and advice for public or private bodies				
R24	Difficulty to arise interest from public bodies	Medium	Low	AnaEE and its members will lobby to attract the interest of policy makers and regulators. AnaEE features activities that have a strong societal impact, and has a very specific bulk of expertise because of its experimental nature and focus on timely topics. AnaEE will provide, on its own or in collaboration with other RIs, expertise that will be sent to decision and advisory bodies. It will also have a positive action to advertise its type of research. Already now, scientists from several members of AnaEE are well-connected with policy makers, but lobbying activities and AnaEE visibility will increase this connection.
R25	Input of AnaEE in policy or standard is not acknowledged	High	Low	As the researchers that belong to specific committees, including at European level, are considered by their nationality, it is likely that the knowledge they acquired using AnaEE RI is understated. Part of the agreement with national platforms, and rules of the AoM will mention that AnaEE should be acknowledged at the right level.
Collaboration with other RIs				
R26	Bad, or delayed, identification of collocation zones	Medium	Low	Co-location of Ris, e.g. AnaEE + eLTER or ICOS or ACTRIS, is interesting because it enhances the scientific output while allowing for saving resources. Co-location should be performed on the basis of the interest of science, and secondly, if no adverse effect, based on finances. For existing platforms there is no risk, as the RI of interest will implement according to various criteria. For newly identified platforms, the risk is that a RI has plans for new facilities, without informing other RIs. AnaEE will work within ENVRI on a collaborative agreement to ensure that any new project is advertised to the whole RI community in order to evaluate the case for co-location well in advance.
R27	Difficulties in exchanging data	Low	Medium	As this eventuality has already been identified, AnaEE works on data standards within ENVRI and leads one of the work packages on metadata. Problems with interoperability and exchange of data will be identified and solved within the ENVRI cluster, or jointly between RIs.

R28	Difficulties in having common programs/calls	Low	Medium	AnaEE will propose to its partners to launch common calls for proposals. Areas of collaboration have already been identified and even published. Common events (workshops, specific sessions at EGU, etc.) will allow us to discuss the best topics with the community, and ways to achieve a successful common call or program. Common applications to grant programs on EGD and Horizon Europe may provide opportunities for intense collaboration.

7. Communication and branding

7.1 Vision

Communication is key in supporting the AnaEE brand and ensure a large outreach of the infrastructure to the relevant users' communities.

Coordinated by the Communication Officer of the Central Hub together with TC, DMC, and ISC, the communication strategy will pursue five objectives:

1. Strengthen the network of national nodes and platforms members by developing a common culture around AnaEE. The aim is to create bonds and bridge gaps in cultures, languages and approaches, so as to facilitate the implementation of scientific projects and results dissemination.
2. Ensure that AnaEE and its services are known to the scientific community so that the user community develops, and that information circulates about events and projects happening within the AnaEE network.
3. Extend the participation thanks to the pan-European nature of the AnaEE infrastructure: attract new members countries and create new partnerships with different stakeholders (institutional, NGO, academia…).
4. Establish AnaEE as a benchmark and key ally for agricultural sector & industry looking to develop innovative technologies and solutions for the global Greentech market. Re/insurance companies, agribusinesses, sensing and instrumentation industries have proven receptive and are natural partners for AnaEE. Industrial engagement efforts will highlight the unique capacity of AnaEE facilities to develop added-value analytics decision-space tools and federate web services to combine existing datasets and new experimental data.
5. Support the fundraising efforts. AnaEE will develop a systematic and ambitious plan of grants application to European and national/regional funds, and will develop links with agricultural sector & industry. Our objective, after the ramp-up period, is that 30% of the revenues of AnaEE will come from grants, partnership, and service provision. Correct communication is an important condition of successful fundraising.

7.2. The communication plan: key audiences, messages and tools

AnaEE's communication plan is summarized in a table format provided in Appendix 11.

The goal of this communication plan is to organize and implement stakeholder relations, lobbying and public relations efforts, based on the following tools:

- Key audiences
- Messages
- Tools and activities
- Resources and timescales
- Collaborative approaches to achieve communications goals
- Evaluation procedures

Key audiences are:

- The staff of the ERIC (corporate communication)
- The community of members (governments, institutes owning platforms, etc.), including platform operators
- The European research community (the academic users) as well as international research community including related infrastructures (CERN, TERN, etc.), related RIs, as Lifewatch, Emphasis, ICOS, ACTRIS, DANUBIUS, and of course the ENVRI (Environmental Science RIs) and LSRI (Life Science RIs) communities
- The agricultural sector & industry
- Policy makers, NGOs, the media
- Educators, teachers, and schools
- General audience

7.2.1. General tools for communication (visual identity, website, material)

An attractive and coherent visual identity has been designed for AnaEE, including a logo, templates and recognizable visual elements to be associated with AnaEE output such as products and services devised at platform-level (reports, data, papers, in-house generated technology, etc.). This visual identity, embodied by the AnaEE logo, will be integrated to all presentations, particularly during international conferences and events – or as new developments come to be promoted through AnaEE's website.

