ExpeER

Distributed Infrastructure for EXPErimentation in Ecosystem Research

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SEVENTH FRAMEWORK PROGRAMME

Capacities

Integrating activities: Networks of Research Infrastructures (RIs)

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Deliverable title: Current capacities of the ExpeER facilities – updated version

Abstract:

The report provides a classification and brief evaluation of the ExpeER facilities in terms of their ecosystem coverage, spatio-temporal resolution and challenges still faced by the facilities. The basis of the report consists of information provided by site managers through questionnaires, fact sheets and visits.

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Glossary

DOW: Description of work
TA: Transnational Access
HIES: Highly instrumented experimental site
HIOS: Highly instrumented observational site

1. Executive summary

The ExpeER research network includes four types of research infrastructure distributed across 33 facilities within 13 European countries. These include Highly Instrumented Experimental and Observational Sites (HIES & HIOS, 29), Analytical Facilities (2) and Ecotrons (2), which provide state of the art analytical equipment and controlled environment facilities for ecosystem research. The extent of the research capability at each site was evaluated using a questionnaire concerning information on the ecosystems under study, the main research disciplines employed (e.g. meteorology, biogeochemistry, hydrology, atmospheric chemistry etc.), and the technical services available at 29 of the 33 facilities. Information on 11 principal research capacities was illustrated graphically using radial charts to characterise the main focus of research at each site. These research capacities were summarised for all 29 sites to evaluate the overall strengths and weaknesses of the ExpeER network. The questionnaire responses revealed that the sites are located within seven climatic zones, including humid subtropical, oceanic, continental, semiarid, subtropical (dry), subarctic, and highland with annual rainfall and air temperature ranging from 500-2500 mm and <5 - >15^{o}C, respectively. About 50% of the sites demonstrated relatively high levels of capacity with respect to meteorological observations and monitoring of soil physical parameters, atmospheric analyses and autotrophic organisms. In addition, the majority of sites have the high levels of technical service necessary to facilitate good quality ecosystem research. However, site responses relating to experimental manipulations, biodiversity studies, hydrology and soil characterisation indicated a need for improvement in these areas at many sites. There was also an indication that there may be the need to increase the number of ecosystem studies at some sites to enhance the number of potential comparisons between similar ecosystems located in different climatic zones. Further work to identify sites suitable for the establishment of new studies will be included in other work packages.

2. Introduction

1.1 Background

Terrestrial ecosystem research in Europe is fragmented due to the wide diversity of ecosystem types (forests, grasslands, arable lands, marshlands, heathlands, ponds, lakes, rivers etc.), and the lack of communication between the different branches of ecosystem research. Often, research carried out in specific disciplines such as hydrology, microbiology and crop production is carried out without linking the different areas together. The current fragmentation between disciplines is a key barrier for an integrated approach, which is needed to solve environmental problems raised by today's society. Since research is fragmented so are the existing facilities for ecosystem research. Facilities range from laboratories to field sites, from experimental to observational sites with varying degree of instrumentation. The key aim of the ExpeER project is to upgrade and interconnect both experimental platforms and long-term observation sites for ecosystem research throughout Europe. The overall objective of this project is to defragment the ecosystem research community by enhancing the integration of highly instrumented European research infrastructures in order to facilitate the development of a multidisciplinary approach to ecosystem research under global change forcing. The scientific value of these infrastructures can be optimised with the introduction of up-to-date technology, and by improving their complementarities and interactions.

2.2 Objective

The objective of the work reported here is to review and evaluate 33 ExpeER facilities, including a summary of ecosystem types covered together with their geographic regions, as well as a summary of the instrumentation, methods, experimental and observational design used at each site. Strengths and weaknesses of facilities in terms of spatio-temporal scales, resolution and control factors are evaluated, as well as their European-wide geographic and ecosystem coverage. This information will be available to all ExpeER partners through a report and an easily accessible overview on the project webpage.

2.3 Linking to other work packages

The work in WP1 provides a first comprehensive review of the sites and basic information for WP5 (communications, fact sheets). It will also be useful for selecting variables and parameters to be standardised by WP2. WP7 and WP8 can use the information as a background for spreading the new technology and methodology; WP4 and WP5 can use it for a specifically organised scientific workshop, where site owners and scientists with experience from these components are invited. This will also be linked to the second task of WP1. The work in WP1 and WP5 is strongly linked to WP6 (Management of the calls for Access), since it forms a first basis for selecting sites that will be visited or where experiments will be conducted based on the specialisation of the individual site (modelling, geophysical exploration, biodiversity mapping etc.).

2.4 Updated D1.1 and new radial diagrams

In order for ExpeER to present each site as accurately as possible and to highlight its strengths and focus, site managers had to provide as much information as possible. After the first collection of information ended (June 2011), many of the questionnaires were still incomplete which made it difficult to analyse the complete capacities of the sites. Initiated by suggestions made by the site managers at the ExpeER WP1 workshop in Leipzig in February 2012, a new version of the questionnaire, accompanied by instructions on how to correctly complete it, was developed and sent to all site managers that belong to the ExpeER network in June 2012. The information provided in the questionnaires was used to generate new radial diagrams for 30 ExpeER sites that are included in this updated version of D1.1.

3. Method

Information on each of the 33 ExpeER facilities was gathered using a questionnaire developed in collaboration between the partners in WP1 and other ExpeER partners during and after the initial project meeting. For the final version a large part was adopted from a similar questionnaire developed in the project EnvEurope (Life Enviroment Project LIFE08 ENV/IT/000339) before it was sent to all partners. Ecosystem observations including those describing the physical state of the surrounding environment are made for a variety of reasons: for the evaluation of long-term changes or dynamics, and/or to increase the understanding of driving and feed-back mechanisms in addition to the various branches of specific species research. In contrast to more specific observations of natural processes such as weather observations (WMO, 2008), ecosystem observations can be performed in a number of different ways. Differences result from the selection of measured variables and parameters, instrumentation, and resolution in time and space. The appropriateness of an observation is the degree to which it accurately describes the value of the variable needed for a specific purpose. Appropriateness is not a fixed quality of any observation, but results from joint appraisal of instrumentation, measurement interval and exposure against the requirements of some particular application. These factors make it challenging to evaluate the quality of the different sites represented in the ExpeER project. The first task of WP1 was to outline classification criteria of the ExpeER infrastructure. Following preliminary discussions at the initial project meeting, it was anticipated that there would be four principal site categories:

Analytical platforms can range from virtual tools, web applications, statistics, software, work flows as well as laboratory facilities. The last category within the ExpeER framework is described in this report. These laboratories are equipped with a range of instruments for the measurement of a large variety of parameters on different types of samples (soil, plant, animals, microbes, air). In particular, they give information on specific molecules that enable an in-depth analysis of ecosystem processes (isotopes, volatile organic components, trace gazes etc.).

Ecotrons: Highly instrumented research platforms designed for ecosystem research under confined, controlled environments and replicated conditions, which allow for manipulation and measurements of complex ecological processes.

Highly Instrumented Observational Sites (HIOS): Highly instrumented research sites designed for long-term monitoring of ecological structures and processes.

Highly Instrumented Experimental Sites (HIES): Highly instrumented research sites designed for in-situ analysis of responses of ecological structures and processes to experimental treatments.

Highly instrumented research sites/facilities include those with sufficient instrumentation to allow monitoring (automatic or manual) of environmental and ecological parameters aiming to generate comprehensive data sets, which allow for hypothesis testing and validation of process-based models.

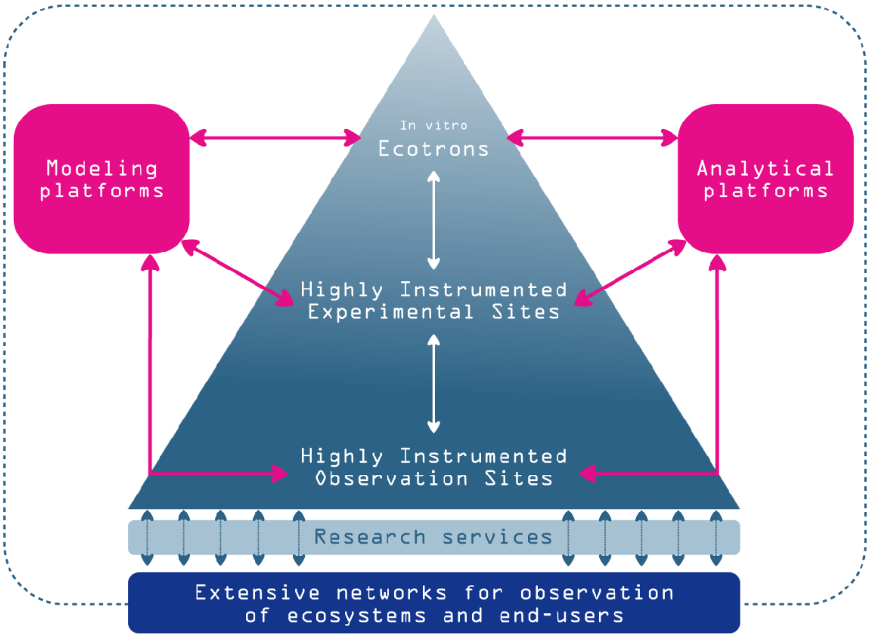


Figure 3.1 Link between the different compartments of the ExpeER project according to the DOW.

3.2 Overall classification of the ExpeER facilities

Based on the definitions given in section 3.1, the ExpeER facilities were asked to define which category they belonged to. These results are given in table 3.1. Some of the sites are defined as both HIES and HIOS. Information about all sites can also be found on the ExpeER web-site http://www.expeeronline.eu/.

Table 3.1. Classification of the different TA sites according to the questionnaire

N	TA site name	Country	Analytical platform	Ecotron	HIES	HIOS
1	Aachenkirch	Austria			x	
2	Apelsvoll	Norway			x	
3	Beano	Italy			x	
4	Braila Islands	Romania			x	x
5	Biodiversity exploratories	Germany			x	x
6	Biogeochemistry lab. BIOEMCO	France	x			
7	Donana	Spain				x
8	Ecosylve, (2)	France			x	x
9	Eifel (TERENO), (3)	Germany			x	x
10	Fruska gora	Serbia				x
11	Harz (TERENO)	Germany			x	x
12	Hesse	France			x	
13	Hyytiala (UHE-Hyde)	Finland				x
14	Höglwald	Germany			x	
15	Jena	Germany			x	
16	Klausen-Leopoldsdorf	Austria			x	
17	Lusignan	France			x	
18	Molecular Ecological Lab. (MEL)	Italy	x			
19	Montpellier	France		x		
20	Moor house	UK				x
21	Negev	Israel			x	x
22	Puéchabon	France			x	x
23	Roma-Lecceto (MedEWater)	Italy			x	x
24	Rothamsted	UK			x	x
25	Seehornwald (SEE Davos)	Switzerland			x	x
26	Silwood park	UK		x		
27	Tatra Windstorm	Slovakia				x
28	Tetto-Fratti (TF-LTEP)	Italy			x	
29	Therwill (DOK Trial)	Switzerland			x	
30	Tolfa-Allumiere	Italy			x	
31	Upper Severn	UK				x
32	Whim	UK			x	
33	Zöbelboden	Austria				x
	Total number	13	2	2	22	17

(n) n is number of sites as part of facility

3.3 Information provided by TA facilities

3.3.1 Questionnaire

Details about the ecotrons, analytical platforms and highly instrumented experimental and observational sites of ExpeER were collected by sending out individual questionnaires in the form of a spread sheet (provided in Appendix A). The questions to be asked and the required details were discussed among all TA managers and relevant WP leaders at the initial Kick-off meeting. After the meeting, further iterations with other WP leaders took place concerning the details, format structure and classification criteria used in other projects. It was important to include as much information as possible in these questionnaires in order to avoid multiple requests for the same data from different WPs. The completed questionnaires were made accessible via the ExpeER website (http://www.expeeronline.eu/) under the heading "Infrastructures".

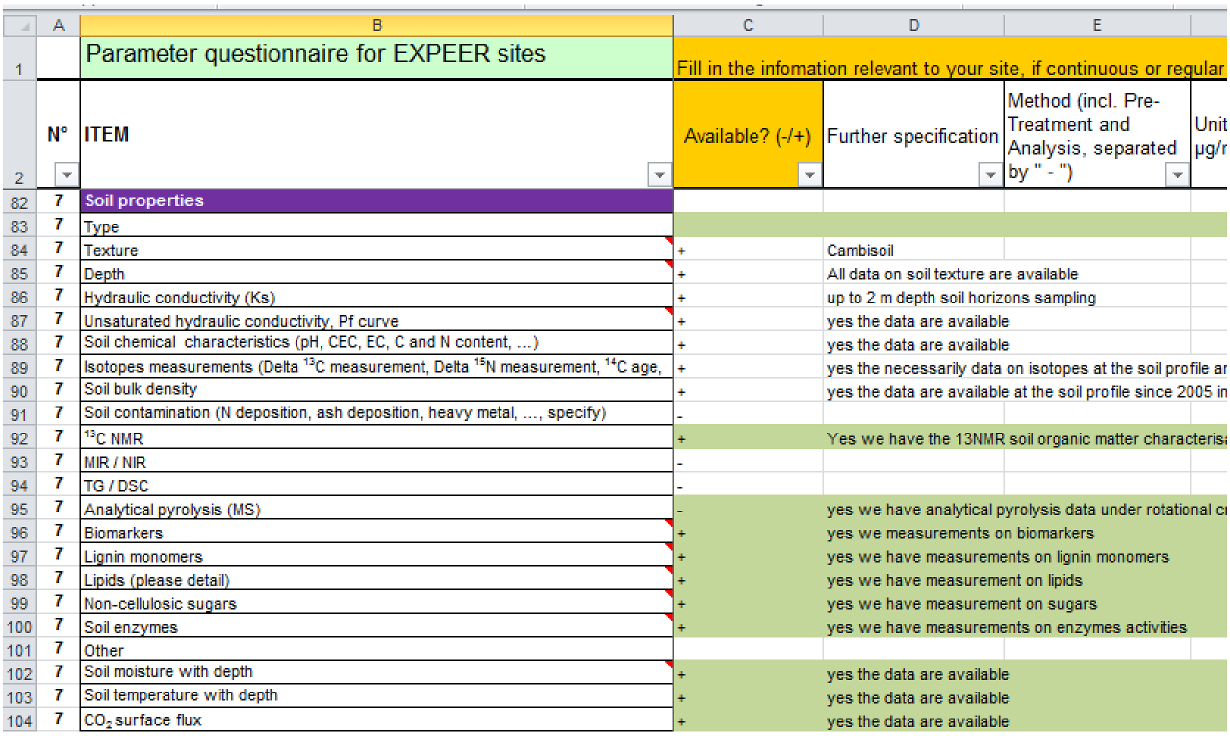
In addition to the questionnaire, each TA site was asked to provide a brief description of the facility together with a map reference and some photos. These constitute the fact sheets that were made available on the website in June 2011. They are supplied as Annex B with this report.

Interviews with contact persons and visits to some of the sites and facilities have been conducted, and will continue after this report. During these visits aspects such as accessibility of site, field procedures, type of experiment having been and being conducted, involvement of other research groups, stability of staff numbers, and financial situation with respect to incoming projects and areas for future development were discussed. Reports from the site visits conducted so far are included as Annex C. As more visits are conducted additional reports will be made available via the TA facility web pages on the ExpeER website.

A key objective of the ExpeER project is to identify how existing research facilities within Europe can be utilised in a more efficient and interdisciplinary way. This may include upgrading instrumentation to make them more complementary, and to enhance their potential for use by different research groups. However, a comprehensive evaluation of the methodologies used at all sites is beyond the scope of this project.

3.3.2 Site comparisons

The different sites have been established for different research objectives. Hence, there is often a different set of data that are collected, following different procedures and variable time resolution. Sites focussing on agricultural production have, for example, traditionally had most focus on crop production and nutrient efficiency. While other sites have had more focus on natural biotopes and development of biodiversity. In order to get a quick impression of the focus of the different sites we developed a diagram similar to those used to show water chemistry (e.g. Stiff diagram, Scholler diagram; see e.g. Domenico and Schwartz, 1998). In this case we simply used the first data column of the questionnaires which contains 1/0 data to indicate whether that specific property, parameter, variable or analysis exists in that field site or not. To illustrate the methodology, we show the example of soil properties (Fig. 3.2). In total there are 19 different properties that can be characterised. In this fictitious case a positive (+) response was given for 5 of the 19 possible properties giving a relative score of 26%. This was done for the site characteristics: ecosystem; technical services; manipulations/treatments; meteorological measurements on the site; soil properties; soil array measurement; local atmosphere; hydrological characterics; autotrophic compartment; heterotrophic compartment (procaryotic and eucaryotic); biodiversity. The maximum scores for the different characteristics are given in table 3.2. These scores do not necessarily reflect the quality of the facility, but indicate which characteristics have larger emphasis than others. For further information about which parameters have been selected for the different characteristics check the questionnaires in Annex A1. The percentage score for each characteristic for each site is shown below as a radial diagram (see section 5).



	A	B	C	D	E	
1		Parameter questionnaire for EXPEER sites	Fill in the infomation relevant to your site, if continuous or regular			
2	N°	ITEM	Available? (-/+)	Further specification	Method (incl. Pre-Treatment and Analysis, separated by " - ")	Unit µg/r
82	7	Soil properties				
83	7	Type				
84	7	Texture	+	Cambisoil		
85	7	Depth	+	All data on soil texture are available		
86	7	Hydraulic conductivity (Ks)	+	up to 2 m depth soil horizons sampling		
87	7	Unsaturated hydraulic conductivity, Pf curve	+	yes the data are available		
88	7	Soil chemical characteristics (pH, CEC, EC, C and N content, ...)	+	yes the data are available		
89	7	Isotopes measurements (Delta ^{13}C measurement, Delta ^{15}N measurement, ^{14}C age,	+	yes the necessarily data on isotopes at the soil profile ar		
90	7	Soil bulk density	+	yes the data are available at the soil profile since 2005 in		
91	7	Soil contamination (N deposition, ash deposition, heavy metal, ..., specify)	-			
92	7	^{13}C NMR	+	Yes we have the 13NMR soil organic matter characteris		
93	7	MIR / NIR	-			
94	7	TG / DSC	-			
95	7	Analytical pyrolysis (MS)	-	yes we have analytical pyrolysis data under rotational c		
96	7	Biomarkers	+	yes we measurements on biomarkers		
97	7	Lignin monomers	+	yes we have measurements on lignin monomers		
98	7	Lipids (please detail)	+	yes we have measurement on lipids		
99	7	Non-cellulosic sugars	+	yes we have measurement on sugars		
100	7	Soil enzymes	+	yes we have measurements on enzymes activities		
101	7	Other				
102	7	Soil moisture with depth	+	yes the data are available		
103	7	Soil temperature with depth	+	yes the data are available		
104	7	CO_2 surface flux	+	yes the data are available		

Figure 3.2 Part of the questionnaire showing the soil properties description.

Table 3.3 Maximum score for each site characteristics.

