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Life08 ENV/IT/000399

Action 3
Report on cause-effect analysis and data evaluation

Activity 3.1 Metadata analysis
-Selection of variables for long term data analysis-

Subactivity 3.1.2 – Preliminary metadata analysis using Infobase/Establish key parameters for cross-site and network level analysis;

Subactivity 3.1.3 - Metadata analysis using new data collected from partners and the involved sites/Integration of the metadata analysis;

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Authors: Mihai Adamescu, Thomas Dirnböck, Constantin Cazacu (A3)
Johannes Peterseil, Alessandro Oggioni (A1),
Mark Frenzel (A2),
Alessandro Campanaro, Paolo Colangelo, ,(A4),
Georgio Matteucci (A5),
Alessandra Pugnetti (A7)

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Contact information:

Mihai Adamescu – Editor
University of Bucharest (Unibuc)
Department of Systems Ecology
Spl. Independentei 91 - 95
050095 Bucharest, Romania
E-mail: adacri@gmail.com
tel/fax: +40 21 318 15 71
mobile +40 722 277 479

Thomas Dirnböck
Austrian Environment Agency
Department for Ecosystem Research & Monitoring
Spittelauer Lände 5
A-1090 Vienna, Austria
E-mail: thomas.dirnboeck@umweltbundesamt.at
tel/fax: +43 1 31304 3442
mobil: +43 664 9668608

Constantin Cazacu
University of Bucharest (Unibuc)
Department of Systems Ecology
Spl. Independentei 91 - 95
050095 Bucharest, Romania
E-mail: constantin.cazacu@gmail.com
tel/fax: +40 21 318 15 71
mobile +40 744357404

Alessandro Oggioni
National Research Council of Italy
Institute for Electromagnetic Sensing of the Environment
Via Bassini 15
20133 Milano
Italy
E-mail: a.oggioni@irea.cnr.it

Peterseil Johannes
Austrian Environment Agency
Department for Ecosystem Research & Monitoring
Spittelauer Lände 5
A-1090 Vienna, Austria
E-mail: johannes.peterseil@umweltbundesamt.at
tel/fax: +43 1 31304 3443

Alessandro Campanaro
CFS - Centro Nazionale Biodiversità Forestale "Bosco Fontana"
di Verona and Università di Roma La Sapienza –
Dipartimento di Biologia e Biotecnologie
Via Borelli 50
00161 Roma, Italy
E-mail: ale.naro@gmail.com

Paolo Colangelo
Università di Roma La Sapienza –
Dipartimento di Biologia e Biotecnologie
Via Borelli 50
00161 Roma, Italy
paolo.colangelo@uniroma1.it

Mark Frenzel
Helmholtz Centre for Environmental Research (UFZ)
Theodor-Lieser-Str. 4,
06120 Halle, Germany
E-mail: mark.frenzel@ufz.de
Tel +44 345 5585304,
Fax +44 345 5585329

Giorgio Matteucci
National Research Council of Italy
Inst. Of Agroenvironmental and Forest Biology and
Inst. For Agriculture and Forestry Systems in the
Mediterranean (CNR-ISAFOM / CNR-IBAF)
Via Salaria, km 29,
300 00015 Monterotondo Scalo (RM), Italy
E-mail: giorgio.matteucci@cnr.it
Tel +39 06 90672533,
Fax +39 06 9064492

Alessandra Pugnetti
Institute of Marine Science - National Research Council,
ISMAR-CNR, Castello 1364/a,
30122 Venice, Italy
Email: alessandra.pugnetti@ismar.cnr.it
Tel +39 041 2404711,
Fax +39 041 5204126

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1. Introduction

Durable integration of the existing **research institutions and infrastructures in the biodiversity research field** as well as integrated monitoring on "biodiversity, ecosystems and social systems" across European scale are among main concerns and opportunities for different institutions.

Many projects have been designed at European scale to deal with the problem of integration. Networks of Excellence, like Alternet and Marbef, are just two such examples. Alternet had contributed significantly to the development of a network of distributed sites for complex ecological research and monitoring across Europe (EU-LTER). The Long Term Socio-Ecological Research Network (LTSER) represents the response of the scientific community to the complex problems raised by environmental concerns. A key feature of LTSER is the emphasis on **long-term management of data and information** as well as the integration between the **ecological and social data over space and time scale.**

LTER/LTSER network should actually act as a **network of pilot areas** that will let managers and decision makers **to make choices** which center on finding the balance between the carrying capacity of the ecosystems (based on the goods and services that different ecosystems are providing) and landscapes and the many demands placed upon it by the different stakeholders of the entire socio-economic system. The long-term study of ecological systems needs an approach based both on ecological monitoring as well as on research with a shared scientifically-sound basis. In the same time there is a need for methodological harmonization at European scale, at least for some important defined variables. All of the above aims are in fact meant to improve the environmental management and to support the development of environmental policies and conservation planning through integrated approaches.

The need to identify the essential variables and indicators for biodiversity monitoring and biodiversity change is recognized for a long time. The assessment of the adequacy of different observation systems for the monitoring of biodiversity was recently assessed at global level by the Group on Earth Observations Biodiversity Observation Network (GEOBONE) (Anonymous, 2011)

This document is reporting about the selection procedure used for the variables/parameters that will be used in action A3 for long term data analysis. The report also presents details about approach used in Action A3 with an extensive list of variables selected to be reported by all the partners as well as a set of priority variables, upon the reporting partners should firstly concentrate. The long term datasets[1] reporting (including tools for data gathering in A1) are based on this report conclusion. The variable selection is different to that of action A2 insofar as it is focused on the availability of long-term data in LTER sites which are ready to analyse.