AnaEE's website showcases the advancement of key projects, provides contact details to all relevant parties, regular news postings and events updates. It is articulated to social media platforms, such as Facebook or LinkedIn, as well as other media in this rapidly evolving sector. An email newsletter in HTML format, is prepared on a bimonthly basis, to present all project advancements and relevant news to external audiences.

AnaEE is now represented at all major ecosystems-related conferences, workshops and corollary research events discussing new developments in the fields of environmental and biodiversity studies. Participation in international conferences plays a key role in disseminating AnaEE planning efforts to all stakeholders during the AnaEE Preoperational and Operational Phases, actively promoting the potential of the infrastructure and its services and products portfolio. The tools for conferences and events include:

- A concise A4 brochure, outlining key points of AnaEE
- A kakemono has been made which is displayed at all major events
- Presentations of AnaEE are requested, e.g. at the EGU assembly
- Case studies
- A standard PowerPoint presentation as a base for AnaEE speakers in conferences
- A 4-minute video

7.2.2 Communication with Community members and Platforms

AnaEE is the single entry point to the AnaEE Research Infrastructure and platforms. By providing a common reference strategic framework, large international visibility, interoperability of service

protocols and data collections, the centralized coordination will enhance the potential of each Node and Operator.

Communication will go through the bimonthly newsletter including case studies, updates on AnaEE projects, EU calls, events calendar, the training of the operators and scientists of the platforms, capacity building and networking, the organization of technology Working Groups (TWGs) to gather internationally renowned scientists.

The signature of Service level agreement which will legally bound the platforms and AnaEE is currently providing an important opportunity to exchange closely.

7.2.3 Communication with researcher's community (users)

By providing easy access to a wide range of infrastructures within diverse ecosystems, AnaEE offers capacities to develop multidisciplinary approaches combining experimentation, analysis and modelling services. It will also provide open and easy access to resources and services to a broad user community world-wide to conduct excellent research, foster innovation and provide high-quality information.

The web portal provides access to the platform catalogue, the service catalogue, and a specialized interface to help the selection of services and platforms.

Technology foresight workshops will bring together TWGs, relevant industries and specialists upstream of the instrumentation used in AnaEE platforms. Training sessions will include theoretical and practical workshops, seminars, or intensive courses.

DMC will develop guidelines and operational tools (thesaurus, ontologies, etc.) to implement metadata and data standardization (data tool kits, software products). Demonstration cases will be prepared to show ways of using modelling to enhance interpretation, upscaling, design of experimental treatments and measurements. Cases will be developed in consultation with national nodes and AnaEE advisory bodies, with the aim to encompass a range of systems, questions and challenges suitable for approaching through the integration of modelling with experimental activities.

AnaEE also recognizes the importance of building the researcher's community by developing higher education programs. From Master to early stages researchers, AnaEE will focus on understanding the role of ecosystems in global biogeochemical cycles and increasing the contribution of ecosystems to mitigate climate change. To achieve this, AnaEE develops a higher education program that will consist of yearly open winter and summer schools for graduate students, early career researchers and professionals across Europe.

7.2.4 Communication with the agricultural sector and the industry

AnaEE provides an efficient and unparalleled way for industrial and agricultural partners to find, develop and test adaptation measures applicable at continental level, or also to explore how to adjust them to specific climatic and soil conditions. The large number of state-of-the-art platforms allows us to identify needs and solutions that may lead to innovation. Moreover, open access to data provides further opportunities for the agricultural sector & industry to reuse data and make innovative analysis.

Particular attention will be devoted to fostering innovative co-designing partnerships between AnaEE users and stakeholders, noticeably amongst small and medium-sized businesses, industries and decision-makers in general. There lies the condition for AnaEE to attract end-users far and wide, as

they are instrumental in the AnaEE infrastructure's ultimate capacity to provide its global community with new services and solutions.

For stakeholders in the agricultural sector in particular, AnaEE will rest upon a "lighthouse" model that requires specific competencies in terms of outreach and stakeholders engagements, for example towards farmers, which we can undertake in partnership with professional organisations or NGOs.