Site characteristics	Maximum score
Ecosystem*	6
Technical services	11
Manipulations/treatments	13
Meteorological measurements on the site	23
Soil properties	19
Soil array measurement	9
Local atmosphere	16
Hydrological characteristics	8
Autotrophic compartment	13
Heterotrophic compartment (procaryotic and eucaryotic)	8
Biodiversity	21

* Ecosystem relates to number of habitat types at the site

4. Evaluation of Ecotrons and Analytical platforms

4.1 Ecotrons

Under the ExpeER consortium the ecotrons have been defined as highly instrumented research platforms designed for ecosystem research under controlled (usually confined) environmental conditions, which allow the simultaneous manipulation and measurement of complex ecological processes in replicated mesocosms. Currently, only two facilities qualify as ecotrons in the ExpeER consortium: 1) The Ecotron – hosted by Imperial College London, UK and 2) Ecotron Européen de Montpellier, France. Since Rothamsted, UK, also has an advanced set-up of confined, environmentally controlled chambers, we also included a brief description of that. All three ecotrons have been visited, and reports on each of these are included in Annex C. Ecotrons are unique tools designed to give new insights in the ecological sciences at an intermediate scale between field and laboratory (from dm to m), and to provide a means to integrate experimental research in a way that is not possible with conventional in situ approaches. Whilst the underlying philosophy of the two ExpeER ecotron facilities is the same, they differ markedly in their structure and capabilities.

4.1.1 Silwood Park Ecotron (UK),

The ecotron opened in 1992 was the first European ecotron and contains an integrated series of 16 ($4m^3$) controlled environmental chambers with smaller confined chambers inside (Fig. 4.1). Its purpose was to establish simplified communities of terrestrial plants, animals and microbes as models of the real world. The facility bridges the gap between the complexity of real field communities and the simplicity of laboratory or greenhouse experiments. Its artificial climate simulates natural environmental conditions within chambers allowing experimental control over light, water, temperature, humidity and CO_2. Sensors monitor both macro- and micro-environmental conditions within the chambers. More recently, the ecotron has been adapted to function as an ecosystem analyser using mesocosms extracted from real ecosystems which are then subjected to recreated climatic conditions.

This facility was closed down in 2012 hence illustrating the vulnerability of the site caused by no regular funding mechanisms, initiators leaving the facility caused by work elsewhere and only two employees, one technician and a post-doc.

Figure 4.1 The Ecotron – a controlled environment facility designed for community and ecosystem research.

4.1.2 The Ecotron Européen de Montpellier (FR)

This ecotron was officially opened in 2011 and is the larger one of the two facilities. It is composed of three independent experimental platforms at different scales (Fig. 4.2). The macrocosms with 12 units of 30m^3 can accommodate soil monoliths from 2 to 12 tons under natural light. The mesocosms, with 24 units of 3m^3, can accommodate monoliths of 0,5 to 2 tons, and run under natural light. In addition, between 12 and 400 microcosms of 0,5 to 300dm^3 can be contained in laboratory conditions (confinement L2, one separate room for radioactive labelling). The number and size of microcosms depends on the ecosystem/organism studied. It has the flexibility to simulate a large array of environmental conditions such as climate (negative frost possible) and atmospheric chemistry including CO_2 and pollutant concentrations. Environmental variables can be set to simulate local conditions or other conditions based on data for other climatic scenarios. A major advantage of the infrastructure is its capacity to measure ecosystem processes. The automated on-line flux measurements of water, CO_2, CH_4 and NO are particularly useful in this respect. A strong emphasis is put on studies using stable isotope techniques (e.g. ^{13}C labelling of the organic matter and on-line measurements of ^{13}C and ^{18}O in CO_2).

Figure 4.2 The mesocosm platform in being built in front of the main building which hosts the microcosm platform and offices. The macrocosm platform (domes) is at the back. (Photo: J. Roy)

4.1.3 Controlled Environment Facilities at Rothamsted (UK)

The main controlled environment facility at Rothamsted was built in 2000/1 and houses 16 small (1.68m^2) growth cabinets, four large (8m^2) growth rooms and four medium size (6m^2) growth rooms (Fig. 4.3). Temperature control is provided in the range 5°C to 30 °C ± 0.3°C with

Figure 4.3 Growth cabinets

lights turned off, and 7°C to 35 °C ± 0.3°C with lights turned on. Humidity control is in the range of 65% to 95% ± 5% at 15°C to 25°C. CO_2-monitoring (Vaisalla GMT 222) and -control is fitted in the large growth rooms and 10 small cabinets. Artificial lighting is provided to simulate a range of light intensities. A Eurotherm 2704 controller, linked to a SCADA package, provides control.

4.1.4 Limitations and challenges

The current design of the ecotrons gives scientists the ability to perform experiments on entire model communities/ecosystems. Whilst recent technological advances allow for significant improvement in the control and monitoring of numerous environmental and biotic variables, we identified several areas with room for improvement:

1. *Improvement of the realism of the emulated climatic and hydrological conditions*.
   The realism of the environmental conditions and experimental treatments recreated in Ecotrons has always been a point of concern. Light quality has been the most often mentioned limitation which currently can be overcome by using a design that takes advantage of natural lighting or usage of solar simulators (sulphur plasma lights). Furthermore, hydrological conditions are known to determine many ecosystem processes. However, accurate representation of hydrological conditions such as realistic water table fluctuations and rainfall need to be improved. In the Montpellier ecotron there is some monitroing of the variation of water content and temperature with depth, while this is missing at the Silwood Park ecotron.

2. *Automatic monitoring of individual and multi-species population dynamics.*
   There is an increasing need for high resolution data on the dynamics of populations for model testing. These populations could include soil fauna (soil insects, mites, nematodes etc) and flora (bacteria and fungi). Automatic and continuous monitoring of individuals in populations has seldomly been used in ecotron experiments. Methodologies such as canopy irradiance measurements, high definition video recording and radio tagging of individuals, which can provide high resolution data on spatial and temporal dynamics of aboveground population and individuals, is currently not implemented in ecotrons. Manual measurements within mesocosm chambers such as those at the Montpellier ecotron is difficult because of the CO_2 release from personel conducting the work. Furthermore, the equivalent methodology to study belowground communities is lacking.

3. *Limited availability.*
   Although research testing ecosystem and community responses in controlled environment conditions have helped develop a mechanistic understanding of many ecosystem processes, the building and maintenance costs of ecotron facilities are prohibitive. Consequently, there are relatively few such facilities available for ecosystem studies. Currently, access to good ecotron facilities is a key factor limiting the implementation of hypotheses driven experiments across multiple ecosystems. Furthermore, certain types of ecosystems cannot yet be accommodated in current facilities (e.g. forest, arctic, alpine and desert ecosystems).

4.2 Analytical platforms

4.2.1 Biogeochemistry laboratory, BIEMCO (France)

The BioEMCO research platform involved in ExpeER is located in Grignon, 30 km west of Paris, at the campus of the “Institut National Agronomique”. The BioEMCO platform is composed of two separate units: one working on soil organic matter dynamics and one working on global change effects on CO_2 and H_2O transfers. A common feature of these two platforms is the use of stable isotopic chemistry for studying the cycles of C, N and water in terrestrial environments. The CO_2 and H_2O team has advanced growth chambers where multiple measurements on water and CO_2 stable isotopes can be conducted. The soil organic matter team is mainly specialized in compound-specific stable isotope chemistry (Fig. 4.4). The SOM team has 3 GC-IRMS units. One is dedicated to both molecular and elemental isotopic analysis, one to $^{13}CO_2$ analyses, and one exclusively to compound-specific isotopic analyses. The SOM team also operates three GC, two of them coupled to mass spectrometry for compound identification, and one coupled to a FID for quantification. The main families of molecules in soils being studied with the compound-specific ^{13}C analyses are lignins, sugars, cutins & suberins and PLFAs. Multiple preparation methods from flash pyrolysis to wet chemistry extractions are used to prepare the samples before isotopic and chemical analyses. The laboratory is pioneering the development of techniques for ^{13}C analyses of these families of compounds. The laboratory is regularly hosting international researchers. The presence of engineer and technicians at BioEMCO is an element contributing to the success of short-term visits for international scientists, such as in the case of ExpeER.

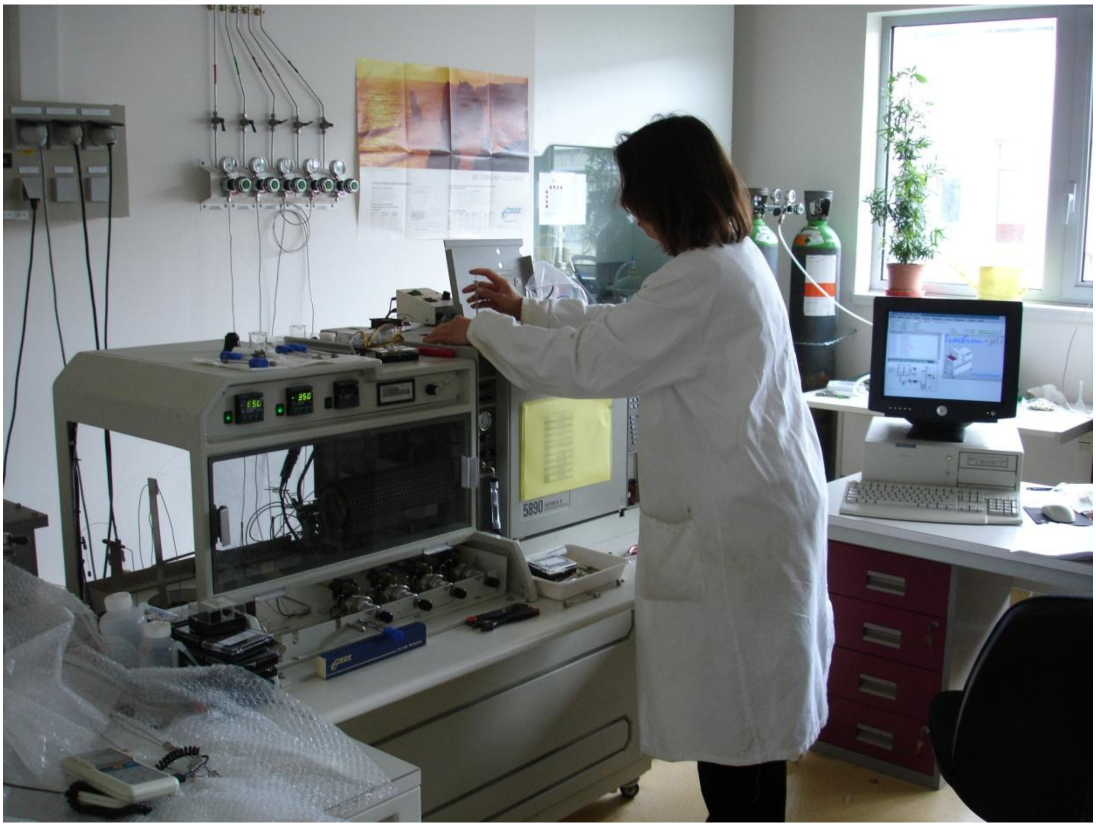


Figure 4.4 One of the analytical facilities of the BIOEMCO platform. (Photo: BIOEMCO)

4.2.2 Molecular ecology laboratory, MEL (Italy)

Molecular Ecology Laboratory (MEL) is distributed among three sites: CNR Research Institutes of Porano, Firenze (biosphere-atmosphere interactions and genomics) and Bologna (ecophysiology and atmospheric chemistry). The group in Porano is focussed on biogeochemistry and operates isotopic mass ratio spectrometers (IRMS) for analysis of stable isotope abundances of C, O, N, H (IR-MS). They are also using portable and laboratory based NMR spectrometers. The group in Bologna is focussed on ecophysiology and atmospheric chemistry. To this end, and in collaboration with Porano, they use high resolution spectrometry (HRGC-MS) systems for positive identification and quantification of volatile components (C4-C16); Fourier Transform Mass Spectrometer (ICR) for measuring the kinetic constants between ionic and neutral atmospheric components; 2 proton transfer reaction-mass spectrometers (PTR-MS) for on-line detection of trace gases in air; and 2 gas chromatograph-mass spectrometers (GC-MS) for trace gases identification and quantification. The third group in Florence is associated with the Institute of Plant Protection and is mostly focussed on molecular genetics with sequencers + rt-PCR instrumentation for the determination of the molecular (genetic) background driving metabolite formation.

The advanced equipment is mainly used and maintained by the scientists themselves. The analytical platform of MEL is state-of-the-art and can serve many research questions in the field of ecosystem and environmental research. For example, one of their own recent main fields of investigation is urban forests, with an emphasis on VOC production. The MEL platform also appears very complementary to that of BioEMCO in France. Indeed, while BioEMCO focuses mostly on solid state soil organic matter, MEL is looking at biosphere-atmosphere exchanges and volatile compounds (Bologna / Porano) and molecular genetics (Firenze).

5. Evaluation of experimental and observation sites

As the classification of the ExpeER field sites showed (table 3.1) some highly instrumented sites are both experimental (HIES) and observational (HIOS). Monitoring the natural processes at the catchment scale can be considered observational. If minor manipulations within smaller areas of the same catchment do not affect the overall performance, these sub-sites can be considered experimental. In this chapter we attempt to give an overview of geographic and ecosystem coverage as well as describe, evaluate and compare the extent to which each of the key environmental parameters can be studied at each of the sites.

5.1 European wide geographic and ecosystem coverage

Evaluation of the ExpeER site questionnaires showed that the main ecosystems represented included peatland, forest, grassland, agriculture and coastal areas (Table 5.1.). Some of the sites consisted of only one ecosystem while others include several.

Table 5.1 Table of Ecosystems/habitat types covered by the ExpeER field sites.

TA site name	Country	Peatland	Forest	Grassland	Agriculture	Coast
Achenkirch	Austria		x			
Apelsvoll	Norway				x	
Beano	Italy				x	
Braila Islands	Romania	x	x	x	x	
Biodiversity exploratories	Germany		x	x		
Donana	Spain	x	x		x	x
Pierroton, (2)	France		x			
Eifel, (3)	Germany		x	x		
Fruska gora	Serbia		x	x		
Harz/Central German Lowland	Germany		x		x	
Hesse	France		x			
Hyytiala	Finland		x			
Höglwald Forest	Germany		x			
Jena Experiment	Germany			x		
Klausenleopoldsdorf	Austria		x			
Lusignan	France			x	x	

Moor House	UK	x		x		
Negev	Israel		x			
Puechabon	France		x			
Roma-Lecceto	Italy		x			
Rothamsted	UK			x	x	
Seehornwald	Switzerland		x			
Tatra Windstorm	Slovakia		x			
Tetto Frati	Italy				x	
Therwil	Switzerland				x	
Tolfa-Allumiere	Italy		x			
Plynlimon	UK		x	x		
Whim	UK	x				
Zöbelboden	Austria		x			
Total number		4	20	9	10	1

(n) n is number of sites as part of facility

The climate zones of Europe and the location of the ExpeER facilities is shown in figure 5.1, to summarise we find the following numbers of sites within each climatic zone; Humid Oceanic: 14, Humid Continental: 9, Subtropical dry summer: 5, Humid Subtropical: 1, Subarctic: 2, Highland :2. More specifically annual precipitation and annual mean temperatures are shown in figures 5.2 and 5.3.

The ecosystem classification shown in figure 5.4 is defined by the European Environmental Agency. As mentioned earlier European wide ecosystem coverage was not the main criteria for selection, but rather the instrumentation of the sites, which is clearly visible from figure 5.4. The geographic spread of the facilities however does cover some of the outer boundaries of Europe such as in the south: Donana in Spain, Roma-Lecceto in Italy and even outside Europe: Negev in Israel, in the north: Hyytiala in Finland, Apelsvoll in Norway and to the east: Braila islands in Romania and to the west: Upper Severn in Wales. The European ecosystem map is of course much too coarse to give a representative picture of which systems are in the facilities, hence the listing in Table 5.1.

Whilst many of the sites fall broadly within the same Ecosystem class, this is not the case when considering climate zone and annual precipitation . Although ecosystem coverage by no means is complete within the ExpeER network, all sites represent a unique combination of climatic, physical and biological factors which influence their specific ecosystems.

Figure 5.1 Climatic zones of Europe and ExpeER facilities, based on the Köppen-Geiger classification (taken from http://printable-maps.blogspot.com/2008/09/map-of-climate-zones-in-europe.html)

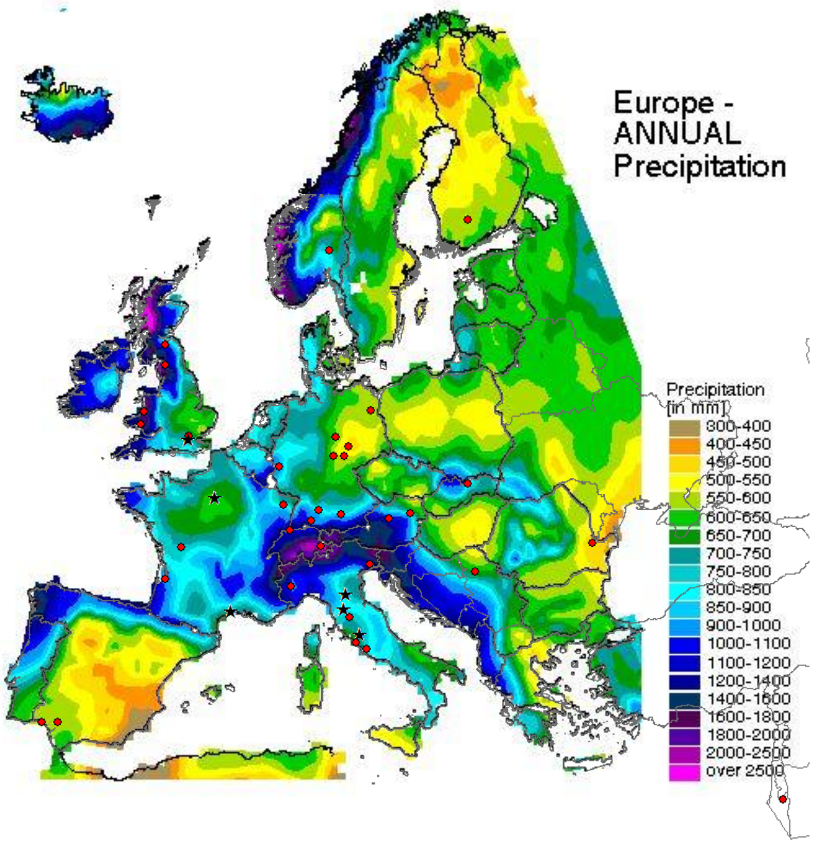


Figure 5.2 Mean annual precipitation in Europe including ExpeER sites (taken from http://printable-maps.blogspot.com/2008/09/map-of-climate-zones-in-europe.html)