[1] A long-term dataset in the context of biodiversity research is simply information on the variety, and ideally the abundance, of species (or other taxonomic units) at one or more locations at a number of points in time (Magurran, 2010). For the use of A3 a long term dataset is the information on a specific list of variables (selected) at LTER sites across Europe.

2. ILTER, USA-LTER, EU-LTER and EnvEurope

International Long Term Ecological Research (ILTER) is a 'network of networks', a global network of research sites located in a wide array of ecosystems worldwide that can help understand environmental change across the globe. ILTER's focus is on long term, site-based research (from the http://www.ilternet.edu/).

The first long term ecological research networks ever developed is the USA-LTER. Here the focus of research was (and still is) on 5 core areas: i) Pattern and control of primary production; ii) Spatial and temporal distribution of populations selected to represent trophic structure; iii) Pattern and control of organic matter accumulation in surface layers and sediments; iv) Patterns of inorganic inputs and movements of nutrients through soils, groundwater and surface waters; v) Patterns and frequency of site disturbances (from the http://www.lternet.edu/overview/). USA- LTER is part of the ILTER.

The Long Term Ecosystem Research network in Europe (EU-LTER) is an essential component of world wide efforts to better understand ecosystems. This comprises their structure, functions, and response to environmental, societal and economic drivers as well as the development of management options (from the http://www.lter-europe.net/). EU-LTER is part of the ILTER.

The objectives of the EU-LTER are:

1. to identify drivers of ecosystem change across European environmental and economic gradients;
2. to explore relations between these drivers, responses and developmental challenges under the framework of a common research agenda, and referring to harmonized parameters and methods;
3. to develop criteria for LTER Sites and LTSER Platforms to support cutting edge science with a unique in-situ infrastructure;
4. to improve co-operation and synergy between different actors, interest groups, networks, etc.

Nevertheless each network has the possibility to define its own research focus. As an example, the key research questions of the Romanian LTER (Vadineanu et all, 2007, Adamescu et all. 2010) are:

1. understanding biodiversity dynamics (composition, structure and functioning processes) in the local and regional socio-ecological complexes, under pressure of interacting driving forces: human colonization and resources exploitation; pollution; alien species and climate changes;
2. assessing ecosystem and landscape functions, resources and services flows along their development cycle;

3. social research supporting societal certification of major strategies, policies and projects, regarding biodiversity conservation, sustainable use and ecological restoration.

EnvEurope was developed by the partner institutions in EU-LTER with the clear aim to support further the integration of LTER networks and sites, in terms of data, metadata, data policy, common research policy, and standardization (variables and methods). In the same time the EnvEurope is recognizing the need to actually having access at tangible results of the network activity in the above aims as well as in providing concrete research results from long term dataset analysis.

The project EnvEurope proposes a design for environmental high quality monitoring sites based on the exemplary establishment of common variable/parameter sets collected across EU-LTER. The project is in fact building on existing infrastructures and also on the existing (long .term datasets) and newly collected data series.

EnvEurope is focused on three classes of ecosystems, terrestrial, freshwater and marine ones, and aims at defining measures relevant to different levels/scales of investigation, with specific monitoring intensities and with methods adjusted to the respective assessment intensity, implementing a multi-level and multi-functional monitoring approach.

The EnvEurope project aims to:

- Select and provide data, information and ecological indicators concerning the long-term quality trends of terrestrial, marine, freshwater ecosystems at European scale, inside the monitoring network EU-LTER
- Select and collect data able to provide information on environmental quality and drivers in respect of indicators and methodologies shared and applied in the main European networks (EU-LTER, EIONET, EU Forest Focus & ICPs of UNECE/CLRTAP/WGE, Natura2000, etc.).
- Reorganize the EU-LTER network on the basis of suitable sites, reflecting ecological, political and economic stratification of Europe. The reorganization will contribute to the development of SEIS and GMES initiatives.