AnaEE participates also in the ENRIITC EU funded project whose aim is to establish a European-wide network of industry liaison and industry contact officers to enhance the collaboration between RIs and the industry.

The communication team will accompany these activities with dedicated instruments to support all partnership and outreach activities.

7.2.5. Communication with policy makers, NGOs, the medias

The experimental approach developed by AnaEE makes it a crucial contributor to public policies, such as the Green Deal, aiming at improving socio-ecological-economic resilience and mitigate the risks associated with multiple and interacting global change drives acting on ecosystems across Europe. It will play a central part in the chain of EU actors committed to fill in these gaps, though its capacity to provide access to a series of coordinated research infrastructures.

This external outreach policy will rely on a targeted press relations effort, especially through special reports on key AnaEE publications. Requests from the media will be addressed with case studies and any appropriate materials, as well as referrals to the relevant AnaEE spokesperson. The goal will be to position AnaEE as a prime source of information and state-of-the- art tools to tackle issues such as food security and biodiversity.

AnaEE will strive to enable its funders as well as key external stakeholders to meet with the European Commission and other policy-makers, funding agencies as well as business and civil society funders.

An annual Stakeholder Outreach Day will be organized in conjunction with the Assembly of members. AnaEE will provide key input regarding the development of long-term strategies and policies. Synthesis and opinion papers will be made by ISC as well as expert reports, maps and graphical portals that could be used for example by members in the formation of National climate adaptation plans, and in the development of basic principles, specific measures, support mechanisms and control tools in the implementation of Common agricultural policy on national level.

7.2.6. Communication with general audience

AnaEE responds to a need to determine the short and long-term reaction of ecosystems, and how human societies can adapt to and mitigate changes in ecosystem functioning. It will explore and test evidence-based adaptation and mitigation strategies that assure plant, soil, water, biodiversity and ecosystem health today and in the future, needed to maintain essential services to society.

In order to deliver those messages, AnaEE will produce educational documentary films and popularization articles, and will organize workshops and conferences. A web-based educational platform will be developed to demonstrate in a user-friendly way the role of ecosystems in the carbon cycle, nutrient cycling and the importance of individual ecosystem services such as biodiversity,

provision of drinking water and others. Field days, pilot farms, technology demonstrations, technical workshops will also be organized.

The Interface and Synthesis Center, in coordination with the Communication officer of the Central Hub, will develop activities to achieve this purpose (publication of articles, organization of conferences…) and recruit an expert in scientific communication.

AnaEE will ensure that students at different levels of education are aware of the production and non-production functions and services provided by ecosystems, with particular respect to their roles in global carbon cycle, climate mitigation and adaptation. To do so, in cooperation with experts in didactics, AnaEE will be involved in creating and publishing motivational teaching materials for elementary and secondary school students.