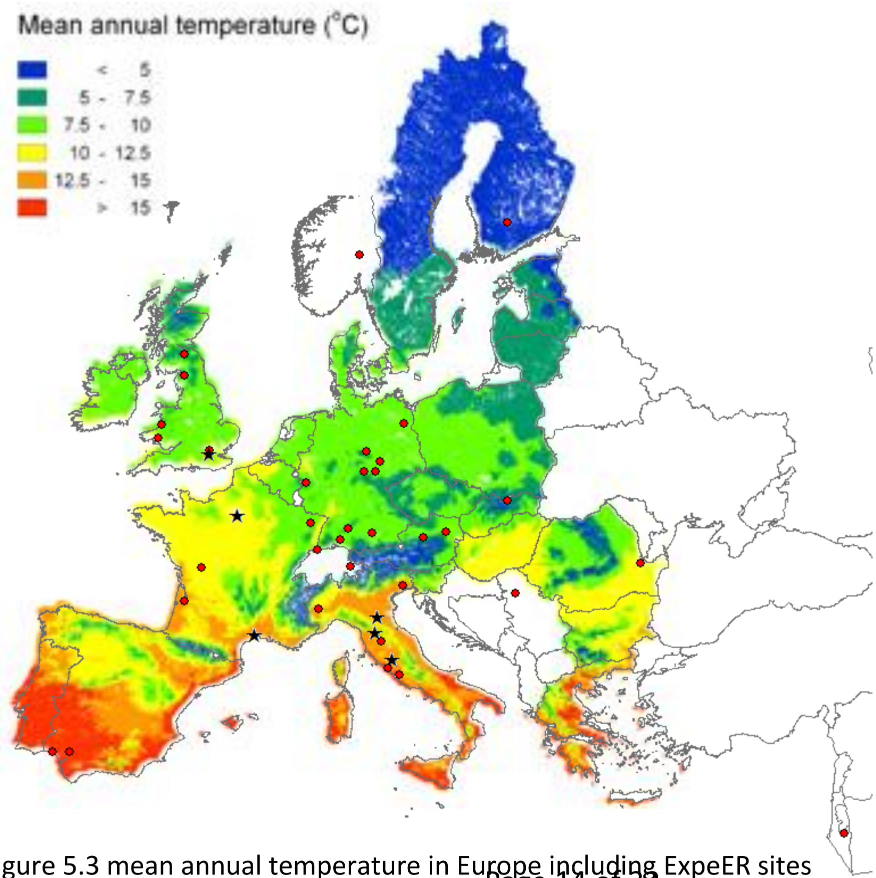


Figure 5.3 mean annual temperature in Europe including ExpeER sites

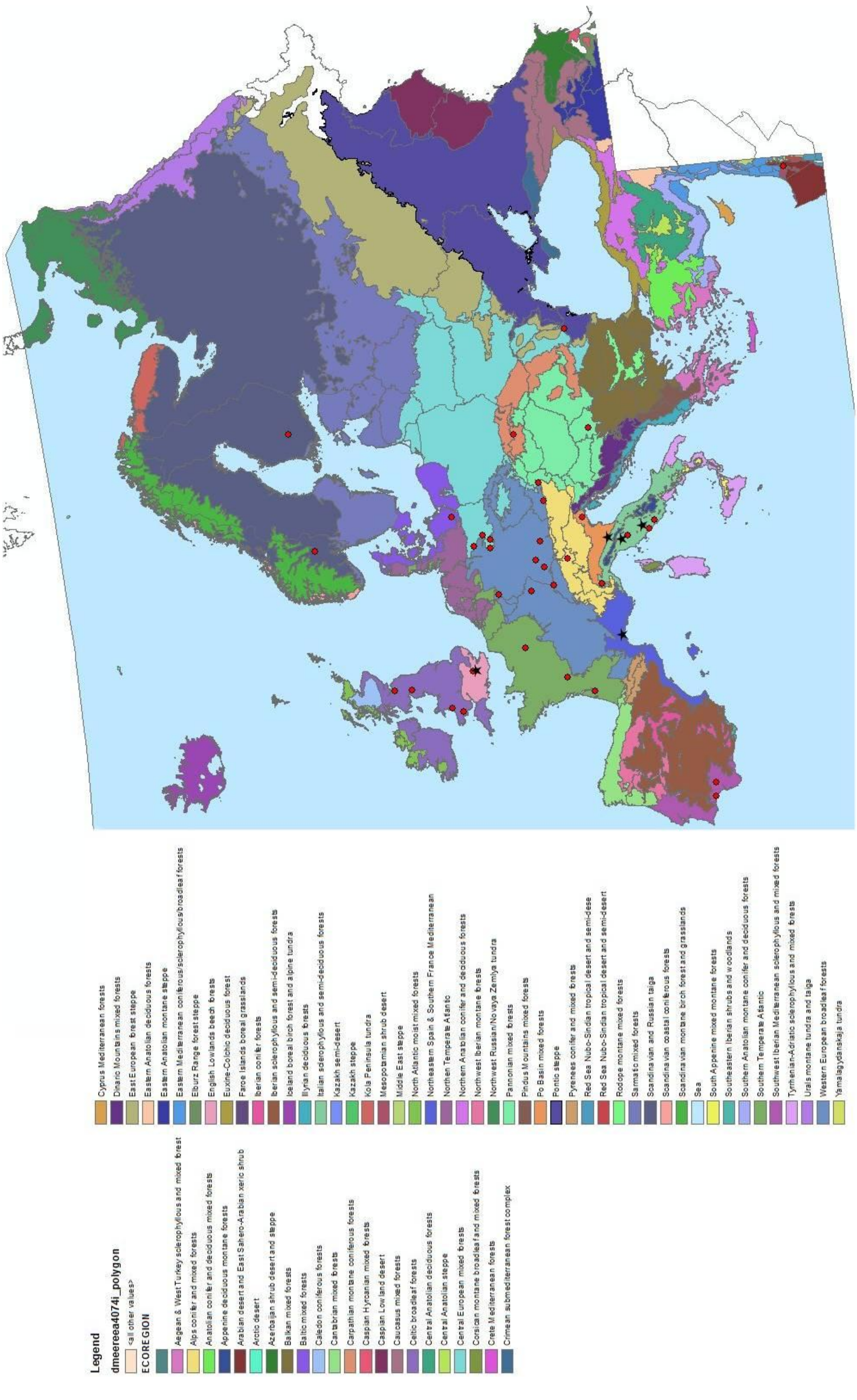


Figure 5.4 Locations of EXPEER, TA sites and Ecoregions of Europe according to EEA

5.2 Site characteristics

For any experimental or observational field site, good monitoring systems for natural conditions are required, the minimum being meteorological data. Next might be to consider the system characterisation and monitoring system, here there will often be a divergence among the different sites depending on the focus of the researchers who originally designed the field site, for example the focus could have been biodiversity, soil chemistry, flow and transport processes. The initial focus may be reflected in the radial diagrams shown in Figure 5.5.

When we consider the full ecosystem however, we cannot isolate these different areas of research as separate units. To understand the full dynamics of an ecosystem we need the meteorological conditions, the hydrological conditions, surface and subsurface water and temperature, the chemical composition of rain as well as the subsurface water, and the biogeochemical conditions of the site, including flora and fauna.

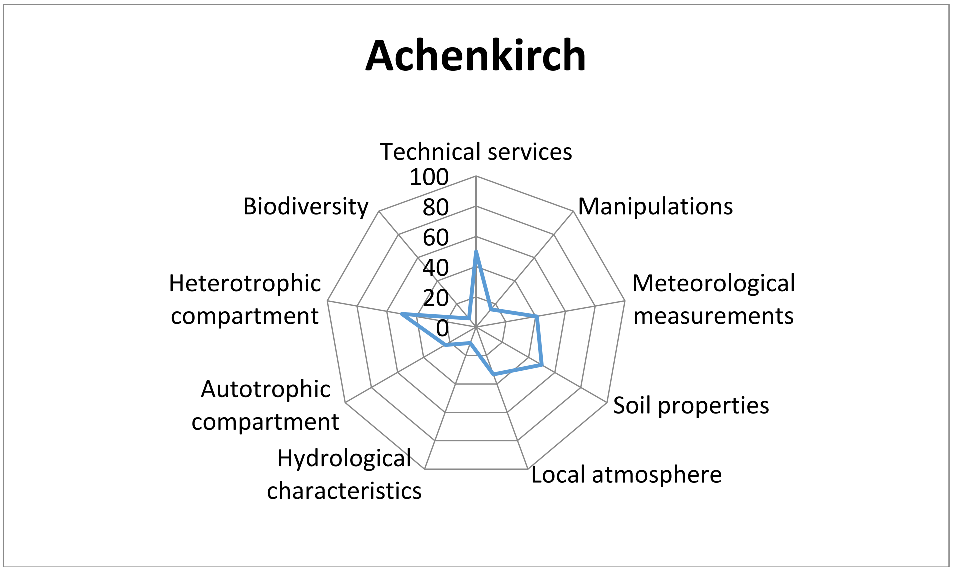
The control of gaseous fluxes and concentrations above and below ground are also important. Other factors that need to be considered are dry deposition, nutrient balance, carbon balance, yield, composition and dynamics of vegetation above and below the ground etc. This point is discussed further in the next section where we discuss the areas for future development identified by the ExpeER site managers. For the system characterisation we can consider the number of parameters or variables that are included, but factors such as spatial coverage in relation to size of site and temporal resolution are factors that indicate quality of the sites. In short, the quality of a site lies in the potential of the data collected at the site to be used to calibrate and validate process based models.

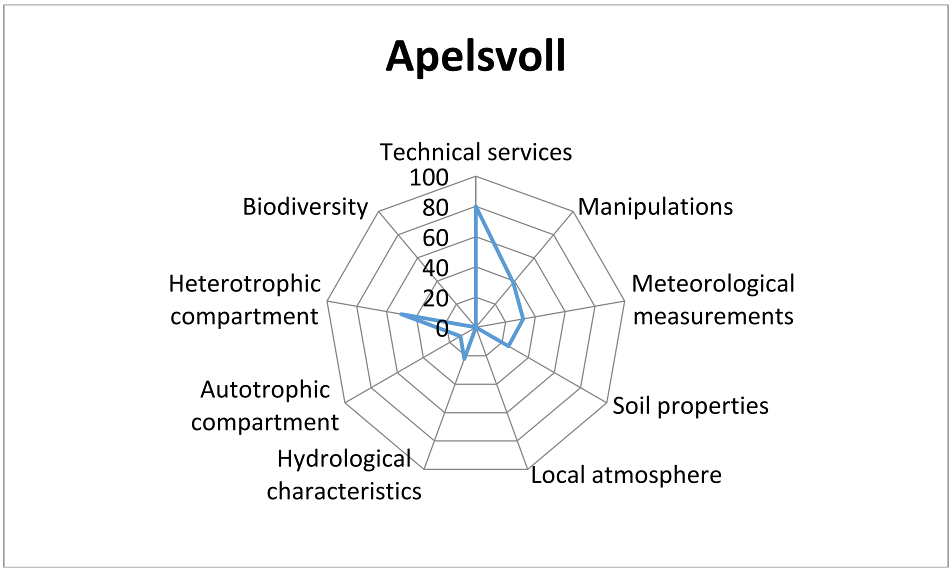
For experimental sites, the number of possible manipulations and the monitoring and control of these will be important for the evaluation of their performance. In Figure 5.5 the number of parameters and variables considered at the different sites is analysed according to procedure described in section 3.3 and the results are presented graphically for all the field sites. This way of presenting the sites, does not identify quality of sites in terms of how good the temporal and spatial coverage is but gives a ‘fingerprint’ of the research emphasis of the different ExpeER field sites. The advantage of this method is that both focus and location can be displayed in the same figure. Here, however, we show the maps and site fingerprints separately in order to get a better view of details.

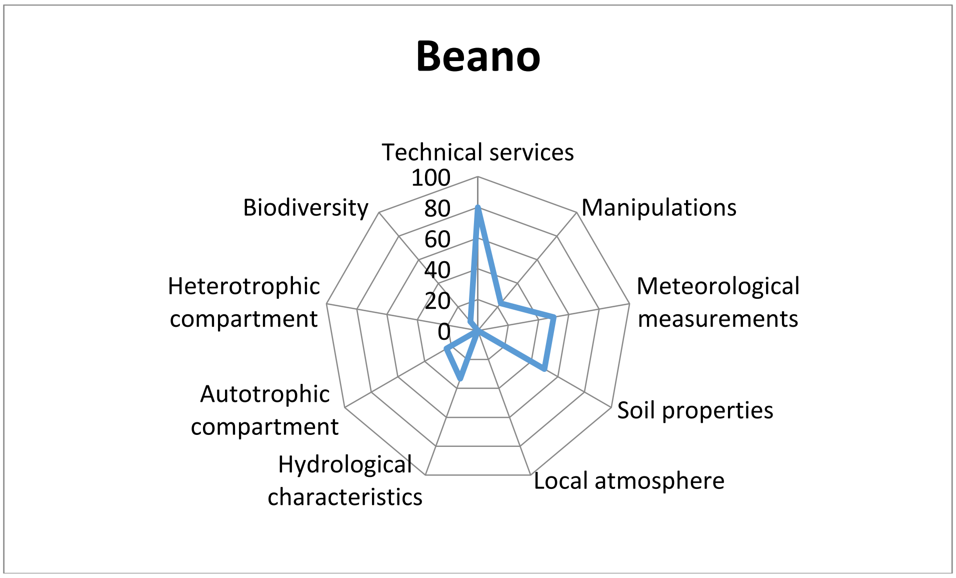
Radial diagrams were found to be a useful to visually highlight the research focus at each site, however, concerns were raised by site managers after the first collection of information that low scores on an axes could be interpreted as an indication of poor quality of the site, while it may just result from some sites being more scientifically focused than others. Site manager involvement at an EXPEER workshop in 2012 resulted in the change of categories (axis) as demonstrated in Table 5.2. Ideally, the diagrams should only be published accompanied by a short analysis/explanation that synthesizes the data provided in the questionnaire.

Table 5.2 Overview over categories (axis) in the old and new version of the radial diagrams

#	Category	Initial version	New version
1	Ecosystem	+	Not included in radial diagrams
2	Technical services	+	+
3	Manipulations	+	+
4	Meteorological measurements	+	+
5	Local atmosphere	+	+
6	Hydrological characteristics	+	+
7	Soil properties	+	+
8	Soil array measurements	+	Category removed from questionnaire
9	Autotrophic compartment	+	+
10	Heterotrophic compartment	+	+
11	Biodiversity	+	






Beano
Technical services
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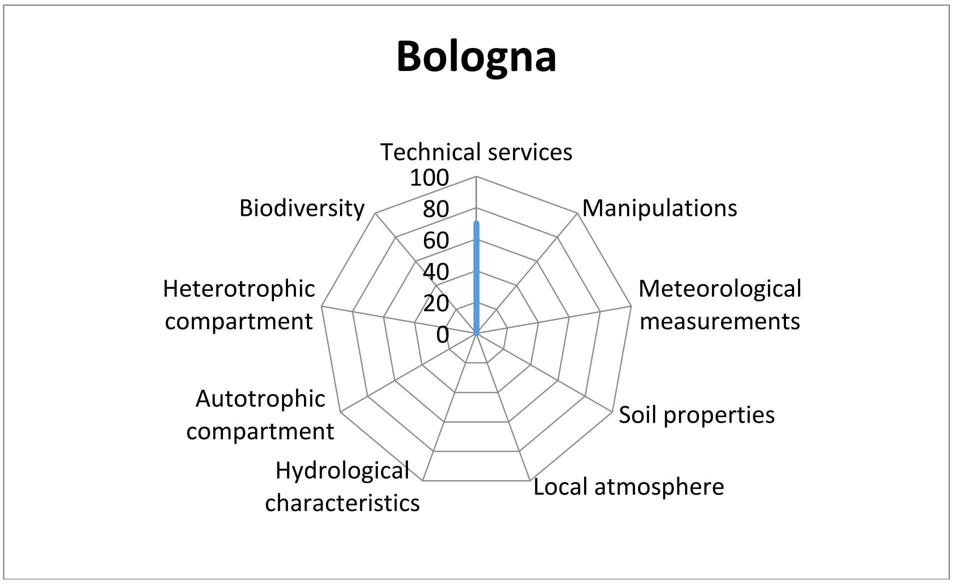
Manipulations
Meteorological measurements
Soil properties
Local atmosphere
Hydrological characteristics
Autotrophic compartment
Heterotrophic compartment
Biodiversity


Bologna
Technical services
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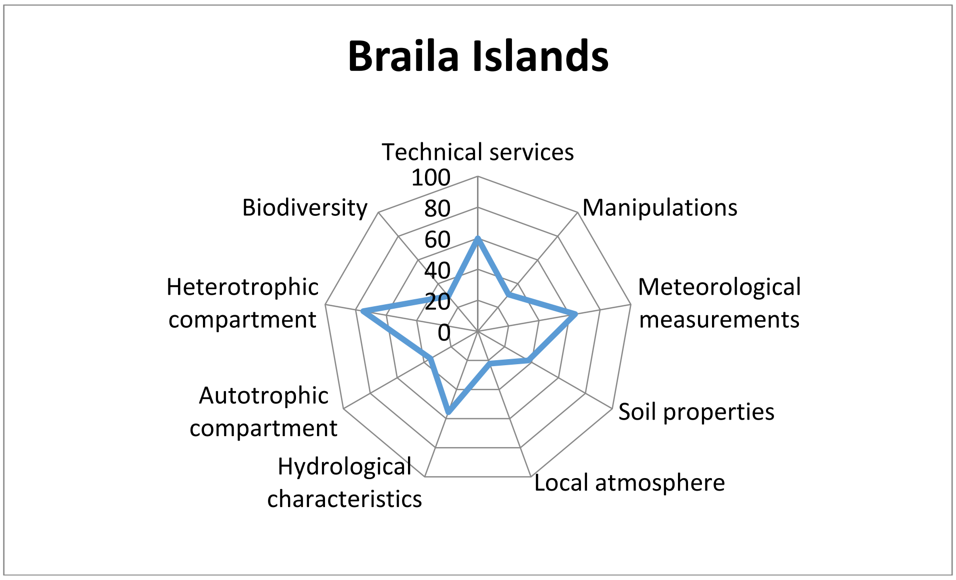
Manipulations
Meteorological measurements
Soil properties
Local atmosphere
Hydrological characteristics
Autotrophic compartment
Heterotrophic compartment
Biodiversity