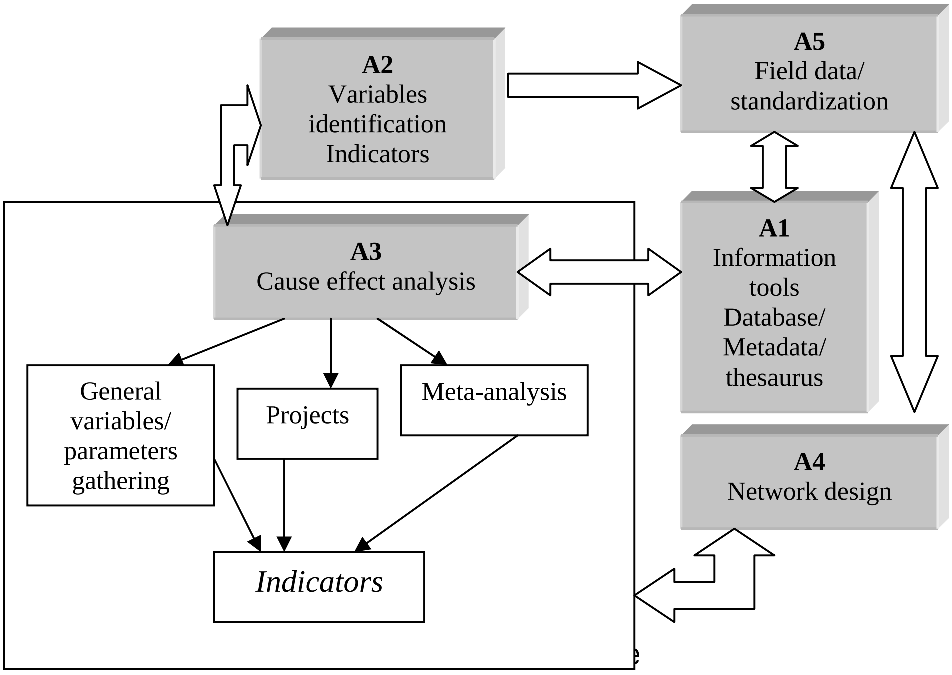


Figure 1.

In this context the action A3 – "Cause-effect analysis and scientific evaluation" (see figure 1) is mainly addressing the analysis of historical and new ecosystem monitoring data coming from a series of LTER sites. It aims at evaluating the status, the trends and the cause-effect relationships at different spatial and temporal scales. The evaluation is taking regional variability and differences between freshwater, marine and terrestrial habitats into account.

Among the very first steps is the selection of an appropriate list of variables/parameters (based on A2 & A3) that will allow such analysis to be carried out at network level including as many sites as possible. The variable selection was based on a series of criteria:

1. allow/contribute to the identification of ecosystems status;
2. identify general characteristic trends across Europe;
3. identify the main drivers of change and their action in time and across spatial scale;
4. possible use of the variables in existing indicators or in the development of new indices and indicators;
5. long term availability of the datasets for each of the sites (longer than 10-15 years, aggregation level – monthly);
6. common availability of the variables across sites (for comparison reasons)- Number of sites measuring the same parameters, ecosystem type, time span, frequency and methods
7. possible use of variables for future monitoring and research activities, including addressing up scaling issues and validation of the GMES products with in situ data
8. correspondence (respond to) with international conventions

3. Conceptual background and approach for A3

3.1. Sharing the datasets[2]

In the early stages of the US-LTER data was managed within individual sites and not shared outside the site (Michener, 2011). This approach (keeping the dataset for the use of each site and possible use of the data in different research projects) is in fact a contra productive one and the US-LTER is moving ahead from this approach (for e.g. in 1990 the US-LTER published a "first version of an LTER-wide data catalogue" (Michener W. K., 1990).

In EU-LTER the collaboration (data sharing, standardization, common protocols etc.) is in early stages of development despite the rapid development that the network took in the last 5-6 years (see Alternet consortium and project, EU-LTER management plan etc.). Nevertheless the EU-LTER has also a catalogue of available datasets included in the Infobase tool and the ILTER web site is working hard to allow access at specific datasets (http://www.ilternet.edu/sites based on the http://www.mexlter.org.mx/en/Main/averages/variables.php). Disregarding the networks (US or EU) in fact, the actual sharing is done by researchers and institutions mainly through specific projects. Actually, the will to share data, ultimately rest on the hands of those who are producing the complex datasets needed to understand ecosystems. Thus in many cases the data sharing is viewed by researchers as only being driven by research hypothesis. Although we are supporting the hypothesis-driven research we are also emphasizing the need to allow a common use of the long term datasets across spatial scale for further reuse of data. The driving factor behind this is the increasing understanding by individual sites and researchers of the intrinsic value of the network through exemplary research done using sites (across sites), datasets and researcher within the EU-LTER network (table 1).

Table 1. Arguments for sharing the datasets 3

No.	Site level research*[4]	Network level research
1	Addressing local issues	Addressing regional, European and global scale issues
2	Focusing and explaining mechanisms	Developed across gradients (at European or global level)
3.	Identifying local drivers and pressures	Disentangling local scale drives and pressures from regional and large scale ones
4.	Addressing site-specific issues	Comparison and synthesis across sites and domains

[2] The data will only be used internally for cross domain and cross site analysis. Any other use of the data is prohibited and has to be negotiated with data provider.

[3] Other arguments (like the fact that in many cases the research has been financed by public bodies and that after 2- 3 years , allowing the publication of results, data should be made available for the scientific community) are not discussed here

[4] *Both research types are important and in fact the network level research is relaying on the research done at site level. Many of the intricate mechanism could not be observed and studied at large spatio-temporal scale. The many cases the same scientists are involved in both approaches. The temporal and spatial aggregation level of datasets could be different.*

5.	Transdisciplinary research at site level	Transdisciplinary research at network level
6.	Local research experiments focusing on mechanisms	Cross-site research activities including cross sites experiments which improve hypothesis testing
7.	Visibility of sites	Visibility of the network and sites
8.	Communication and knowledge transfer to local decision makers	Improved communication and knowledge transfer involvement of local and regional decision makers
9.	Limited spatial coverage	Extended spatial coverage; Possibility for trade-offs like space for time approach
		Increased research capacity of the involved research institutions (Alternet report- Nina 569)
		Increased capacity for interdisciplinary research (Alternet report- Nina 569)
		Increased rate of success in future research programmes (Alternet report- Nina 569)
		Contribution in keeping the compliance with the EC's INSPIRE Directive and the future initiative for a European Shared Environmental Information System (SEIS) (Alternet report- Nina 569)