References

1. De Boeck, H. J. *et al.* Global Change Experiments: Challenges and Opportunities. *BioScience* **65**, 922–931 (2015).
2. Hanson, P. J. & Walker, A. P. Advancing global change biology through experimental manipulations: Where have we been and where might we go? *Glob. Change Biol.* **26**, 287–299 (2020).
3. Leuzinger, S. & Quinn Thomas, R. How do we improve Earth system models? Integrating Earth system models, ecosystem models, experiments and long-term data. *New Phytol.* **191**, 15–18 (2011).
4. Peters, D. P. C., Loescher, H. W., SanClements, M. D. & Havstad, K. M. Taking the pulse of a continent: expanding site-based research infrastructure for regional- to continental-scale ecology. *Ecosphere* **5**, art29 (2014).
5. Rineau, F. *et al.* Towards more predictive and interdisciplinary climate change ecosystem experiments. *Nat. Clim. Change* **9**, 809–816 (2019).
6. Clobert, C. A. *et al.* How to integrate experimental research approaches in ecological and environmental studies: AnaEE France as an example. *Front Ecol Evol* **6**, (2018).
7. Song, J. *et al.* A meta-analysis of 1,119 manipulative experiments on terrestrial carbon-cycling responses to global change. *Nat. Ecol. Evol.* **3**, 1309–1320 (2019).
8. Dieleman, W. I. J. *et al.* Simple additive effects are rare: a quantitative review of plant biomass and soil process responses to combined manipulations of CO_2 and temperature. *Glob. Change Biol.* **18**, 2681–2693 (2012).
9. Langley, J. A. & Megonigal, J. P. Ecosystem response to elevated CO2 levels limited by nitrogen-induced plant species shift. *Nature* **466**, 96–99 (2010).
10. Jamieson, M. A. *et al.* Global change effects on plant–insect interactions: the role of phytochemistry. *Curr. Opin. Insect Sci.* **23**, 70–80 (2017).
11. Hooper, D. U. *et al.* EFFECTS OF BIODIVERSITY ON ECOSYSTEM FUNCTIONING: A CONSENSUS OF CURRENT KNOWLEDGE. *Ecol. Monogr.* **75**, 3–35 (2005).
12. Stuart-Haëntjens, E. *et al.* Mean annual precipitation predicts primary production resistance and resilience to extreme drought. *Sci. Total Environ.* **636**, 360–366 (2018).
13. Leuzinger, S. *et al.* Do global change experiments overestimate impacts on terrestrial ecosystems? *Trends Ecol. Evol.* **26**, 236–241 (2011).
14. De Boeck, H. J. *et al.* Understanding ecosystems of the future will require more than realistic climate change experiments – A response to Korell et al. *Glob. Change Biol.* **26**, (2020).
15. Kayler, Z. E. *et al.* Experiments to confront the environmental extremes of climate change. *Front. Ecol. Environ.* **13**, 219–225 (2015).
16. Roy, J., Tardieu, F., Tixier-Boichard, M. & Schurr, U. European infrastructures for sustainable agriculture. *Nat. Plants* **3**, 756–758 (2017).
17. Verdier, B. *et al.* Climate and Atmosphere Simulator for Experiments on Ecological Systems in Changing Environments. *Environ. Sci. Technol.* **48**, 8744–8753 (2014).
18. Fernández-Martínez, M., Vicca, S., Janssens, I. A., Campioli, M. & Peñuelas, J. Nutrient availability and climate as the main determinants of the ratio of biomass to NPP in woody and non-woody forest compartments. *Trees* **30**, 775–783 (2016).
19. ESFRI. *Monitoring of Research Infrastructures Performance*. www.esfri.eu/sites/default/files/ESFRI_WG_Monitoring_Report.pdf (2019).

Tables and figures

Index of acronyms

ACTRIS Aerosol, Clouds and Trace Gases Research Infrastructure
AKPI AnaEE KPI (cf. KPI)
AnaEE Analysis and Experimentation on Ecosystems
AoM Assembly of Members
APF Associated Platform
ARISE Atmospheric Dynamic Research in Europe
ASAP As Soon As Possible

CERN Chinese Ecological Research Network
CIHEAM International Centre for Advanced Mediterranean Agronomic Studies
CNR Consiglio Nazionale delle Ricerche
CORDEX Coordinated Regional Climate Downscaling Experiment
CREA Consiglio per la Ricerca in Agricoltura e l'Analisi dell'Economia Agraria
CzechGlobe Global Change Research Institute of the Czech Academy of Sciences

DG Director General
DMC Data and Modelling Centre
DMP Data Management Plan

EMB Extended Management Board
EMPHASIS European Infrastructure for Plant Phenotyping
ENRIITC European Network of Research Infrastructures and Industry for Collaboration
ENVRI Environmental Research Infrastructures cluster
ERA European Research Area
ERIC European Research Infrastructure Consortium
ESA European Space Agency
ESFRI European Science Forum for Research Infrastructures
EU European Union
EUPHORISC European Plant Health Open Research and Innovation Starting Community

FAIR Findable Accessible Interoperative Re-usable
FAO Food and Agriculture Organization of the United Nations., Finance and Accounting Officer
FTE Full Time Equivalent

GHG GreenHouse Gas
GSL Growing Season Length

HR Human Resources

ICOS International Carbon Observatory System
IEAC Independent Ethical Advisory Committee
IPBES Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
IPCC Intergovernmental Panel on Climate Change
ISAC Independent Scientific Advisory Committee

KPI Key Performance Indicator

LTER Long-term Ecological Research

MB Management Board

NDACC Network for the Detection of Atmospheric Composition Changes
NEON National Ecological Observatory Network
NSF National Science Foundation (USA)

O3HP Oak Observatory at OHP: cf. OHP
OHP Observatoire de Haute Provence

PRC Proposal Review Committee

RCP Representative Concentration Pathway
RI Research Infrastructure

SDG Sustainable Development Goals
SHC Stakeholder Committee
SLA Service Level Agreement

TERN Terrestrial Ecosystem Research Network (Australia)
TWG Technology Working Group