Braila Islands
Technical services
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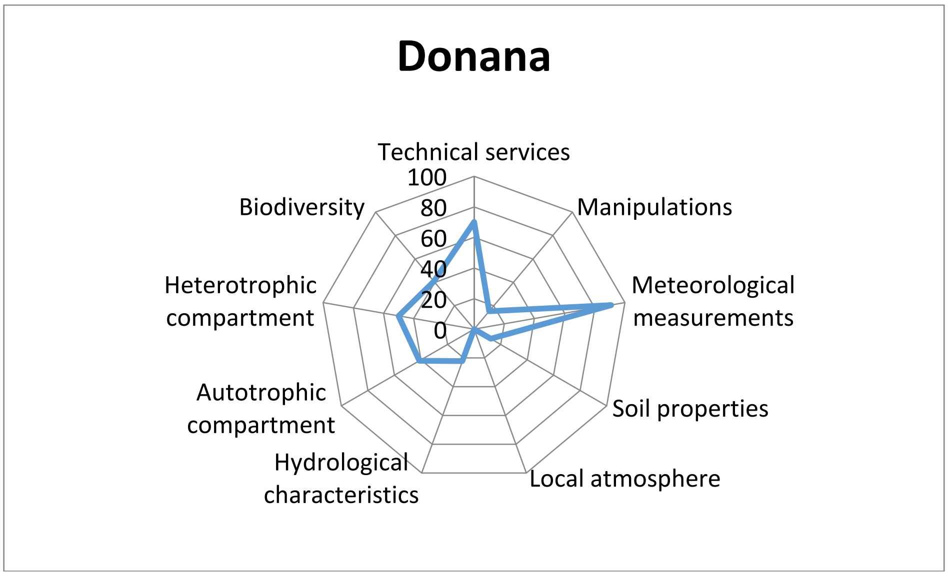
Manipulations
Meteorological measurements
Soil properties
Local atmosphere
Hydrological characteristics
Autotrophic compartment
Heterotrophic compartment
Biodiversity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Technical services
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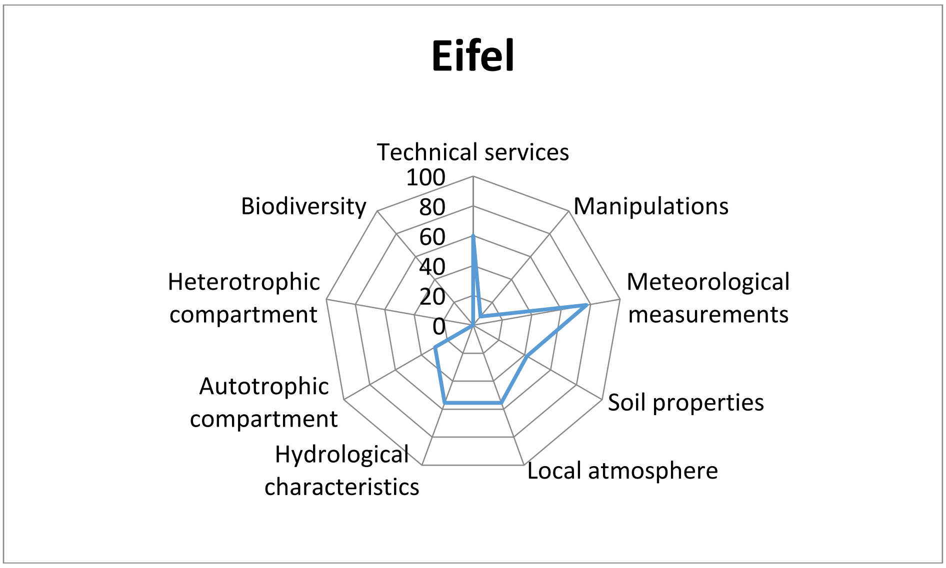
Manipulations
Meteorological measurements
Soil properties
Local atmosphere
Hydrological characteristics
Autotrophic compartment
Heterotrophic compartment
Biodiversity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Technical services
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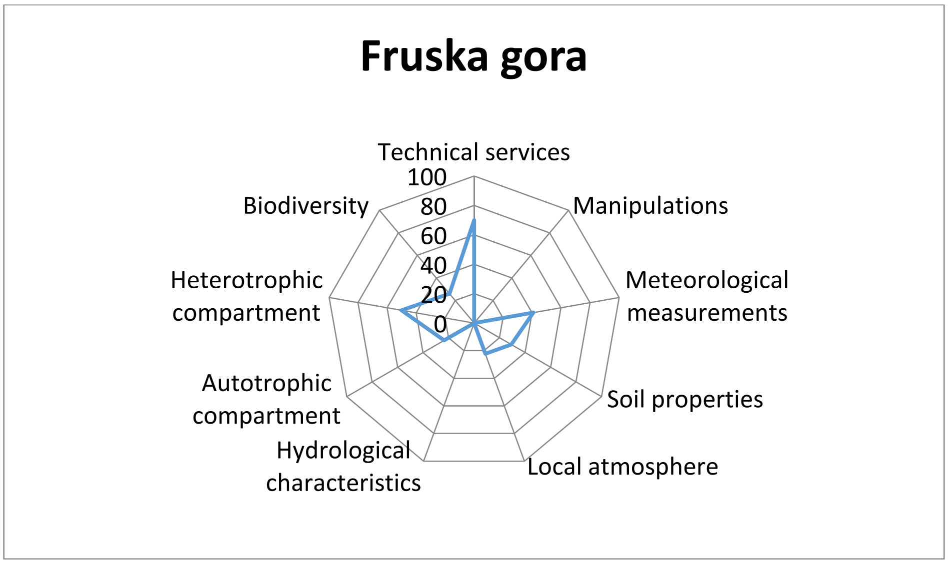
Manipulations
Meteorological measurements
Soil properties
Local atmosphere
Hydrological characteristics
Autotrophic compartment
Heterotrophic compartment
Biodiversity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Technical services
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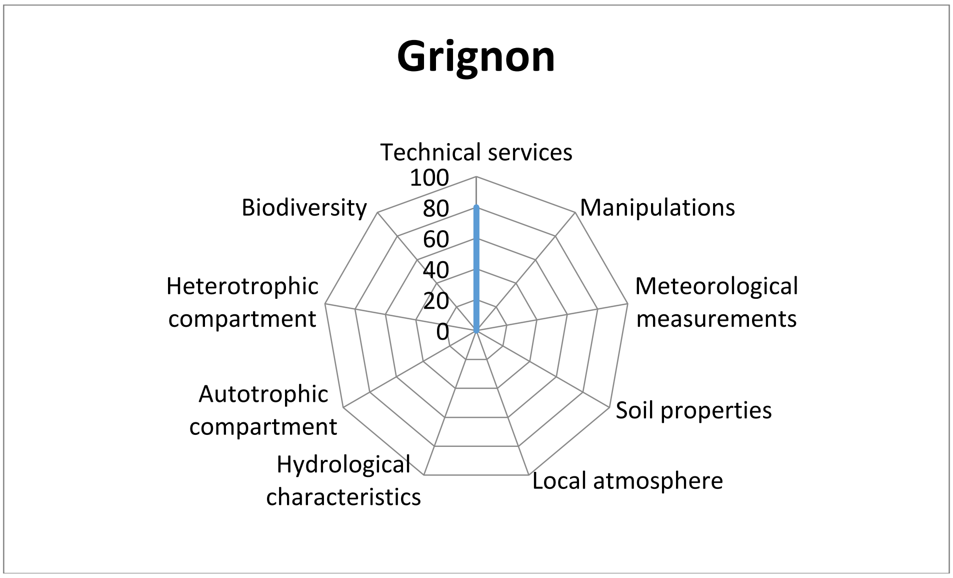
Manipulations
Meteorological measurements
Soil properties
Local atmosphere
Hydrological characteristics
Autotrophic compartment
Heterotrophic compartment
Biodiversity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Technical services
Manipulations
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Soil properties
Local atmosphere
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Autotrophic compartment
Heterotrophic compartment
Biodiversity
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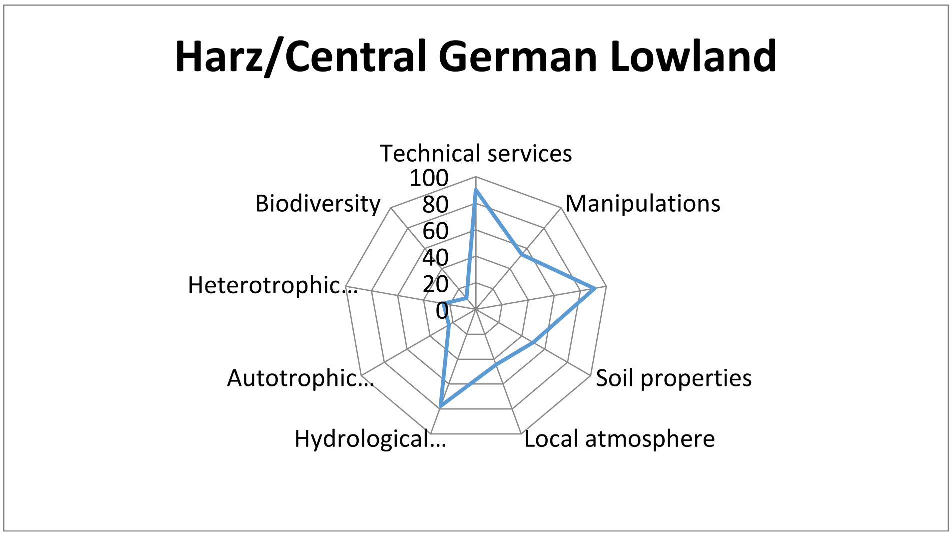
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Soil properties
Local atmosphere
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Autotrophic...
Heterotrophic...
Biodiversity
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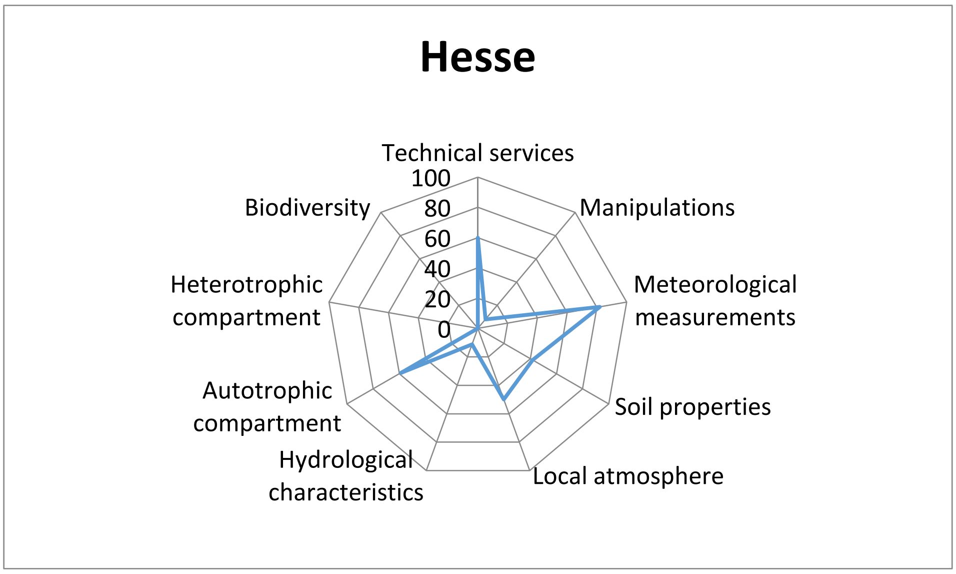
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Technical services
Manipulations
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Soil properties
Local atmosphere
Hydrological characteristics
Autotrophic compartment
Heterotrophic compartment
Biodiversity
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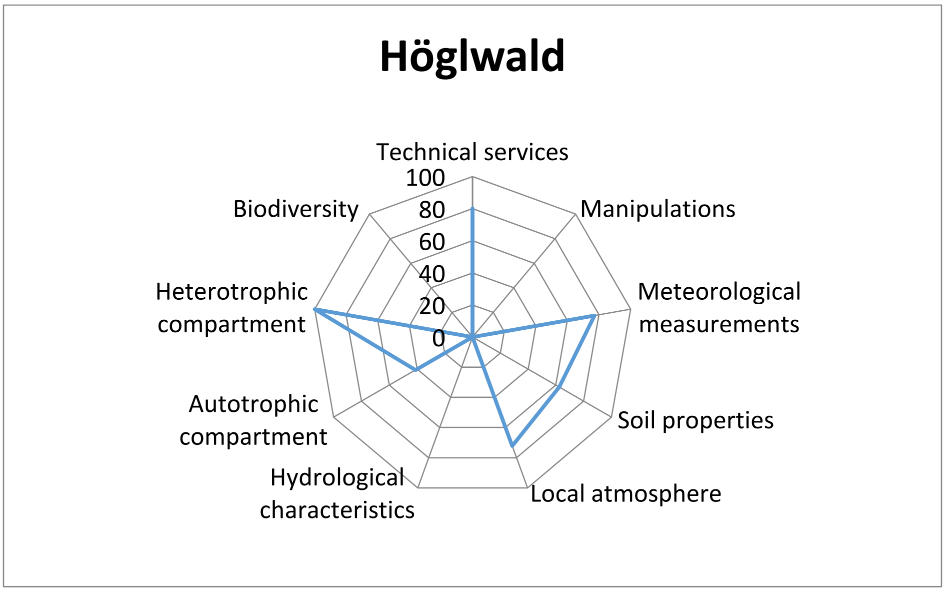
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Technical services
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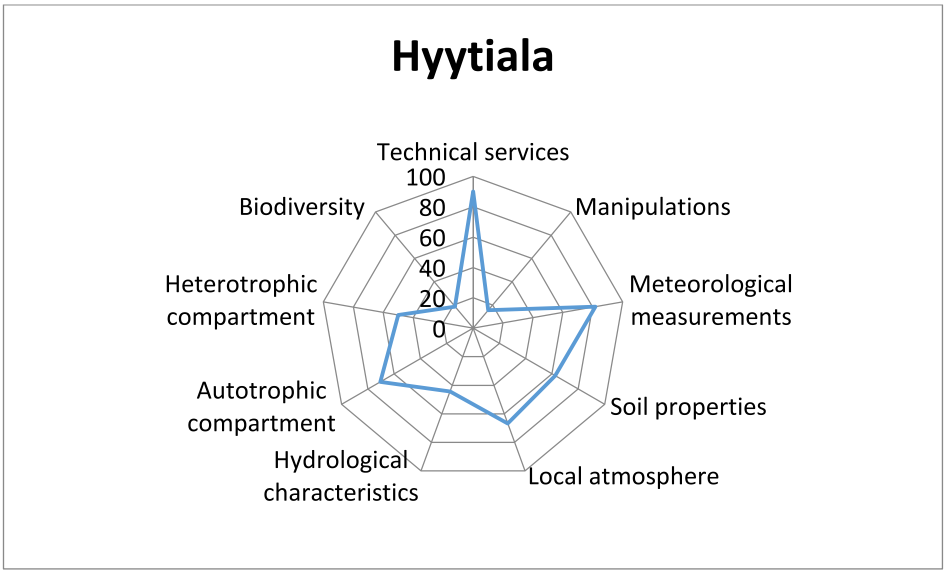
Manipulations
Meteorological measurements
Soil properties
Local atmosphere
Hydrological characteristics
Autotrophic compartment
Heterotrophic compartment
Biodiversity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Technical services
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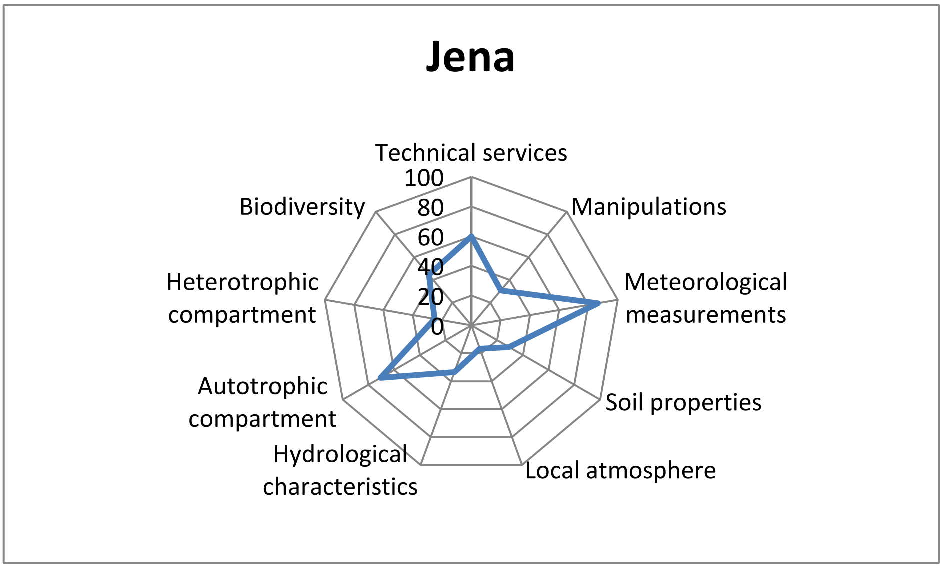
Manipulations
Meteorological measurements
Soil properties
Local atmosphere
Hydrological characteristics
Autotrophic compartment
Heterotrophic compartment
Biodiversity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Technical services
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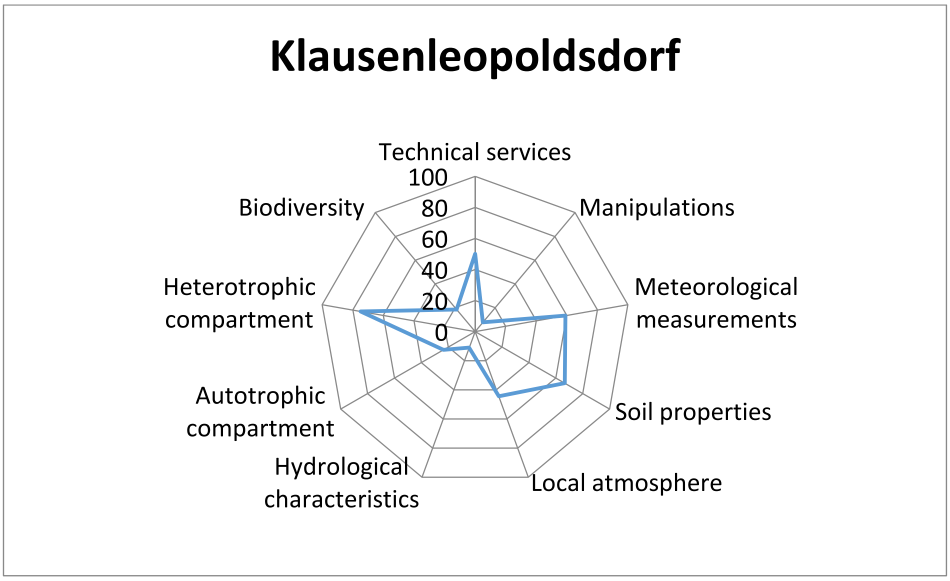
Manipulations
Meteorological measurements
Soil properties
Local atmosphere
Hydrological characteristics
Autotrophic compartment
Heterotrophic compartment
Biodiversity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Technical services
Manipulations
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Soil properties
Local atmosphere
Hydrological characteristics
Autotrophic compartment
Heterotrophic compartment
Biodiversity
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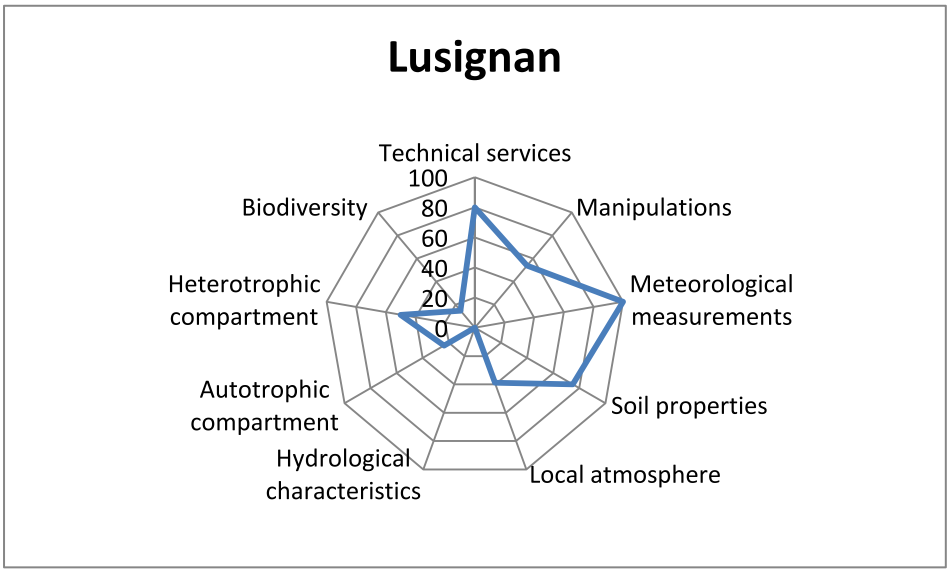
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Soil properties
Local atmosphere
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Autotrophic compartment
Heterotrophic compartment
Biodiversity
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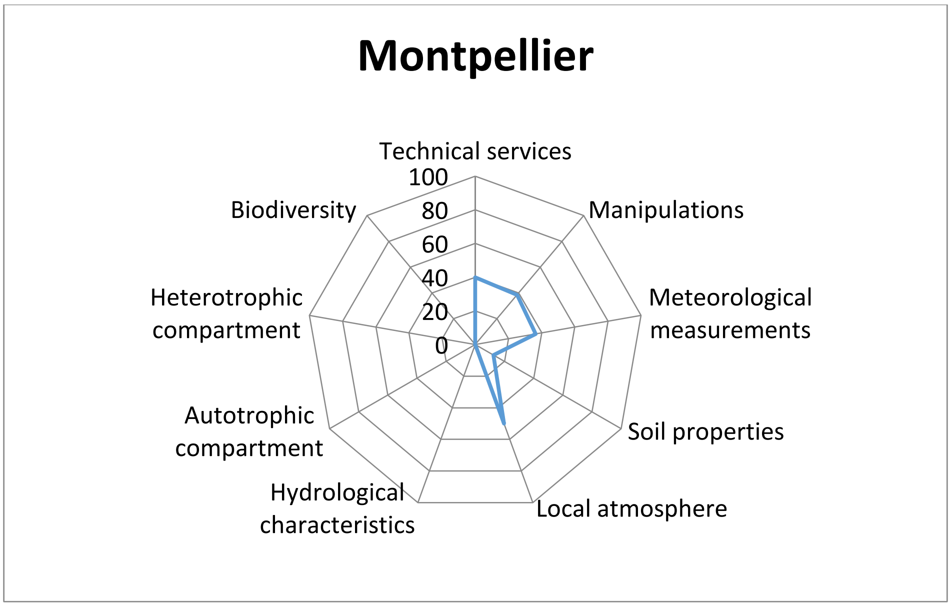
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Manipulations
Meteorological measurements
Soil properties
Local atmosphere
Hydrological characteristics
Autotrophic compartment
Heterotrophic compartment
Biodiversity
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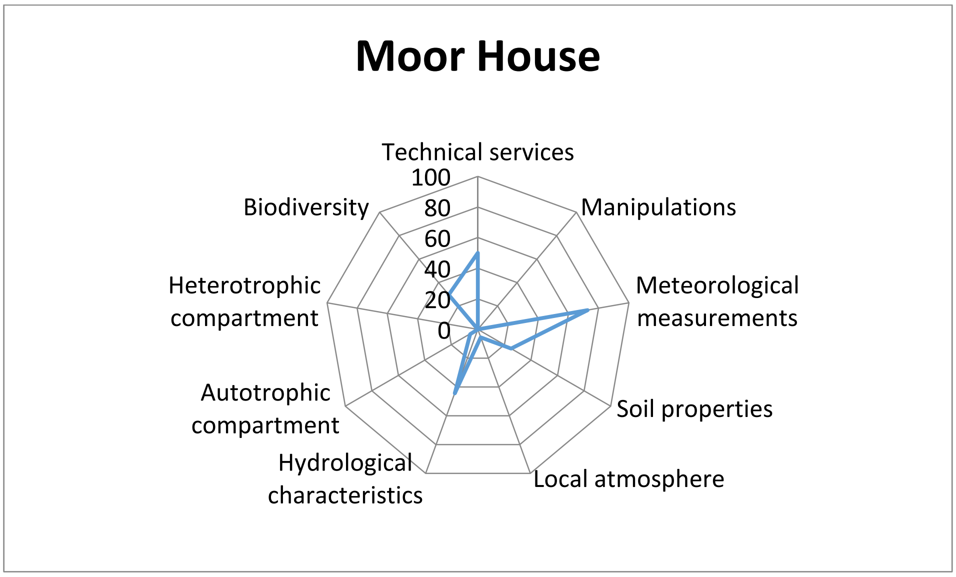
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Manipulations
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Soil properties
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Hydrological characteristics
Autotrophic compartment
Heterotrophic compartment
Biodiversity
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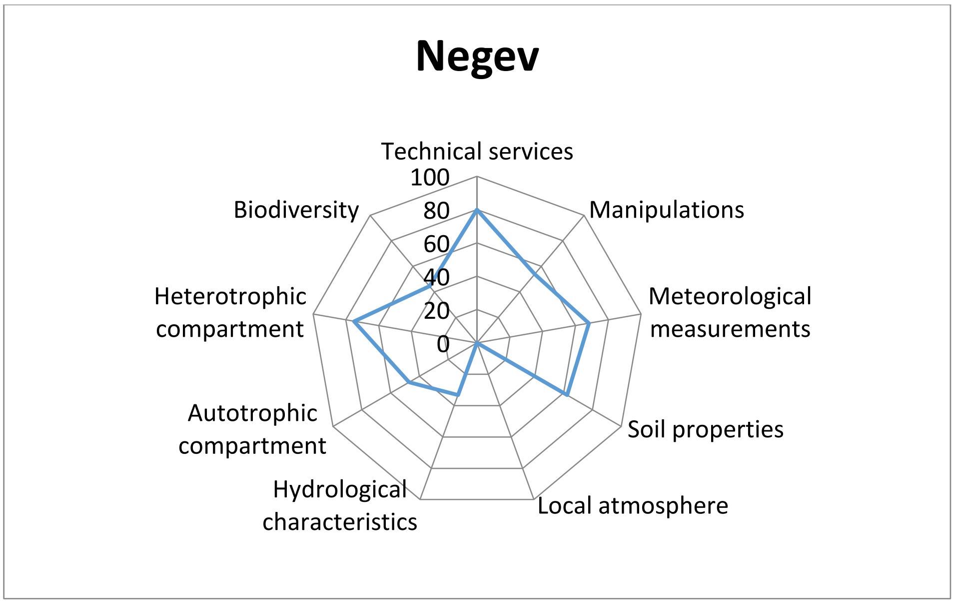
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Manipulations
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Soil properties
Local atmosphere
Hydrological characteristics
Autotrophic compartment
Heterotrophic compartment
Biodiversity
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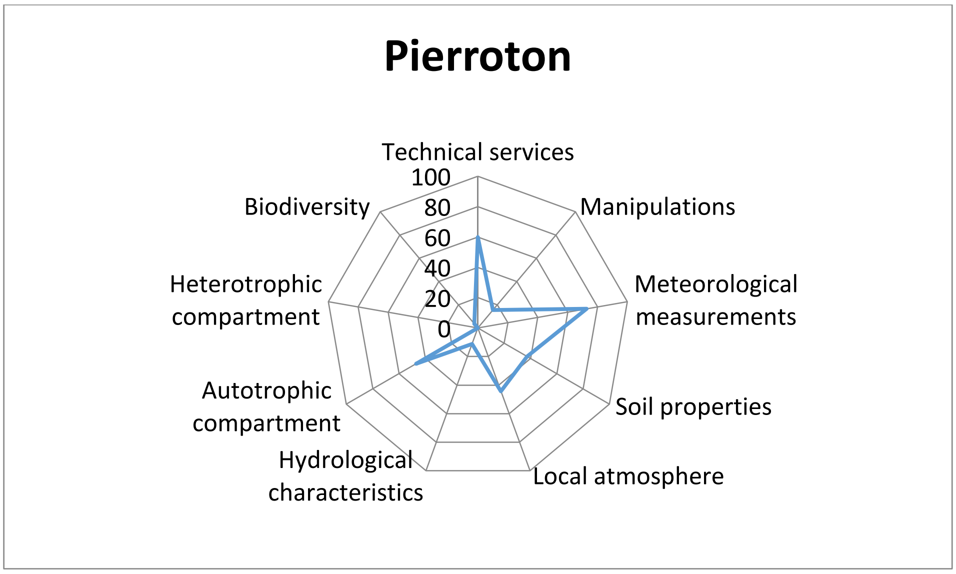
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Soil properties
Local atmosphere
Hydrological characteristics
Autotrophic compartment
Heterotrophic compartment
Biodiversity
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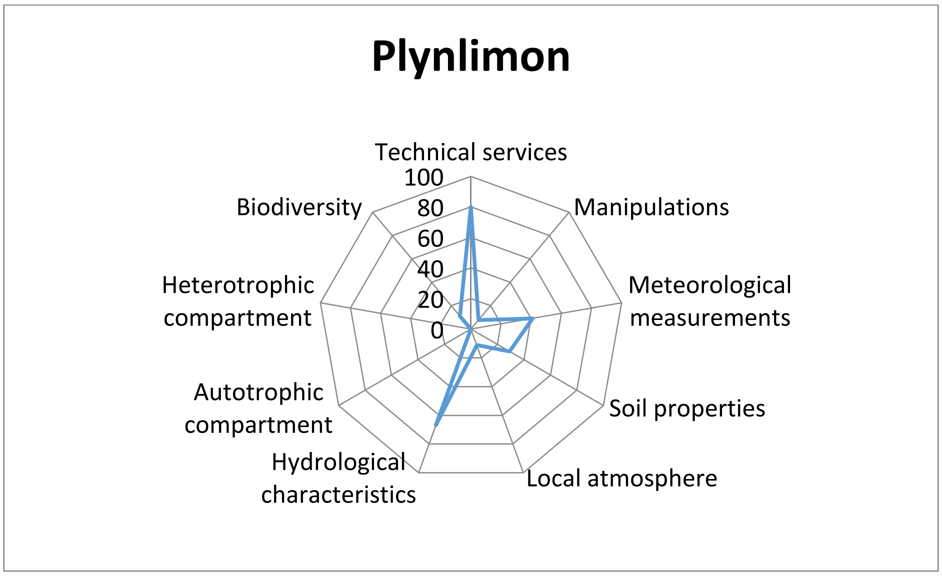
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Meteorological measurements
Soil properties
Local atmosphere
Hydrological characteristics
Autotrophic compartment
Heterotrophic compartment
Biodiversity
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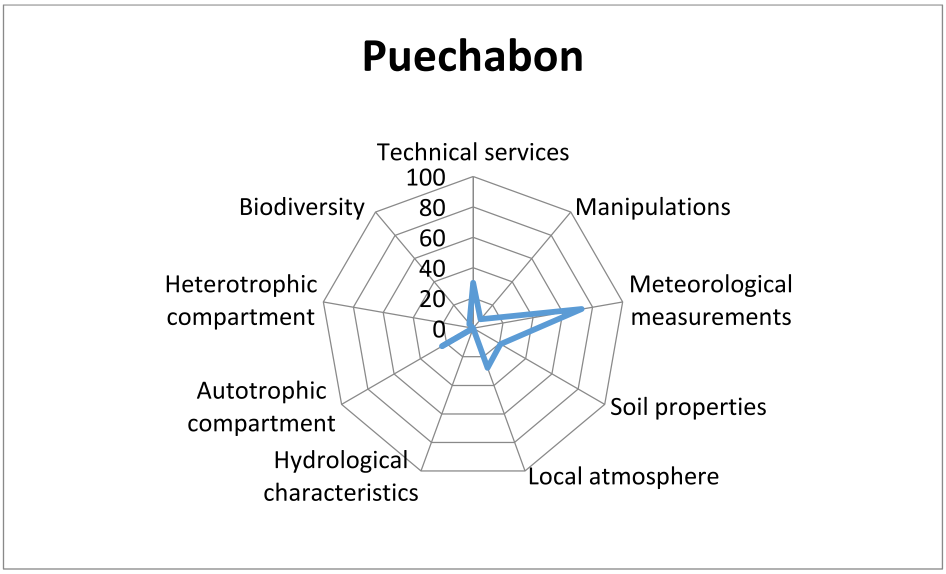
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Soil properties
Local atmosphere
Hydrological characteristics
Autotrophic compartment
Heterotrophic compartment
Biodiversity
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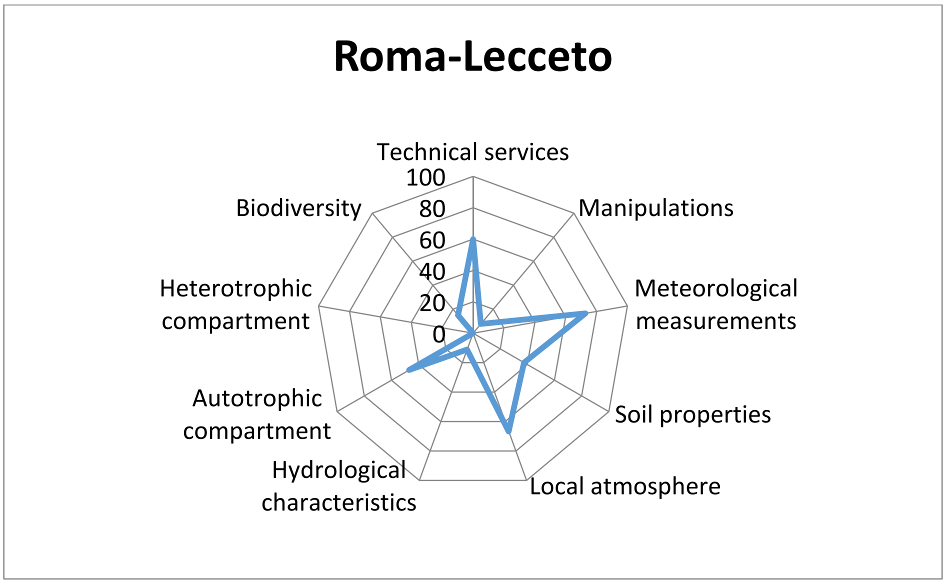
Roma-Lecceto
Technical services
Manipulations
Meteorological measurements
Soil properties
Local atmosphere
Hydrological characteristics
Autotrophic compartment
Heterotrophic compartment
Biodiversity
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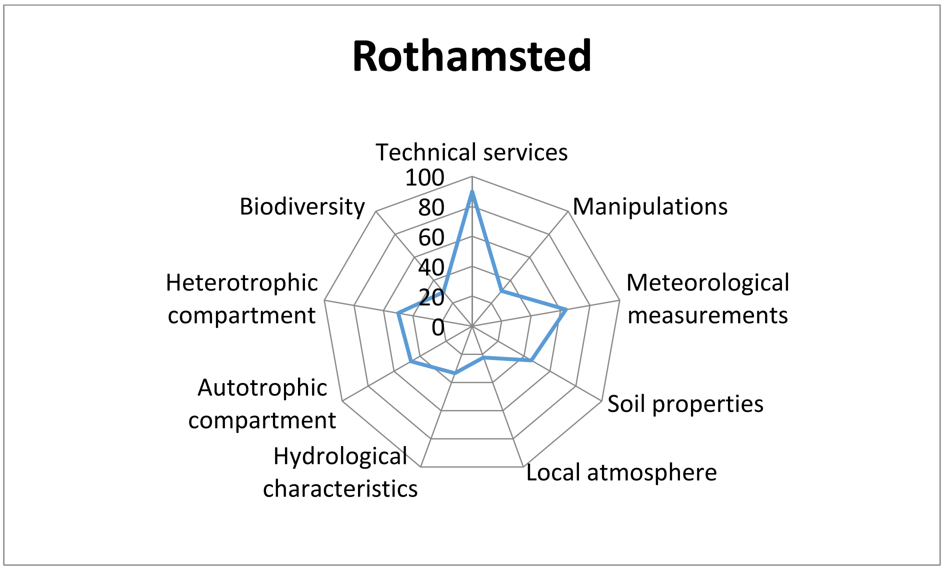
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Technical services
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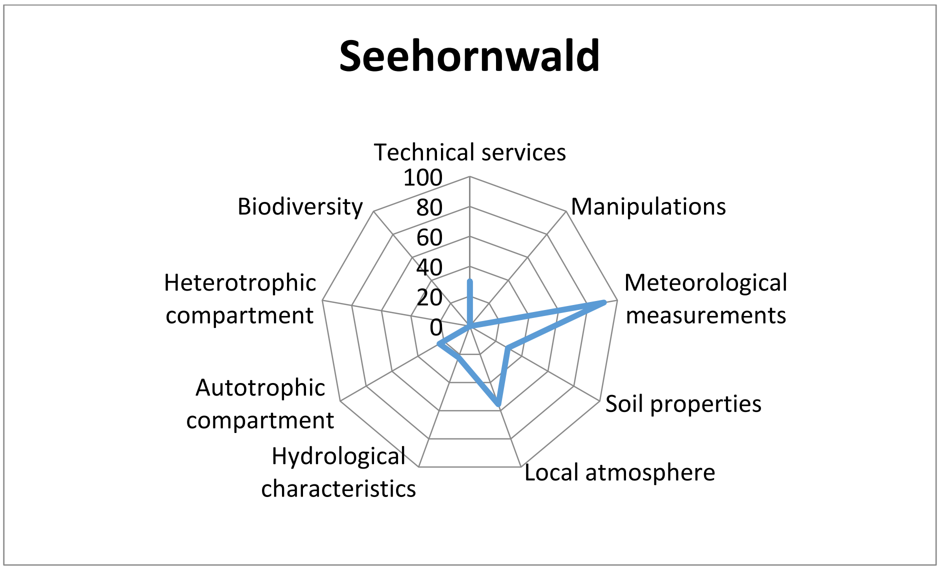
Manipulations
Meteorological measurements
Soil properties
Local atmosphere
Hydrological characteristics
Autotrophic compartment
Heterotrophic compartment
Biodiversity