3.2. Conceptual background

The site-driven development of EU-LTER has the disadvantage that different variables, all selected addressing locally important properties and processes, are measured across the entire network. Identification of a limited list of "important" variables to describe ecosystem changes in a complex way (see e.g. CBD definition – biotic and abiotic components; ecosystems, landscapes, communities/populations and human diversity) is a challenging task. Complicating aspects are the huge complexity of the investigated systems, the hierarchical organization up to the non-linearity of the systems. It became rapidly obvious that we do need a conceptual framework, not necessary to solve the problem, but at least to bring arguments for the "let aside" variables.

We could use the approach used by the GEOBONE (figure. 2) that in fact is implementing the PSR (Pressure state response) system. The GEOBONE model is a practical approach but it is not dealing with the intrinsic proprieties of the systems.

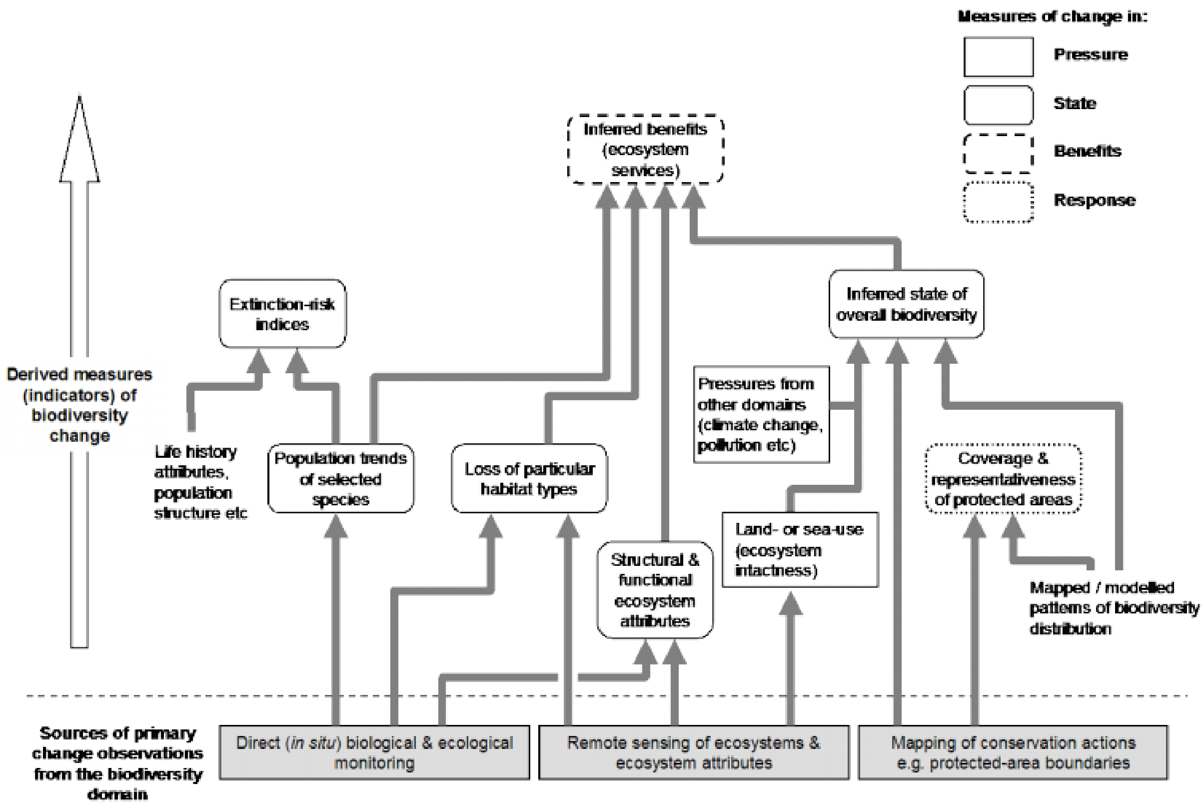


Figure 2. Proposed model for the identification of the biodiversity variables (from GEOBONE 2011)

The proposed conceptual framework for EnvEurope is based on the systems ecology (Vadineanu, and Botnariuc, 1982, Odum, 1983). The basic ideas are: i) matter is organised in systems ii) there is a hierarchical organization of the systems iii) there are emergent proprieties of the systems (not all the proprieties of a specific level could be explained with the proprieties of that level) etc. Based on this and as the ecological theory developed, the concepts and methods dealing with the "environment" (physical, chemical, biological, including human dominated and created environment) changed and improved. The identification and description of the natural, semi-natural and human-dominated and created systems have changed, from a former conceptual model which defined the environment as an assemblage of factors (air, water, soil, biota and human settlements), to the most recent one, which considers that the environment has a "hierarchical spatial and temporal organization" (Odum 1993, Pahl-Wostl 1995, Vadineanu 1998, 2001, Holling et al. 2002).

In this context socio-economical systems are no longer perceived as units external to the environment or as reactive and pro-active units in connection with the nature, but as parts of its hierarchical organization at space and time scale.