UN United Nations
UWG User Working Group

WG Working Group

Glossary

Agro-ecosystem: Managed ecosystem with agriculture (cf. *ecosystem*).
AnaEE-ERIC: The legal structure of AnaEE (an ERIC) that includes the Central Hub, the Technical, Interface and Synthesis, and Data and Modelling Centres.
AnaEE-RI: The overall AnaEE distributed research infrastructure, that includes AnaEE-ERIC, the national nodes, and the network of experimental, analytical and modelling plat
Analytical platform: Facility that offers advanced biological, physical and chemical analyses for a deeper insight into processes.
Anthropic stress: Pressure of human origin that reduces ecosystem state and/or ecosystem functioning below optimal
Aquacosm: aquatic mesocosm that allows manipulations (cf. *mesocosm*). In AnaEE, all aquacosms are in freshwaters.
Ecosystem: A system that includes all living organisms (biotic component) in an area as well as its physical environment (abiotic component)
Ecotron: A set of enclosed experimental units hosting replicas of a given ecosystem (from few dm^3 to several m^3) where environmental conditions are tightly controlled and multiple ecosystem processes are automatically monitored. Ecotrons allow ecologists to run for several months to years experiments with controlled environmental factors such as temperature, rainfall, greenhouse gases, pollutants, etc. Cf. *ecosystem*, *experiment, enclosed platform*.
Enclosed platform: Controlled environment facility where replicas of a given ecosystem (from few dm^3 to several m^3) can be experimentally exposed to tightly controlled environmental conditions in enclosed units
Experiment: A test, trial, or tentative procedure; an act or operation for the purpose of discovering something unknown or of testing a principle, supposition, etc. (Collins English Dictionary). Cf. *manipulation*
Experimentation: The act, process, practice, or an instance of making experiments (Collins English Dictionary). In AnaEE manipulation of the conditions or environment of the ecosystem under study (either open-air or enclosed) to explore its behaviour.
Macrocosm: Large experimental object physically representing an ecosystem in enclosed platforms, consisting of for example several m^3 of soil with vegetation or a water body with aquatic organisms. Macrocosms are simplified ecosystems used to simulate and predict the behaviour of real ecosystems under controlled conditions.
Manipulation: A manipulation of the environment or conditions of an ecosystem in order to simulate environmental pressures such as climate warming, changes in rainfall regime, elevated atmospheric CO_2, different management practices, etc. Cf. *experiment*.
Mesocosm: Medium-sized experimental object physically representing an ecosystem in enclosed platforms, consisting of for example several dm^3 of soil with vegetation or a water body with aquatic organisms. Mesocosms are simplified ecosystems used to simulate and predict the behaviour of real ecosystems under controlled conditions.
Microcosm: Microscale experimental object physically representing an ecosystem in enclosed platforms, consisting of for example a test tube with microorganisms in soil or water. Microcosms are simplified ecosystems used to simulate and predict the behaviour of real ecosystems under controlled conditions.
Modelling platform: A user interface allowing to run numerical models in ecology to compute the behaviour of a simulated ecosystem under several initial conditions and measured (or simulated) experimental parameters. A modelling platform can host the models on its own computers or elsewhere.
Observation: Observation is the action or process of carefully watching someone or something (Collins English Dictionary). In the context of AnaEE and more generally environmental sciences, the process of

monitoring or surveying objects or phenomena on Earth or in the Universe without direct intervention on them (e.g. measuring the greenhouse gases over time).

Open-air platform: An experimental platform in open-air conditions (*in natura*) allowing the manipulation of several environmental pressures (e.g. rainfall, heating, management practices, etc.). The platforms can be installed in several ecosystem types (forest, grassland, peatland, fields, unmanaged land, etc.), as well as several climate types (Mediterranean, sub-arctic, alpine, etc.).

Platform: In the AnaEE context the unit where the activity (experimental, analytic or modelling) is performed; platforms are not belonging to AnaEE, but linked to it thanks to a Service Level Agreement. Cf. *enclosed platform* and *open-air platform*

Service Centre: one of the AnaEE centres where additional services are provided to the users, stakeholders or to the platforms.

Service Level Agreement: A legal agreement binding AnaEE and a (group of) platform. Services, such as experiment accommodation, data and metadata production and open access, are provided by the platform to AnaEE and the users. In turn, AnaEE provides services to the platform such as visibility, open and FAIR access to the data, technological expertise, modelling, transnational access, link with other platforms and RIs, etc.

User: The external commissioner of services from AnaEE.


AnaEE
Analysis and Experimentation on Ecosystems