Seehornwald
Technical services
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Manipulations
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Soil properties
Local atmosphere
Hydrological characteristics
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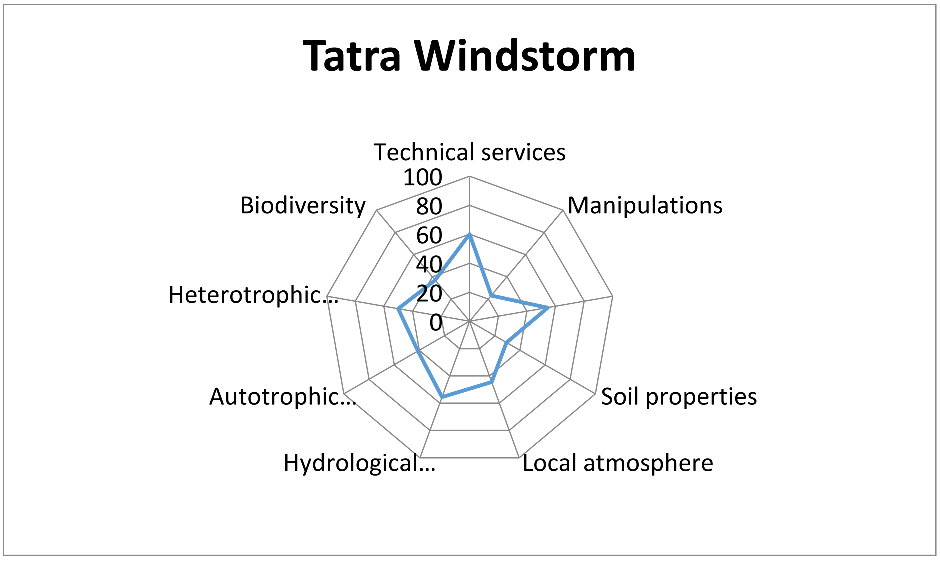
Biodiversity