We have used this conceptual schema (Adamescu et al, 2007) also for the Infobase (that was used in the preliminary collection of metadata from sites) as well as other tools used for data and metadata collection have been based on such a hierarchical structure. The Infobase has a hierarchical structure (from the LTSER site level, through landscape level and then to the ecosystem level) (Figure 2). The term level is the most appropriate term due to the fact that they are coming from systems ecology were they are defined as "organizational levels" of matter (Vadineanu and Botnariuc, 1982).
Each level has attached a list of variables (structural and functional) and the metadata needs (information level).

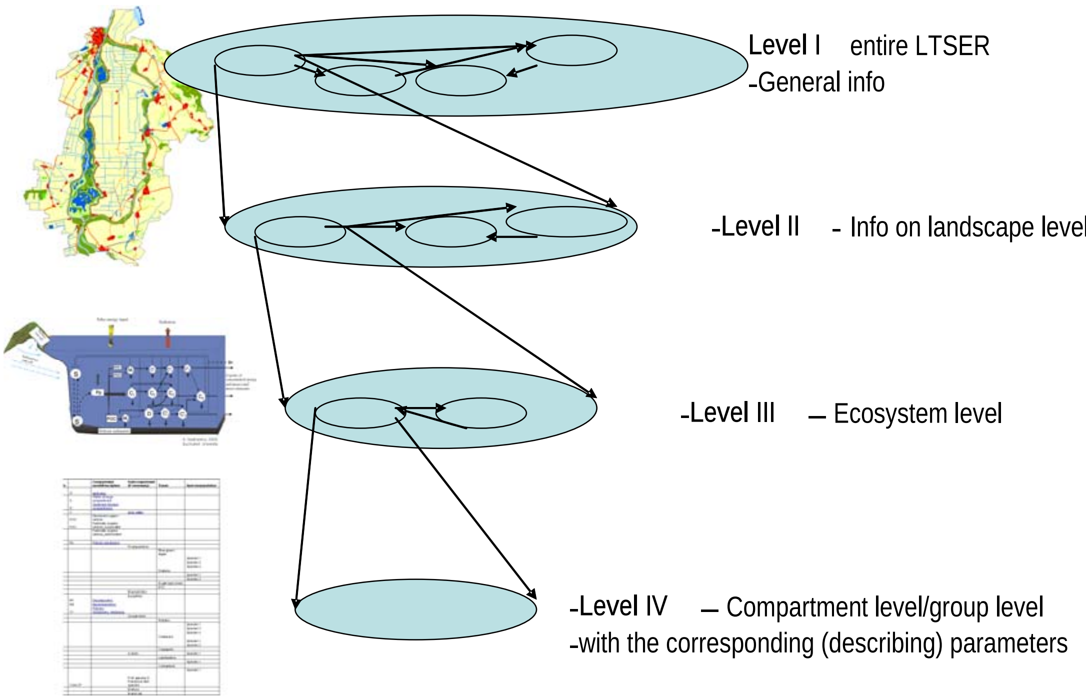


Figure 3 Schema for the Infobase structure (hierarchical approach – includes several organizational levels of matter: from compartment (that could be even a single species, to ecosystem and landscape level).

For practical reasons, in the tool developed in A1 (EnvEurope _DataReporting_v0.8) for data gathering, we only included the following basic themes:

1. Climate and physical variability,

2. Biogeochemistry data,

3. Structure and function of ecosystems, communities and populations,

4. Human population and economy.

The proposed themes are covering all of the hierarchical levels described in figure 3.

Variables are used to describe/characterize the ecosystems (different types), different abiotic and biotic compartments (primary producers, consumers, water and sediment characteristics, soil etc.), the human component as well as the specific drivers and pressures.

In identifying the data needed we took into consideration the hierarchical structure of the environment (landscape level, ecosystem and compartments).

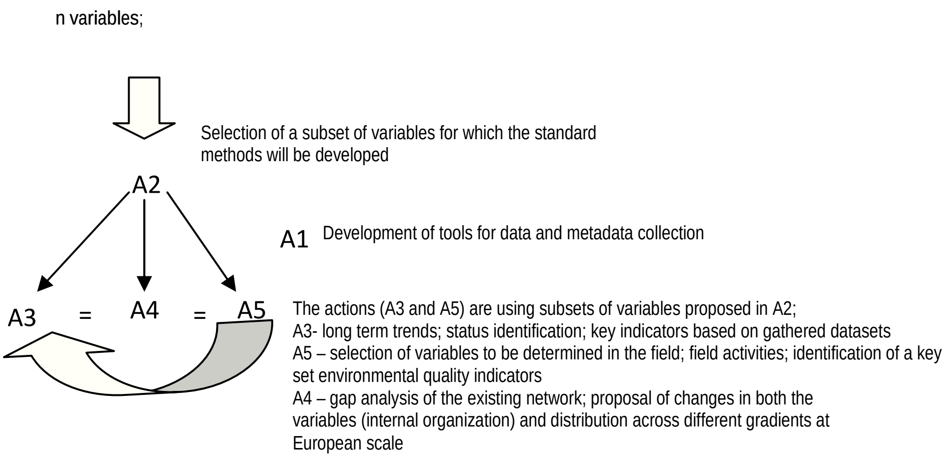


Figure 4. Interaction between activities in EnvEurope and selection of variables/parameters and indicators of change

EnvEurope is important for the EU-LTER network and for ecological research area not only because is focusing on important research questions but also because is contributing to the creation of the tools (e.g. data policy, database, metadata, thesaurus, manual of common methods, field experience and protocols) and understanding needed for better integration of sites and datasets at EU-level.

The added value of the EU-LTER network is actually being developed in many activities under EnvEurope (A1, A2, A4, A5) but it must be proved firstly to the network itself.

3.3. Approach for A3 action

A3 – "Cause-effect analysis and scientific evaluation" is focusing on long term datasets on specific variables gathered from LTSER/LTER sites (sites from which some have been selected for EnvEurope) viewed as complex landscape/ecosystem sites.

Because action A3 is dealing with long term datasets analysis for integrated analysis across scales and networks, an important part is focused on the identification of the variables that have been measured for long time in as many sites as possible (to cover the heterogeneity at European level).

In the early stages of the project implementation a more elaborated action plan has been proposed respecting the entire requirements of the initial EnvEurope project but with much more details about the proposed activities and sub-activities. The action plan was also proposing a list of 4 themes (i. Climate and physical variability, ii. Biogeochemistry, iii) Structure and function of ecosystems, communities and populations and iv) Human population and economy) to be considered for historical data analysis regarding ecosystem state, spatial variability and temporal trends at different levels (A.3.3.4 page 15 action plan description).

As already mentioned we could choose from two proposed approaches for the activity A3:

A) Variable/parameters identification

i) identify important variables across sites (identification of what is important was and is still an issue)

ii) collect the datasets from the sites

iii) see what are the commonalities based on existing datasets

iv) address the cause-effect analysis in terms of: status assessment, trend analysis/time series analysis and cross-site and cross domain linkages by making use of the available datasets.

B) Project proposals

i) work on projects (hypothesis driven) and allow each of the proposed projects to define a list of important variables needed to test the hypothesis.

ii) develop the hypothesis for the meta-analysis

The solution for A3 is in fact a mix of the above approaches. Based on the Infobase we have identified the available datasets at LTER sites (common measured variables); the information was supplemented with information from the questionnaire proposed by A2 integrating in this way new metadata from the EnvEurope partners as stated in A3 action plan (see http://www.EnvEurope.eu/docs/action3/action-plan, accessed June 2nd 2012). The next step was the development of a common structure for project submission (General_project_structure.doc). The common project structure was based on the themes identified in the action plan and proposed initial variables. All the above activities have been developed and presented on the member area of the EnvEurope under the A3 webpage or in meetings of EnvEurope: Rome meeting (for the projects, please see the presentation about projects in 7th June) Budapest meeting – 22 April 2011 (the metadata analysis based on the Infobase and questionnaire) and after Bucharest meeting (for the projects)- 8 December 2011[5]. All the above performed activities were and still are open to contributions and discussion for the EnvEurope community.

In parallel with the data collection process we were proposing identification of a list of hypothesis to be tested using the collected datasets (Action plan A3.3.2 Identification of datasets and sites for comparison and trend analysis). It was acknowledged the fact that dealing with long term datasets we should have access first at the datasets and based on their characteristics to draw hypothesis and make a selection of sites for cross-site comparison.

A very important responsibility lays on the A3 activity due to its demonstration character. The demonstration character was seen by the A3 as being based on the proposed approach (taking into consideration the integration needs of the EU-LTER, but also the needs of individual researchers involved in this process) and especially on:

i. general data gathering, using a set of common defined parameters
ii. project based (hypothesis driven), taking into consideration the common defined set of parameters and possibly adding new parameter)
iii. meta-analysis (hypothesis driven), taking into consideration the existing large set of literature based on research done at each of the individual site.

We think that this approach (i-iii) has several advantages: first for the project, allowing reaching the proposed objectives of A3, but also for the researchers involved.

4. Methods and metadata for variables/parameters selection

Identification of variables having a long term dataset is a difficult endeavour. Long term data analysis and synthesis in ecology should be based on the availability of the datasets and the describing metadata for the scientific community. This is actually a very difficult process not only for the EU-LTER but also for the US-LTER network (Michener, 2010). From the beginning we have to mention that the search for a list of most important or most needed variables to be measured for long term research and monitoring programmes is not a new endeavour and that in fact this search is as old as the LTER program or even older (Strayer 1986, NSF 1979). Even the approach for identification of the base variables is somehow similar (interviews, questionnaires, research analysis). The results were presented as recommendations for the LTER community.

[5] All the above presentation and some of the tables are also included as annexes to this report (see also the EnvEurope web page)

Nevertheless the EU-LTER is facing much more complex problems than the US-LTER due to the diversity of the involved institutions, the heterogeneity in the financing bodies and in the organizational structure of the EU-LTER. The EU-LTER is actually trying to “burn” several steps in the development as the data sharing and free access to data is one of the crucial aspects for ecological research (Porter 2000, Wicherts et al. 2006)

Variables selection was based on the available metadata:

i) based on Infobase (data already existing about the LTER sites);

ii) data from the questionnaire developed in A2;

iii) project documentations (as a wish list for variables to be selected for hypothesis driven research within and across LTER sites)

5. Results

As already stated the variable selection was based on a series of criteria:

1. allow/contribute to the identification of ecosystems status;
2. identify general characteristic trends across Europe;
3. identify the main drivers of change and their action in time and across spatial scale;
4. possible use of the variables in existing indicators or in the development of new indices and indicators;
5. long term availability of the datasets for each of the sites (longer than 10-15 years, aggregation level – monthly);
6. common availability of the variables across sites (for comparison reasons), i.e.: number of sites measuring the same parameters, ecosystem type, time span, frequency and methods
7. possible use of selected variables for future monitoring and research activities, including addressing up scaling issues and validation of the GMES products with in situ data
8. correspondence (respond to) with international conventions

5.1. Analysis based on Infobase

The analysis started with the meta-data stored in the Infobase. The Infobase is now describing almost 400 sites distributed across Europe (Figure 5) and is subject of regularly updating, the last going to be finalized, also with the contribution of EnvEurope A4 (*see the update call on Infobase on the webpage of EU-LTER*). Initially the Infobase was containing information for more than 1800 LTER and LTER like sites carrying out research in 32 European countries.

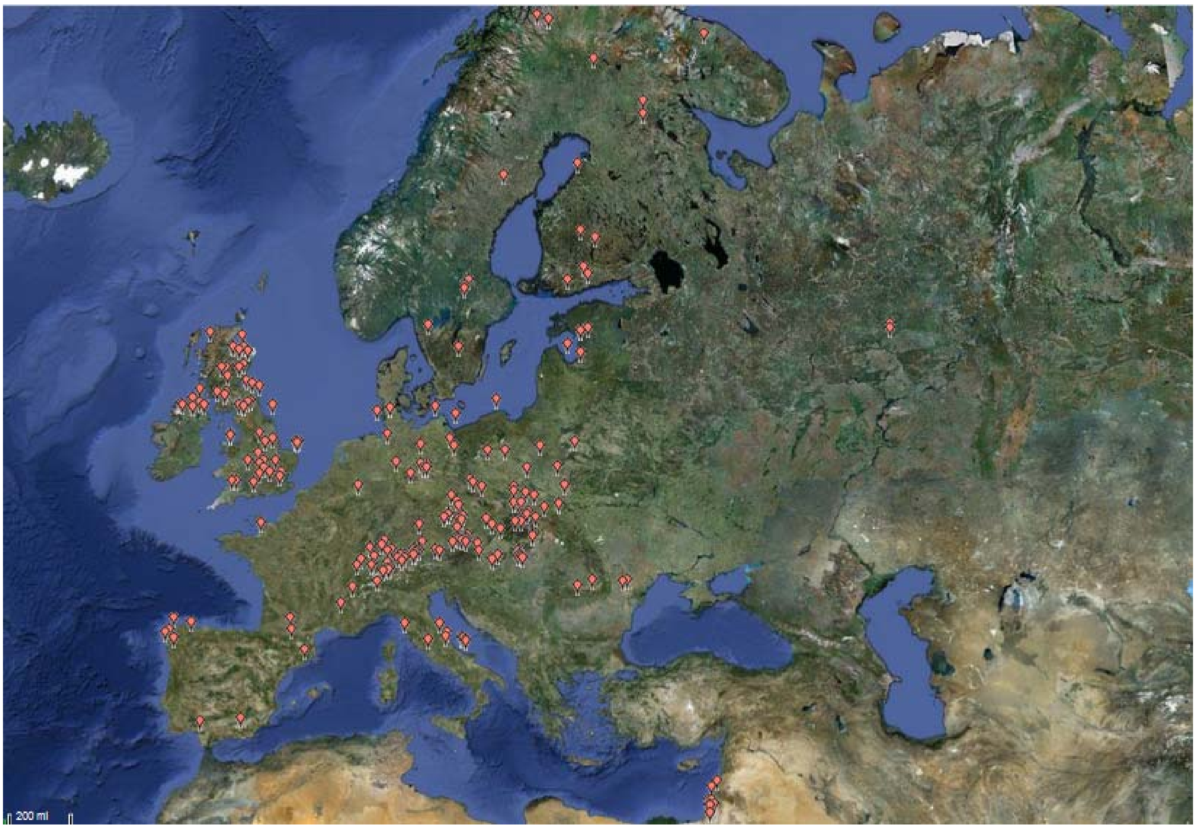


Figure. 5 LTER sites distribution across Europe (2012 from LTER web site)

The first selection was made taking into account the number of sites involved in EnvEurope (Figure 6).