Tatra Windstorm
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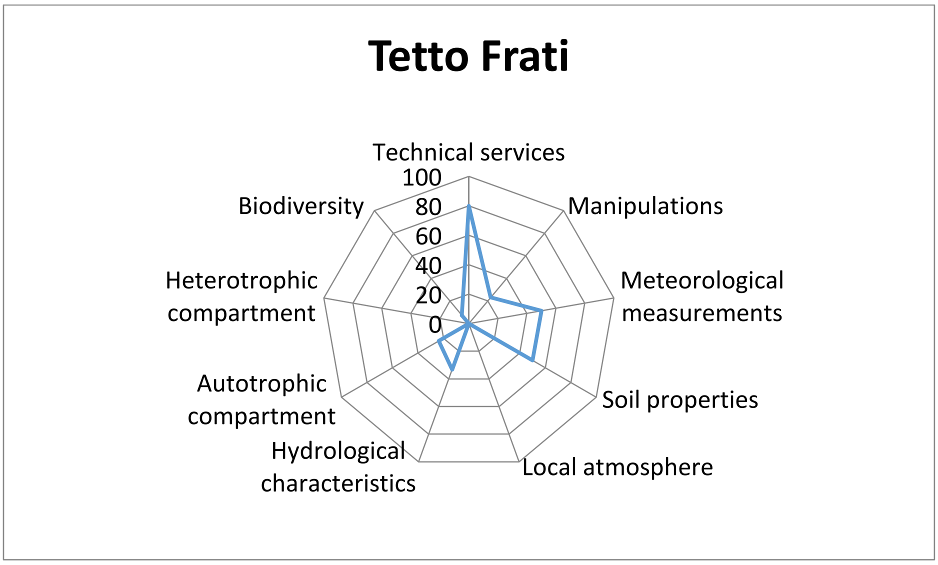
Manipulations
Soil properties
Local atmosphere
Hydrological...
Autotrophic...
Heterotrophic...
Biodiversity


Tetto Frati
Technical services
Manipulations
Meteorological measurements
Soil properties
Local atmosphere
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Autotrophic compartment
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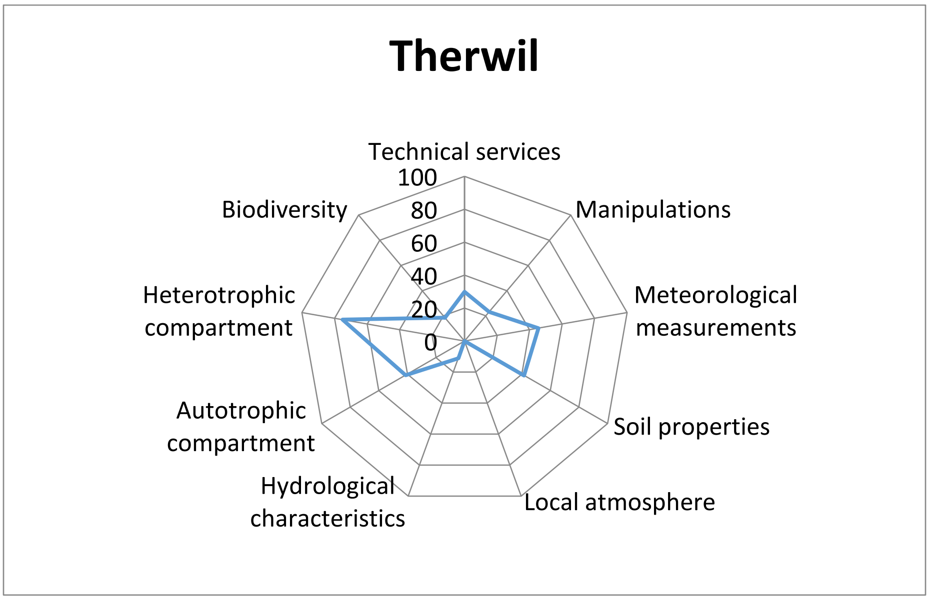
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Technical services
Manipulations
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Autotrophic compartment
Heterotrophic compartment
Biodiversity
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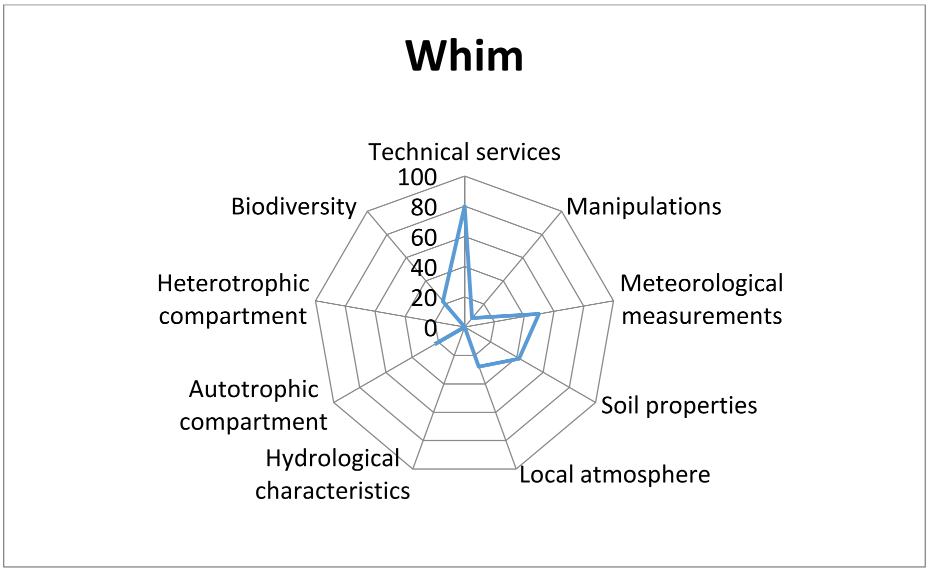
Whim
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Manipulations
Meteorological measurements
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Biodiversity
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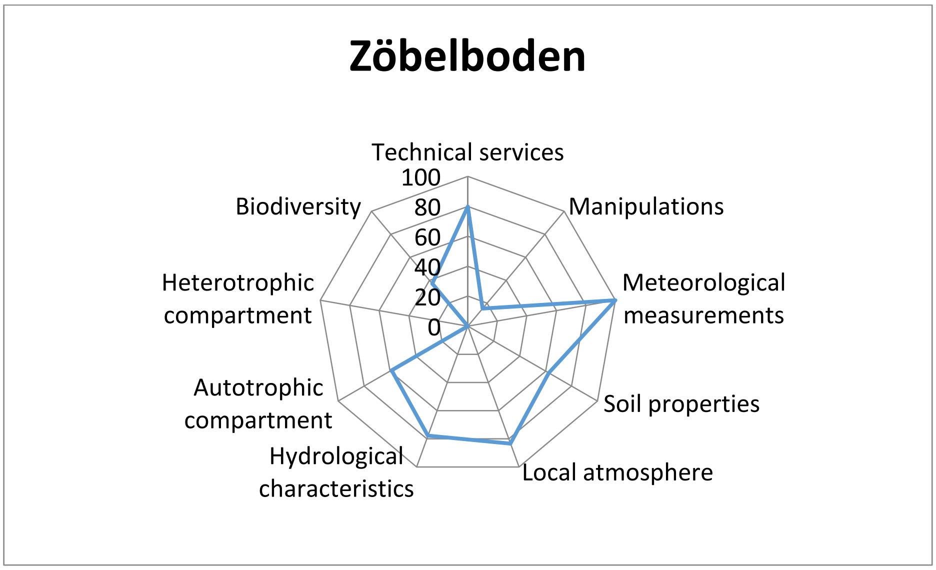

Figure 5.5 ExpeER facility research emphases or characteristic "fingerprint", the site name is given above each sub figure.

These figures illustrate that the Zöbelboden site for example has a strong focus on physical conditions as well as the autotrophic organisms, while Therwil has less diverse characterisation of the physical conditions and more emphasis on heterotrophic organisms.

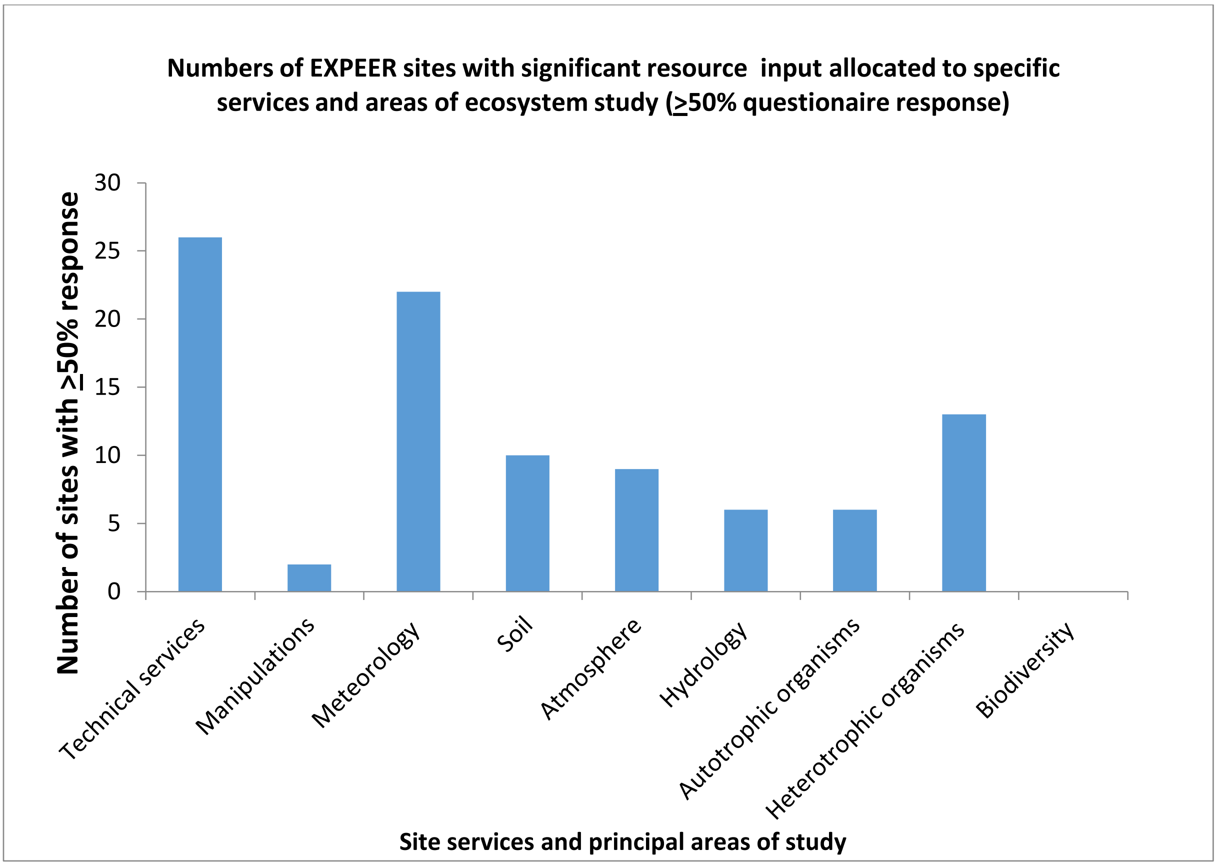

Fig 5.5 Evaluation of the 30 ExpeER sites based on questionnaire responses.

The ExpeER questionnaire responses revealed that more than 50% of the sites demonstrated relatively high levels of capacity with respect to meteorological observations. In addition, the majority of sites have the high levels of technical service necessary to facilitate good quality ecosystem research. However, responses relating to soil, atmosphere, hydrology and autotrophic compartment indicated scope for improvement in these areas at more than 2/3 of the sites. Experimental manipulations and biodiversity studies are especially underrepresented with biodiversity as the only area where none of the 30 sites could answer positively to ≥50% of the questions included in the ExpeER questionnaire.

5.3 Challenges

In the questionnaire, site managers were asked to consider missing data, process descriptions and challenges for their sites. This feed-back is presented in table 5.3. Not surprisingly the comments often reflect the scientific background and focus of that particular field site, and not necessarily what is missing from an overall full ecosystem description as discussed in the section above.

Table 5.3 Factors which site managers consider as challenges and missing information at their site.

ExpeER **facility**	**What is missing/challenge**
Aachenkirch	No info
Apelsvoll, Norway	Plot specific drainage data, there is only at system level
Beano	No info
Biogeochemistry laboratory	No info
Braila Island	Meteorological monitoring is basic and there is little information available on soil characteristics or hydrology. No monitoring of gaseous fluxes is done.
Doñana, Spain	No info
Ecosylve, France	No info
Eifel (Tereno), Germany	Monitoring of autotrophic (plants) and heterotrophic (micro-organisms, insects, mammals etc) organisms could be increased. These could include measurements of nutrient uptakes and biodiversity. A system to monitor drainage losses and quality of drainage water would increase the value of the site. Increased availability of accommodation for visitors could be useful.
Fomon	There is little information on soil hydrology and local atmosphere. Instrumentation to monitor drainage fluxes and surface/local atmosphere gaseous fluxes (CO_2 & CH_4) would be beneficial. Modelling (in development).
Harz (Tereno), Germany	No drainage flux measurements at some locations. Information sheet indicates that not all parameters monitored at the same locations?
Hesse, France	Information about C & N in the soil, N cycling in general
Höglwald forest	Soil heterogeneity as affected by forest management
Hyytiala (UHE Hyde), Finland	Biodiversity of Heterotrophs, including insects, birds and mammals could be included in future, as could measurements of plant nutrient contents/off takes.
Jena experiment, Germany	No info
Klausen-Leopoldsdorf, Austria	GHG production/consumption in different soil depths,

	measurements at re-established forest at gridded plots
Lusignan, France	No info
MEL Italy	No info
Montpellier, Ecotron	No info
Moor House, UK	Some soil surface CO_2 flux measurements made by visiting scientists, but gas flux monitoring is not done regularly. Drainage volumes are not monitored, but discharge at the catchment level is recorded.
Negev	studies of interactions among water, carbon and nitrogen fluxes
Puéchabon, France	None identified, but the inclusion of facilities to monitoring drainage and gaseous fluxes could be included in future plans for site development
Roma-Lecceto (Med EWater), Italy	Facilities to monitor hydrological fluxes and water quality are needed. Longer-term monitoring of surface fluxes could be included rather than short campaigns, as in the past. Continued monitoring of meteorological variable beyond 2006 & 2009 are required.
Rothamsted, UK	Facilities and equipment for monitoring of atmospheric chemistry (CO_2, N_2O etc.) and drainage fluxes are limited. In particular there are no automated facilities for sample collection and monitoring of gas fluxes (surface) or drainage losses. Power supplies are restricted to a few fields.
Seehornwald (SEE Davos), Switzerland	No info
Silwood park, ecotron	Realistic light intensity and spectrum. Upgrade with plasma lights possible but prohibitively expensive with the current funding.
Tatra Windstorm, Slovakia	CO_2 flux missing
Tetto-Fratti (TF LTEP), Italy	No info
Therwill (DOK trial), Switzerland	Installation of facilities to measure climate gases
Tolfa Allumiere, Italy	No info
Upper Severn, UK	Spatially extensive soil characterisation and terrestrial biodiversity research data is limited. No mention of gas flux measurements is made.
Whim bog, UK	Process modelling, isotope studies, challenge What does N do and how?
Zöbelboden, Austria	Eddy flux on existing tower

5.4 Spatial coverage

Some sites cover entire catchments while others consist of plots covering only a small area. Consequently, the size of the different field sites might determine what kind of studies can be performed there, In Table 5.4 the size of the field sites and dominating ecosystem or vegetation coverage is summarised.

Table 5.4. Size of field sites and main ecosystem cover.

ExpeER site	Ecosystem	Size of site/study area (ha)
Aachenkirch	Forest: Spruce, beech, silver fir	1
Apelsvoll	Agricultural land	3
Beano	Agricultural land	12
Biodiversity exp	300 plots. 3 regions, grassland, forest	
Braila Island	Varied: Forest, grassland, arable, wetland	
Doñana	Forest, agricultural land, coast, river, marsh	113.034 (113034?)
Ecosylve	Forest: pine, ulex nanus, molinia grass	plots
Eifel, Tereno	3 sites: Forest 27 Ha, grassland 27 Ha, arable land 1.5 Ha	55.5
Fruska Gora	Forest, grassland	34771
Harz, Tereno	Hydrological observatory 3300 km2	2700000
Hesse	Beech forest	0.5
Höglwald	Forest: Spruce	370
Hyytiala	Forest	12.6
Jena experiment	Grassland	10
Klausen-Leopoldsdorf	Forest: Beech	2
Lusignan	Agricultural land. Grass –crop rotation	25
Moor House	Peatland, grassland	7500
Negev	Forest, shrubland	2000
Puéchabon	Forest: Quercus ilex evergreen oak	50
Roma-Lecceto	Forest: Mediterranean evergreen	800
Rothamsted	Agricultural land	408
Seehornwald	Forest	
Tatra Windstorm	Forest: Spruce	400
Tetto-Fratti	Agricultural land	1
Therwill	Agricultural land	1.84
Tolfa	Forest	6
Upper Severn	Forest: Sitka spruce, Grassland	3000
Whim bog	Peatland: ombrotrophic bog	1
Zöbelboden	Forest: Dominated by spruce	90

5.5 Temporal resolution and earliest observations

The temporal resolution of data collected at the different sites varies; the individual questionnaires contain details of this, but in some cases this information was not given by the site managers and so cannot be included in this evaluation. Further information on temporal resolution will be collected as part of the project in due course. Since meteorological observations are a common feature of all the sites, and of key importance, we show the time resolution of rain data as an indicator for the temporal resolution of the datasets provided at the different sites. They vary from every 0.2 mm (for the Tatra windstorm site), here given as 1-min to 60-minute resolution. The earliest observations are usually consistent with earliest rain measurements, but not in all cases. Here they range from 1843 at Rothamsted to 2006 at the Beano site.

Table 5.5. Time resolution of precipitation measurements and earliest observations at the sites. Blank cells were not provided by the site managers.

Site	Time resolution for precipitation, min	Earliest recorded data from the site
Aachenkirch	10	1994
Apelsvoll	60	1990
Beano	30	2006
Braila Islands		1957
Donana	1	2003
Pierroton	30	1996
Eifel	30	2005
Fruska gora		
Harz/Central German Lowland		2002
Hesse		1997
Höglwald		missing
Hyytiala	1	1996
Jena		2002
Klausenleopoldsdorf	30	1996
Lusignan		2005
Moor House	5	1992
Negev		2004
Puechabon	30	1998
Roma-Lecceto	60	1996
Rothamsted	60	1843
Seehornwald		missing
Tatra Windstorm	1	missing
Tetto Frati		1992
Therwil		missing
Plynlimon	15	1970
Whim	15	2001
Zöbelboden	30	1992

6. Conclusive remarks

The ExpeER ecosystem research sites cover a broad range of climatic zones across Europe and have good levels of capacity with respect to meteorological observations and the monitoring of soil physical parameters, atmospheric analyses and autotrophic organisms. In addition, the majority of sites have good technical infrastructure necessary to facilitate high quality ecosystem research.

However, site responses relating to experimental manipulations, biodiversity studies, hydrology and soil characterisation indicated needs for improvement in these areas at many sites. There was also an indication that there may be the need to increase the number of ecosystem studies at some sites, to enhance the number of potential comparisons between similar ecosystems located in different climatic zones. Further work to identify sites suitable for the establishment of new studies will be included in other work packages.

7. References

Domenico, P.A. and Schwartz, F.W., 1998, Physical and chemical Hydrogeology, John Wiley and sons inc., second edition

WMO, 2008, WMO Guide to meteorological instruments and methods of observation, WMO-No. 8 (Seventh edition)

8. Appendices

Annex A1 Questionnaire

Annex A2 Evaluation of the 30 ExpeER sites

Annex A3 Visit reports

Annex B Expeer site fact sheets – separate document

Annex A1 Questionnaire

	Parameter questionnaire for EXPEER sites	Fill in the information relevant to your site, if continuous or regular measurements are conducted include further sampling routines etc. in columns I-O, any additional notes can be included in column P													
N°	**ITEM**	Available? (-/+)	Further specification	Method (incl. Pre-Treatment and Analysis, separated by " - ")	Unit (eg. µg/ml)	Protocol available	Reference for protocol	Sampling frequency (time resolution)	Size of plot	Number of plots/ stations	Number of replicates	Sampling depth	Start date	End date	Notes
1	Site name			Grey cells: no filling is required!											
1	Site classification, ECOTRON, HIES, HIOS														
1	Website														
1	Responsible site manager (name, email)														
1	Questionnaire filled by (name, email):														
1	Key contacts														
1	Site ownership														
1	Distance from closest public transportation station														
1	Key words														
1	Main purpose of facility														
1	Spatial coordinates														
1	Landuse history														
1	Total area of facility														
2	**Ecosystem coverage**														
2	Forest														
2	Arable land														
2	Grasslands														
2	Shrublands														
2	Wetland														

2	Other
3	**Technical services**
3	Safe to leave equipment
3	Water supply
3	Powersupply
3	Accomodation possibilities
3	Access restrictions
3	Sample arcive
3	Laboratory space on the site
3	NIRS database
3	Modelling platform
3	Analytical platform/Joint laboratory facility
3	Other
4	**Manipulations/treatments**
4	Temperature
4	Irrigation/drought
4	Drainage
4	Fertilizers, inorganic
4	Fertilizers, organic
4	Soil management
4	CO_2 enrichment
4	Ozone enrichment
4	Atmosperic deposition
4	Salinity treatment
4	Biodiversity
4	Controlled radiation (Light intensity and spectrum treatment, lamp type)
4	Landuse
4	Other

5	**Collaborations and future work**	
5	Already in EU database	
5	EU project involvement	
5	other collaboration	
5	What is missing at the site? Challenges?	
5	What type of upgrades are planned at the site? Timeframe? Estimated costs?	
5	What kind of collaboration would you be interested in?	
5	Best reference for description of site	
6	**Meteorological measurements on the site** (according to WMO standards)	
6	PAR	
6	Wind direction (mean and gust)	
6	Wind speed (mean and gust)	
6	Air humidity	
6	Air temperature	
6	Precipitation	
6	Rainfall Chemical analysis (NO_2^-, NO_3^-, NH_4^+, DOC…)	
6	Global radiation	
6	Reflected global radiation	
6	Sky temperature	
6	Ground temperature	
6	Albedo	
6	Net sol radiation	
6	Net far radiation	
6	Net radiation	

6	Diffuse sol radiation
6	Sunshine duration
6	Heat flux
6	Temperature soil at 5cm
6	Atmospheric pressure
6	Wet/Dry Deposition Collector
6	UV radiation
6	Others, please specify
7	**Soil properties**
7	Type
7	Texture
7	Depth
7	Hydraulic conductivity (Ks)
7	Unsaturated hydraulic conductivity, Pf curve
7	Soil chemical characteristics (pH, CEC, EC, C and N content, …)
7	Isotopes measurements (Delta ^{13}C measurement, Delta ^{15}N measurement, ^{14}C age, specify)
7	Soil bulk density
7	Soil contamination (N deposition, ash deposition, heavy metal, …, specify)
7	^{13}C NMR
7	MIR / NIR
7	TG / DSC
7	Analytical pyrolysis (MS)
7	Biomarkers
7	Lignin monomers
7	Lipids (please detail)

7	Non-cellulosic sugars
7	Soil enzymes
7	Other
7	Soil moisture with depth
7	Soil temperature with depth
7	CO_2 surface flux
7	N_2O flux
7	Soil solution sampling and measurements: DOC, DON, P, K, Ca, Mg, Na, Cl…(specify)
7	Soil archiving
8	**Local atmosphere**
8	Ozone
8	Aerosols
8	Humidity
8	N-deposition, dry
8	N-deposition, wet
8	CH_4 flux
8	CH_4 concentration
8	CO_2 flux
8	CO_2 concentration
8	N_2O flux
8	N_2O concentration
8	Throughfall
8	Temperature
8	Global radiation
8	PAR
8	$^{13}C/^{12}C$
8	$^{18}O/^{16}O$

8	H_2O flux
8	other
9	**Hydrological characteristics**
9	discharge, catchment
9	drainage
9	runoff, local/plot
9	groundwater level
9	soil water quality
9	groundwater quality
9	surface water quality
9	Groundwater temperature
9	Groundwater chemistry: DOC, DON, P, K, Ca, Mg, Na, Cl…(specify)
9	other
10	**Autotrophic compartment. Please indicate organism group!**
10	Abundance
10	Biomass
10	Phenology
10	Production
10	Root biomass
10	Root distribution with minirhizotrons
10	Hyperspectral canopy measurements
10	Leaf (canopy) temperature
10	Specific measurements on specific species (for example Oak water potential …)
10	LAI
10	C, N, Mg, K, P, Na, content...
10	Photosyntehtic rate/net CO_2

	exchange rate
10	Vegetation cover
10	Crops
10	Weeds
10	Light profile
10	Sap flow
10	Other
11	**Heterotrophic compartment (procaryotic and eucaryotic) Please indicate organism group!**
11	Abundance
11	Biomass
11	Phenology
11	Specific measurements on specific species (e.g. enzymes, C&N content, etc...)
11	Other
12	**Biodiversity:**
12	Procariots
12	Microalgae
12	Macroalgae
12	Vascular plants / Aquatic macrophytes
12	Lichens
12	Mosses
12	Fungi
12	Bacteria
12	Rhizobia
12	Myccorrhiza
12	Annelida
12	Molluscs

12	Crustaceans	
12	Insects	
12	Spiders	
12	Other Arthropods	
12	Amphibians	
12	Reptiles	
12	Mammals: small mammals	
12	mammals: ungulates	
12	Birds	
12	Fish	
12	Species richness	
12	Traditional diversity indices (e.g. Shannon, Simpson, etc…)	
12	Functional diversity	
12	Phylogenetic diversity	
12	Food web analysis/characteristics (length, connectivity, etc…)	
12	Others	
12	Other categories: Zooplancton, Meiofauna, Benthic macroinvertebrates	
12	Added by JyU Finland: Paleolimnological samples (diatoms, ostracods, chironomid headcapsules, chaoborus mandibles, fish scales etc.) Lake sediment are integrating information on the environmental change (e.g. climate change)	

Annex A2 Evaluation of the 30 ExpeER sites

Table shows % response by each site for questionnaire categories listed (Technical services etc).

	Site Name	Site #	Technical services	Manipulations	Meteorological measurements	Soil properties	Local atmosphere	Hydrological characteristics	Autotrophic compartment	Heterotrophic compartment	Biodiversity	Items with >50% response
1	Achenkirch	4	50	15	41	50	33	11	24	50	7	3
2	Apelsvoll	7	80	39	32	25	0	22	12	50	0	2
3	Beano	30	80	23	50	50	0	33	24	0	7	3
4	Braila islands	26	60	31	64	38	22	56	35	75	30	4
5	Doñana	14	70	15	91	13	0	22	41	50	41	3
6	Pierroton/ Ecosylve	2	60	15	73	38	44	11	47	0	4	2
7	Eifel	19	60	8	77	42	56	56	29	0	0	4
8	Fruska gora/Fomon	31	70	0	41	29	22	0	24	50	26	2
9	Harz/Central German Lowland	27	90	54	91	50	44	78	24	25	11	5
10	Hesse	1	60	8	82	42	50	11	59	0	0	4
11	Höglwald	20	80	0	77	63	72	0	41	100	0	5
12	Hyytiälä	28	90	15	82	63	67	44	71	50	19	6
13	Jena	17	60	31	86	29	17	33	71	25	44	3
14	Klausenleo-poldsdorf	5	50	8	59	67	44	11	24	75	19	4
15	Lusignan	3	90	46	100	79	72	11	59	50	30	6
16	Bologna/MEL	8	70	0	0	0	0	0	0	0	0	1
17	Montpellier	13	40	39	36	13	50	0	0	0	0	1
18	Moor house	21	50	0	73	25	6	44	6	0	30	2
19	Negev	6	80	54	68	63	0	33	47	75	44	5
20	Puechabon	11	30	8	73	21	28	0	24	0	4	1
21	Roma-Lecceto	9	60	8	73	38	67	11	47	0	15	3
22	Rothamsted	24	90	31	64	46	22	33	47	50	30	3

23	Seehornwald	33	30	0	91	29	56	22	24	0	0	2
24	Tatra windstorm	25	60	23	55	29	44	56	41	50	37	4
25	Tetto Frati	29	80	23	50	50	0	33	24	0	7	3
26	Therwil	16	30	23	46	42	0	11	41	75	19	1
27	Plynlimon/ Upper Severn	23	80	8	41	29	11	67	0	0	11	2
28	Whim	22	80	8	50	42	28	0	24	0	22	2
29	Zöbelboden	15	80	15	100	63	83	78	59	0	37	6
30	Grignon		80	0	0	0	0	0	0	0	0	1
	Number of sites >50% response		26	2	22	10	9	6	6	13	0	

Annex A3 Visit reports

List of site-visits per 04.08.2011

Montepellier, France, ecotron

Pueachabon, France, HIOS/HIES

Silwood park, UK, ecotron

Rothamsted, UK, HIOS/HIES

Whim bog, UK, HIES

Moor house, UK, HIOS

Braila island, Hungary, HIOS

The EXPEER Transnational access site

Notes from Montpellier Ecotron visit May 24th, 2011;

Host: Jacques Roy

Visitors: Odd-Arne Olsen and Helen K. French

Access: Accessible from Montpellier by local bus, with limited departures. Easiest to come by car.
Accommodation: hotel in Montpellier

Financial situation: Total cost of facility will be: €10M, at present: €7M, phase 1 and 2 , including equipment. Funding provided by CNRS (national) and local funds. Local funds implies 20% local use, 80% national and international use.

Sharing of data: The scientists, who have designed the experiments, are also responsible for the use of these data. (check…)

Hydrological description: NA

Soil conditions: NA

Outreach:

Local expertise:

Permanent staff ranging from researchers to laboratory technicians, various students staying on internships or conducting thesis work

Support and related facilities on site:

Smaller laboratories, for soil physical measurements, root sampling, …others

Controlled environment:

12 ecosystem domes, each 1-5m2, on each side empty dome to create same conditions in all 12 domes. Dome cover made of FP (Teflon based see through plastic) transparent to UV, can be folded up like an umbrella. Air blown in from top, air flow modelled by INRA to create uniform temperature and air humidity throughout system. Circulation equal to 2 volumes per minute; 80m3/minute. Not totally confined due to natural air density changes caused by temperature changes. Air circulation causes inflow not= outflow. Input is measured proportional to volume exchange (retention) in chamber to compensate or measure (sjekk). Over pressure inside dome (10Pa), under pressure in pipe system below dome. Measure gradient over dome walls (inside outside) (sketsj).

At the moment includes 4 blocks in each dome to include variability in initial biodiversivity. 80% radiance compared to outside dome. Below: up to 2m deep soil profile. Leachate (surplus water) collected for water quality analysis. System on a scale with 200g accuracy. Water balance measurements (estimates of evapotranspiration). Some loss of humidity through condensation. 12 TDR sensors per dome, 3 in each block, at 7, 21, and 50 cm depth, measures temp and water content.

Each chamber: a single computer, stores all data for 10 days. Not connected to a national database storage unit yet. At the moment: CO_2, water, CH_4, N_2O (€14-15.000), setting up system for O18 and C13 isotopes (€80.000), for multiplexer € 5.000. Gas measurements, calibrated every 2 weeks, gain, offset measurements. Next on wish list: Fourier transformed spectrometer. Every measurements takes 1 min, 12 min to measure all chambers, 20 min delay because of retention time in chamber (?) hence measurements in output gives over or underestimated measurements compared to real value depending on time of day. Flows are fairly accurate on a daily basis,Data is stored as soon as measured, ISO standardisation. All information about activities on Ecotron shared on Sharepoint.

Macro scale: domes, manual measurements problematic because of breathing out.

Meso scale: under construction, will be made for more flexibility than domes, natural light, possibly artificial in addition, aiming for 24 compartments each for the cost of €100.000

Micro scale: pipes for flow system and room ready, standard: L2, P32, C14 lab. First experiment request: 400 microcosms for litter degradation experiments. (too large number to be realised). Use of plasma light(?) which has a continuous spectrum, but may interfere with electromagnetic waves. Lemnatec – example of proxy system, here only real measurements, could be compared in order to validate proxy methods.

Software used to control facility: required that it be flexible menough to incorporate new measurements in facility, (new instruments etc.): Labview. Automatic data cleaning and quality check. At the moment, staff are on guard to go online and check dataflow on each dome, can check errors on instruments and interfere with measurement set-up etc.

Costs:

Energy (?): €50.000/yr

Gas: €30.000/yr

Water: €7.000

Gas calibration: €10.000

Contracts for equipment: €50.000

Running costs: €200.000 including travel, PC replacements etc.

Reno: 4 units, 11m2

CO_2, NO, ozone monitoring

Temperature through water and glycol circulation system: 5-35C, daily temperature profile, natural light source, light monitoring. Fresh air circulation, humidity control

Present experiments:

Confined ecosystem samples, measure as many features as possible, monitor exchanges, improve control and measurements at different scales.

Collboration with Jena, undisturbed soil columns from their experiments, impose Jena climate from period March-October

Pilot experiment ongoing at the moment: Extreme event expected CO2, temperature and rain for 2050

The EXPEER Transnational access site

Notes from Moor house visit July 20th, 2011;

Host: Rob Rose, Beverly Dodd, Amy Goodwin

Visitors: Helen K. French

Access: The Moor house site is only accessible by car. The closest village is Garrigill. It takes about 1.5 hours to drive from Lancaster University, where CEH is located. The field site can be accessed through the west or the main entrance point in the east, by the Troutbeck foot.

General description of the area:

Whole protection area is 42km2, several smaller catchments within the area, one of these is 11 km2 draining to the Trout beck. Main vegetation zones, in the east: blanket bog, central part: montein grassland, to on the steep slopes in the west; acid grass.

Financial situation: Stable funding from CEH and DEFRA for the past 18 years, no sign of cutting down funds. As part of the Environmental Change network programme (ECN), two people visit the site every Wednesday. In addition to protocol measurements defined by the ECN programme, they do other kinds of routine measurements that can be fitted in within the regular sampling programme. At the time of the visit possible locations for regular tick sampling were considered.

Sharing of data: Data is stored and is available for users of the site.

Hydrological description: The blanket bog area is built up of limestone, overlain by glacial material and a thin layer of clay. Above the clay is approx. 1-1.5 m of peat soil. The water flow paths determine the water quality, during high discharge most flow occurs through peat soil and the water has low pH. During periods of low discharge pH increases, due to flow mainly through the limestone. Groundwater is logged at the TSS station together with data from a rain gauge and two soil moisture sensors and temperatures. This is not the main meteorological station. Some of the river systems are continuously logged for discharge, the Tees river at the boundary of the reserve, while others are monitored on a temporary basis, detail of what was measured when must be obtain through site managers, who can direct to the right contacts.

Soil conditions: Peat soil,

Vegetation mapping: Quadrats, repeated within each vegetation type, also random plots.

Outreach: The Moor house National Nature Reserve has a sign at the entrance explaining about the extents, river systems and wildlife of the area, but no information about research going on there. A photo from the site is taken every week and put on the web-site. The area can only be entered by car if you have key to the gates.

Energy: Only solar panels.

Local expertise, staff: 2 permanent staff are involved in the work, in addition an internship student is hired for a year.

Support and related facilities on site:

Several activities are carried out at the same site, these are led by Leeds, Durham, Manchester, Liverpool and Lancaster Universities – often PhD students. University of Edinburgh has Eddy covariance tower, powered by solar panels and wind. But many of the measurements are conducted by CEH personnel on their weekly visits.

Other units:

CEH has a chemical laboratory at Lancaster, they carry out analysis of water sampled at the field site.

History:

The area was used for lead mining, there are several open mining pits in the eastern part of the nature reserve, measurements of heavy metals in the water are conducted on a regular basis, but apparently there are no systematic studies of the transport processes of these heavy metals from the area. First data collected in the area was standard meteorological data, these data were collected from the 1930's. In the 1960's different experiments were conducted to explore the possibility to increase production in the area (grass and forest). Drainage and burning were some of the measures that were tested. Trees were planted, but were unsuccessful in establishing a useful production.

Measurements:

Meteorological station: two parallel set ups, one old and one new, several rain gauges, manual and logged, one is for water quality analysis, in addition there are two more meteorological stations in the catchment.

Digital cameras (manually downloaded – memory cards): some for monitoring vegetation development, some monitoring rabbits (now birds), sheep, one is overlooking the Trout beck, this is also where the weekly field photo is taken and placed on the web-site.

Animal registrations: Four bat surveys are conducted throughout the summer season and there is some experimenting with some bat loggers that have been out through that period. Three frog ponds are monitored and timings of spawning and growth in the tadpoles are recorded. Sound recordings register birds and bats

Arthropod sampling: moth trap, this is done weekly from March –October and is part of the light trap network run by Rothamsted. Beetle traps also catch spiders which also have been collected for the last few years with some funding to identify these recently. Butterfly transect are done when the weather permits April-Sep and as well as the data being available from Moor house at ECN it feeds into the Butterfly Conservation organisation.

Water sampling:

-in Trout beck, part of the ECN fresh water sites, discharge measurements by EA (Environmental Agency). Water samples (grab samples) taken once a week. Analysed for pH, EC, DOC, cations, anions, SS, heavy metals, ..According to protocol by ECN – measurements are done for all sites in the UK on the Wednesdays.

-in Cottage hill (SS, ions, DOC), discharge measurements here? Mike Billot , CEH

TSS, Target sampling site: 30 beetle traps, 12 soil water samplers (Prenart) at two depths: 10 and 50 cm sampled every other week, only half samples are analysed due to costs. IRGA- Infra red gas analyser (Nick Ostel), measures CO2 release from the bog, when it is not saturated all the way to the surface. This has been tested for about 2 months, 6 points are measured, these have different vegetation, moss, grass, or other. Both CO2 and soil water samples are taken in the same area, some meters apart. Groundwater levels in 5 dip wells are also measured, one of them is also logged. Manual and automatic rain gauge. Soil moisture and temperature measured at two depths and logged.

Experiments:

Durham University: One project looking at the process of peat soil breaking off along the river, and how it affects transport of carbon. Another project is examining transport of boulders with the river system.

Lancaster University: In collaboration with CEH: Open top warming chambers, objective; simulate climate change and study effect on carbon dynamics.

The EXPEER Transnational access site

Notes from Puechabon visit May 24th, 2011;

Host: Serge Rambal

Visitors: Odd-Arne Olsen (UMB) and Helen K. French

Access: Puechabon is reached by car, to get into the field a small road with rough stony surface is followed, probably best to have accompanying person first time visiting. Area is quite remote with some distance to nearest village (Puechabon) with access to shops etc.

Financial situation: Experiments and monitoring funded by various research projects (EU: MINES?, Nitro Europe?... or national)

Sharing of data:.

Hydrological description: 7 neutron probe wells down to 5m depth, max suction about -5MPa, measured once per month. The subsurface is karstic and the hydrogeology of the area has been studied by the local University in Montepellier.

Soil conditions: Extremely rocky soil, with high infiltration capacity, little soil. Homogeneous geological condition, 5% slope. Soil sampling/mapping conducted in nthe area in 1983-90, data and locations of sampling exists in archive.

Vegetation: Trees quercus elex?, bushy shrubs; rosemary, thyme…trees pre-cut at the same time all over area.

Outreach: The experimental grounds are open to the general public but is not easy to find for and little by-passers most likely. Little general traffic in area apart from hiking tourists, seems safe to leave equipment.

Energy: 2 sets of solar panels, depending on financing may have regular electrical power supply from 2012.

Local expertise, staff:

1 engineer, 1, technicians, 3.5 research scientists, post-docs, PhD students and Master students

Support and related facilities on site:

Other units:

History:

After 2nd world war, decline in agricultural activity, natural forestation, changes documented by photography, incl. air photos, now stable conditions, some logging activity for burning purposes. Area 50Ha, representative of larger area. Mostly privately owned. Research field on state property.
Animals: Sheep, wild pigs, dear

1984: Start up of site, Objective: monitoring of tree growth , C and N cycles in soils,

1998: Installation of Eddy flux tower

Limestone/Karstic bedrock forming a flat plateau,

Eddy flux tower; difficult to close energy balance underestimation of evapotranspiration, i.e. challenge: get a good estimation of evapotranspiration

Numerical modelling, some performed by own team, some through collaboration e.g. through Carbo extreme,

Natural conditions: 900 mm precipitation per year, 134 mm/yr plant available, 90% rocks, roots up to 5m depth.

300-400 automatically logged sensors (every 0.5 hour), in the process of unifying all loggers to one station. Approximate distance between sensors 600 m. Automatioc sensors include: TDR, playmat?, manual measurements: radial growth?, phenology, litter mass, leaf bio-chemistry,

Rain removal experiment: 30% of rain removed by drain (takrenner) hanging in the area (approx.. 1-2 m above ground). Running for 8 years, started during Mines project (EU). 4 treatments (control, 30% removal,….?), including 3 replicates.measurements of radial growth, sap flow, water contents in top soil, TDR, neutronmeter probes, temperature, growth phenology component of C-balance, litter fall, soil respiration, 12 automatic chambers, CO_2 flux, measurements every 0.5 hours during 1 week in location. Each treatment (Jean Marc Ourcival); 7 trees, 21 twigs, monitored manually, once a week during period: March-July (end of growing season). Twigs registered manually,; stage of development, 2 yr leaves, count at end of growing season. Rain gauges at 12 m height and 2m at Eddy tower. 3 meterological stations, including 1 for met. Network. Forest function: important for air quality, trees emit terpenoid, groups at Bordaux work on ozone interaction with these trees.

Drought experiment:

Total rain exclusiomn experiment, initiated by Laurent Misson (deceased). A rack for supporting plastic roof: 20 by 14 m can be moved over two different areas, one end was used to exclude spring period (6 months) the other end for excluding autumn rain. This represents a 50 yr return period. Monitoring of CO_2 soil concentration (Vaizela? Probe) at two depths, also chamber flux measurements.

The EXPEER Transnational access site

Notes from Rothamstedvisit May 6th, 2011;

Host: Andy Macdonald

Visitors: Alex Milcu and Helen K. French

Access: Rothamsted is easily accessible by train, and is within walking distance from the train station Harpenden. Accommodation is found in the village or in the Manor house at Rothamsted.

Andy Macdonald presented the history of the Rothamsted site and the long term experiments. Further information is available in the brochure; Rothamsted Long-term experiments (attach pdf) and the short summary (poster pdf). The first experiments were started here between 1843 and 1856. The focus was on agricultural production including the use of different fertilizers, organic matter, weed-control, pests and diseases. The monitored control factors were yield and changes in soil chemistry. Also loss of nutrients in drains was monitored on part of the area. The site has hence long time series of agricultural inputs and outputs, meteorological data. The site also has a unique archive of old materials, soils, grains, and straw.

In addition to the long term experiments (which have been assigned as access site in the EXPEER project), there are also short term experiments going on at the site, and advanced climate controlled laboratory, which will be described in more detail later.

The soil is sampled every 2-10 years for full chemical composition including pH, org-C, nutrient status etc. Plant diversity is also examined on the long-term grassland experiment (Park Grass) by recording the number of plants comprising >1% of biomass.

Financial situation: The Rothamsted Long-Term Experiments are supported jointly by The Lawes Agricultural Trust and the UK Biotechnology and Biological Sciences Research Council (BBSRC).

Sharing of data: Data is available to internal and external researchers via the Rothamsted Electronic Archive. Data is usually shared in collaboration with Rothamsted researchers to ensure no mis-interpretation or misuse of data.

Hydrological description: No measurements of groundwater dynamics, water through drains or surface water (last point limited, only observed as surface water collected in local depressions). Drain water collected from part of Broadbalk, but only for water quality measurements.

Soil conditions: Mainly described for the plough layer (0-23 cm depth) although deeper cores have been taken down to 2 m on some experiments, location usually available. Details of soil classification are available for most sites. There are no comprehensive . geophysical measurements to map deeper geological conditions and variability of the plots.

Outreach: The experimental grounds are open to the general public and the different research plots have information signs showing the purpose and some history about the experiments. Usually more specific signs of treatments are put out every year.

Local expertise:

Soil chemistry group

Hydrology/soil physics group

Plant/crop group

Bio-imaging group

Statisticians (5-10)

Support and related facilities on site:

Bioimaging group

Scanning electron microscopy; X-ray spectron analyser: detects elements: C, N, Bor, Ar, Se…?

Transistion electron microscope, CCD camera; fluorescents, in soil analyse for different elements

Image: 2X2 um, x 100.000, 3D imaging, Cryon electron microscopy courses, special competence on type of samples that are examined here, close collaboration with experimental work at the site.

Light and laser microscopes

Stereo microscopes: fluorescent, light, living org. time lapse

Confocal laser scanner microscope,

Laser sectioning equipment.

Staff: high competence and available software

Controlled environment:

Cabinets Sanyo: Fitotron: 16 cabinets, each 1.68m2

Vasala(?) CO2, NO, ozone monitoring – controlled in the room, up to 2000 ppm , above: problems with leakage

Temperature through air ventilation system: 5-35C, daily temperature profile, light monitoring and control. Fresh air circulation, humidity control

Each cabinet: Energy consumption per week: £70

Cost per cabinet: ca £30.000, building: £2.1M (completed in 2001), now probably ca.£3 M, a new closed building with similar instrumentation was completed in 2010

Growth rooms: 8 rooms, 6-8 m2?

Maximum size plants: small trees, 2 yrs.

Temperature through air ventilation system: 5-35C, daily temperature profile, light monitoring and control. Fresh air circulation, humidity control,minimum airflow to maintain uniform temperature: 0.5 m3/sec

Humidity and CO2 controlled, water balance in soils: tensiometers, sensors, weighing (scales up to 25 kg), rain water quality used to ensure soil wetness. Can provide soil moisture probes, but also possible to bring in external equipment. (Richard Wally?)

Research: Less plant physiology, more on crop research

Energy (where?): £475 per week

Rental price: £600-800 per week, depending on energy consumption

Costs: 1/3 on each: energy, maintenance, work, commercial price: x1.3-2 regular price

Energy consumption per month for entire building: £90.000, 2 networks to ensure secure power, high priority on controlled environments, regular maintenance

Other units:

Work shops

Green-houses

Sample archive (ca 5 take-outs per year)

Soil preparation room (drying ovens, tables, sieves etc.)

System of approval: The farm and field experiments committee (FFEC) evaluate sampling requests and proposals for changes to the long-term experiments: yes/no

The EXPEER Transnational access site

Notes from Silwood Park, Ecotron visit May 9th, 2011;

Host: Alex Milcu

Visitors: Andy Macdonald and Helen K. French

Access: Easily accessible by public transport, train to Silverdale?, taxi from railway station to Silwood park or reasonable accommodation at …., walking distance between accommodation and Silwood park. Some distance to village with shops, cycling distance. Accomodation centre suitable for organising larger meetings.

Financial situation: group working with Ecotron has been reduced from about 20 people to 1 permanent technician (Dennis) and one research scientist (Alex Milcu) employed on soft money. Little funding last few years, threatens the existence of the facility.

History:

Facility building completed in 1989, first experiments in 1993. Objective: to test the effect of environmental conditions on plant community and diversity. Climate change experiments. Full control of physical/chemical conditions, add all species – so it is known. Later sample monoliths, e.g. from peat (water table controlled experiments).

Sharing of data:

Hydrological description: NA

Soil conditions: NA

Outreach:

Local expertise:

Support and related facilities on site:

Controlled environment:

Chambers; 2 x 2 x 2 m chambers, 0.5 tonnes block of soil. Containers 60 x 60 40 cm

Other units:

16 chambers, 2 temperature regimes. Not individual temperature control. Temperature controlled by air flow 8 m3/s. Reduced circulation to achieve wanted CO2 , then reduced control of temperature. Temperature range 5-25C, diurnal changes monitored at 10 cm into soil, response monitored.

16 units of Glove box technology , physical model of C-cycling, pot with plant inside, control of CO2 in whole system, materially closed system. Can control temperature in boxes. Depending on CO2 level can emulate atmospheric changes, biotic feed-back mechanisms. First step: watering the plants, recycling of water within system. Chambers could be used anywhere, in this case light emission from external (room) sources. Dennis has set up all electronics and internal temperature control inside

boxes. Control of CO_2, O_2, pressure, Relative humidity, soil humidity. avoid pvc cables- they leak gases, ptfe cables used, problem with silicon; often additives such as fungicides – also not completely sealed, alternative: epoxy resin.

4 gas controls over the 16 chambers,

Artificial light

Experiment:

*Control sample: 15C, pre industrial CO_2, temp.

*Increased/injected CO_2

*Increased/injected CO_2, based on IPCC scenarios

Plant uptake in CO_2 was higher than what is suggested bymodels

IR gas analyser coupled via tubings to chambers, instrument behind climate rooms, sensitivity: <500ppm, breathing gives 50.000ppm, Monitor drift for whole system rather than individual measurement (chambers?), readings every 15 minutes, Avoid condensation in tubes, heating cables are included to avoid this.Producer: TREND controller and logger.

System for detection of light bulb failure. deviation of temperature.

No backup power supply

Future plans: Conduct ozone experiments, vulnerable staff positions

Suggestions; scales below small chamber, camera or other devices to monitor changes in plants online. Ecotrons on ground floor rather than 1st floor.

Original size of tanks: 125 x 82 cm, 38 cm high.

Greenhouses:
Elevated CO_2, no temperature control, natural light and spot light. Request from commercial company, use facility to test properties of filter technology for light.

System of approval: if intellectual properties is involved it should go a local board at Imperial

Collaboration activity, research services of facilities,

Ecotron used to be part of Centre of population biology (doesn't exist any longer) now part of Institute of biology.

Outdoor facility: elevated ozone chambers,
Generally: indoor: ecological studies, outdoors: grass studies
Useful from EXPEER +: Database of experts of such facilities, creativity and innovation capabilities of electro engineer required.
USA experiment: biosphere, soil respired more than plants could use.

The EXPEER Transnational access site

Notes from Whim bog visit July 18th, 2011;

Host: Lucy Sheppard

Visitors: Helen K. French

Access: The Whim bog site is reached by car, ~ 20 min drive from CEH Edinburgh (it may be possible to use CEH cars) It is possible to get to the CEH station near Penicuik via train to Edinburgh and bus 37 or 47 (to Penicuik) from the centre (disembarking at the Gowkley Moss roundabout). Some buses come via Bush: 67, 47 (some), 15a.

Financial situation: Limited resources, only Lucy Sheppard and Ian Leith are permanent staff with responsibility for the science and data collection and storage, with Ian Leith, who having responsibility for the atmospheric science section field sites.

Sharing of data: Vegetation cover data is stored in an Access database, remaining data (met data, vegetation and soil chemistry are on Excel data files, means and error are available on UKREATE website and some data (meteorological data , GHG fluxes and soil water are on the NEU database). It is recommended that work with the data will be most efficient if undertaken in close collaboration with the site owners.

Hydrological description: Most meteorological parameters , including water table and soil temperature (3 depths) are logged continuously and data is provided as 15 min or 1 min averages.

. In addition there are 0.7m high dip wells (filter entire depth), for monitoring water level next to static gas chambers in 28 the dose response wet treatments and 12 (1 per sampling distance (8, 12, 16, 20, 24, 28, 32, 40, 50 and 60m along the ammonia release transect). These are measured once a month. On one side of the area, along the road is a drainage ditch. **Soil conditions:** Peat soil, maximum 6 m. The underlying geology is from the Ordovician (Ashgill, Caradoc, Llandeilo, and Arenig).

Vegetation: *Calluna, Eriophorum vaginatum, Sphagnum capillifolium*, NVC M19 are the key species on this ombrotrophic bog. The *Sphagnum* species presentincluding *S. papillosum* and S*. fallax* which are common in the wetter areas reflect the water table which ranges between the surface and 40 cm below. Species richness is quite low with very few forbs. The hummock forming *Sphagnum* are the most widespread.

Outreach: The experimental grounds are situated within a peat extraction site, which is closed to the public. Results from the experiment have fed into both Critical levels for ammonia re-evaluation and N critical loads re-valuation.

Energy: Standard mains power supply (240 AC) to the site hut, with limited capacity to run additional instruments. Along the ammonia transect there is a mains supply, converted to 3 12 volt outlets.

Hydrological system:

Bog area, low gradient stable flow in one direction Dip wells near all static gas chambers, water level measured once a month together with gas sampling. Groundwater level is logged near meteorological station near the site hut.

Local expertise, staff:

2 permanent staff are involved in the work, in addition the running of the site is highly dependent on temporary personnel such as master and internship students to conduct the routine analysis, in addition post-docs and PhD students may have specific analyses or experiments running.

Support and related facilities on site:

Other units:

Laboratory at CEH there are GC facilities for N_2O , CH_4 and CO_2 CEH has a various gas exchange equipment that could be borrowed for NEE, soil respiration. There is a well equipped molecular lab on site**.** Funnels for extracting, soil macro fauna are also available and there are the usual equipment for soil pH and extractions, mills, ovens etc.

History:

Whim bog research site was established in 2001 and the all year round treatments have been running since May (dry) June (wet) 2002, with various expansions in monitoring methods starting up later.

Experiments:

Main focus on N deposition experiments, different N form and for some plots also addition of P + K. Area is divided in two main supply systems; wet deposition with irrigation system – circular sprinkling system.

Wet deposition: Rain water for the irrigation system is collected onsite. The wet treatments increase the total amount of water supply by about 10% compared to the background. The single sprayer head at the centre of each plot, supplied with treatment by individual 100m length plastic pipes provides a a fairly even distribution with time within the monitored area (a certain radius around each irrigation hose). Each plot has a unique identity number which is displayed together with the treatment on 2 sides of each plot. There are 4 replicates per treatment, 11 wet treatments (3 doses @ 1, 3 and 7 times the ambient deposition (8 kg N/ha/yr) with the N supplied as oxidised ($NaNO_3$) and reduced (NH_4Cl) plus a control no added N and 16 PK treatment plots where the high and low N additions are supplemented with K_2HPO4 (P:N 1:14).

Dry deposition: gaseous ammonia is emitted from a cylinder of liquid ammonia, by free air release, automated in response to wind direction: gas release is controlled by wind direction through a sonic anemometer and logger linked to a a mass flow controller. The ammonia is mixed with air and dispersed by the wind from a pipe, drilled with small holes. This creates an exponential gradient of ammonia concentrations down the release transect. Ammonia concentrations are measured using passive ALPHA samplers , which are changed every month. These measurements have been calibrated against continuous measurements (Airrammonia system) conducted during a specific period in 2010. . In this area cotton grass has replaced *Calluna* and *S. capillifolium* and most of the other mosses which have been killed.

In addition to dip well samplers and static gas sampling chambers, the ammonia transect and wet N dose plots are instrumented (since 2006) with soil mini-Rhizons for collecting peat water samples. White sticks are used to identify quadrat grids for analysis of composition and cover of plants species at the same locations (permanent quadrats). In addition to changes in plant composition effects on frost hardiness, winter desiccation and pest and pathogen damage have been studied in the ericoids (Sheppard et al 2008) studied. A photographic record has been maintained as a record of changes in the plots and along the transect over time.

N has not increased the cover of this vegetation, although in the early years there was a tendency for longer shoot extension in Calluna and after 5 years The 56 kg NH4 treatment did increase Calluna cover and has increased litter(Carfrae 2005, Sheppard et al …in press). The additional N has had a detrimental effect on the growth and C balance of the main peat forming moss Sphagnum capillifolium (Kivimaki 2010) and appears to be slowing the rate of mass loss ofdecay of Sphagnum (Kivimaki 2010).

Where P+K is added; more moss (Hypnum jutlandicum) and algae are observed to the detriment of the *Calluna.* Along the ammonia transect there has been an increase in the amount of *Eriophorum* but there has not been the increase in grass, *Molinia caerulea* and *Deschampsia flexuosa* seen in sandy heathlands in East Anglia and the Netherlands.

The site has also been used by other experimenters to introduce different plant species in turves eg *Drosera* and species of *Sphagnum* and lichen, so that they can be treated with either wet or dry deposition.