i.1. Distribution of sites across biogeographical regions

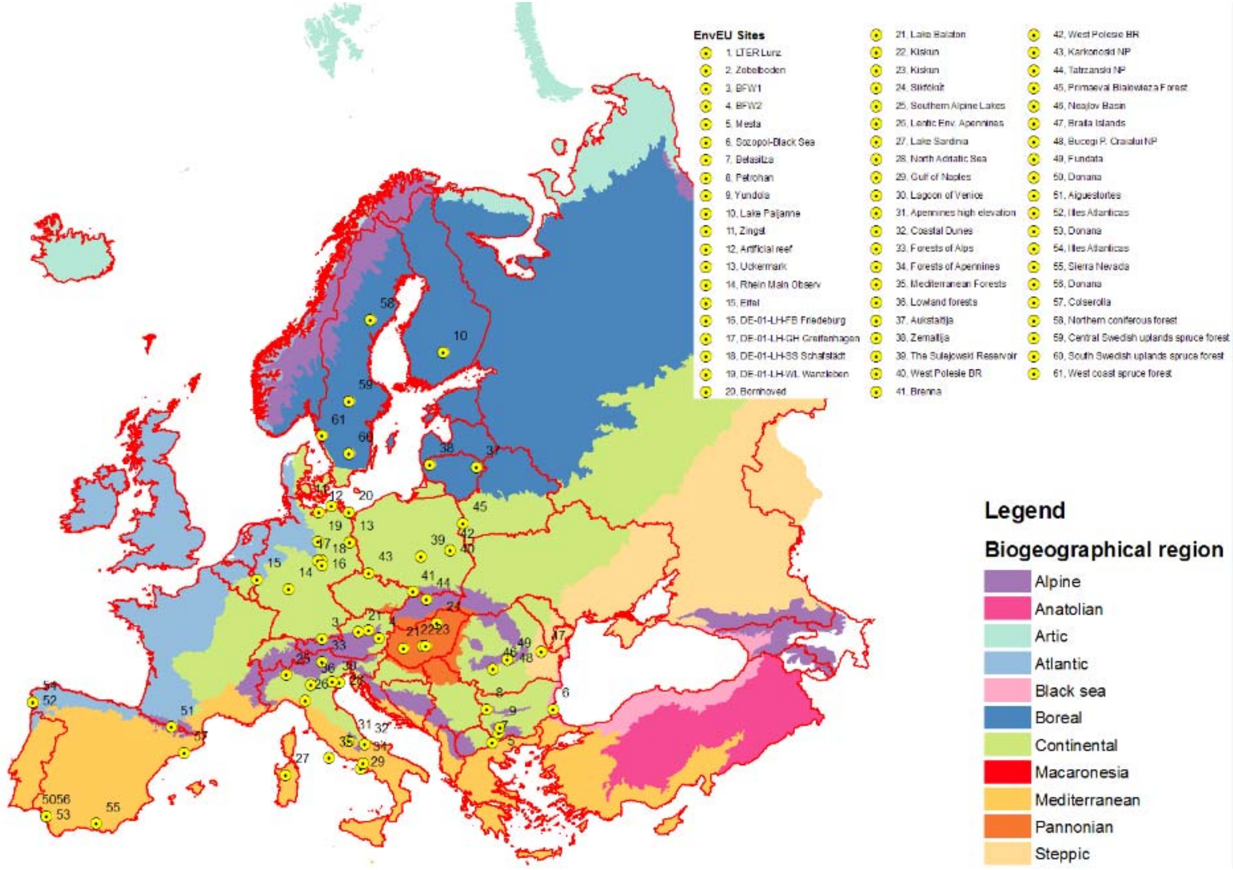


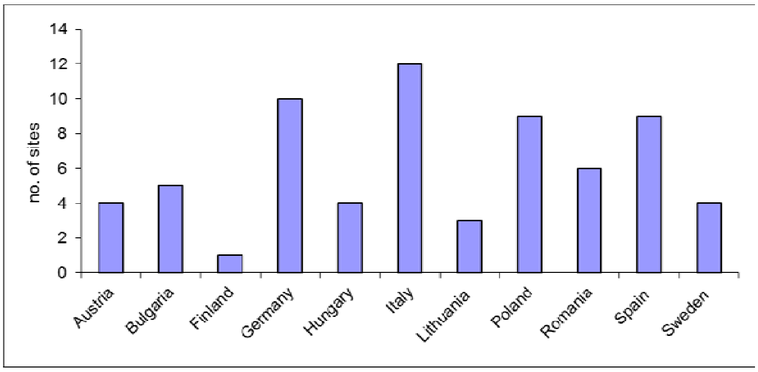
Figure 6. Distribution of EnvEurope sites across Europe biogeographical regions (from EnvEurope)

Biogeographical region	**No. of sites**
Alpine	18
Black sea	1
Boreal	7
Continental	20
Mediterranean	9
Pannonian	4
Steppic	1
Marine	7
Total sites (with geographical coordinates)	67

Table. 2 Sites per biogeographical region in EnvEurope (four regions are not represented – Anatolian, Arctic, Atlantic and Macaronesian)

The content of the Infobase allowed the search to be carried out in terms of cover at European level (over major biogeographical regions), altitudinal disposition/cover, habitat cover (Eunis level 1), measured variables, facilities and major research areas.

i.2. Distribution of sites across countries



In total 11 countries are involved in EnvEurope with 67 sites (annex 1 list of sites), figure 7.

Figure 7. LTER sites in EnvEurope

i.3. Measured variables across sites

In order to identify the variables that were most measured across LTER sites (the EnvEurope subset) a selection based on multiple thresholds was used. The threshold were that 1) more than 40% of the sites in EnvEurope are measuring the variable 2) more than 30% of the sites in EnvEurope are measuring the variable and finally the last threshold was that 20% of sites are measuring the variables.

Based on the above thresholds the results are as follows:

1) the 40 % thresholds (table 2)
2) the 30 % thresholds (table 3)
3) the 20% thresholds (table 4)

Table 3. The 40 % threshold as selection criteria for variables based on Infobase

Count of PARAMETER_NAME			A) Number of sites measuring the same parameters				
PARAMETER_NAME	Total	Number of sites measuring the same parameter	Total sites in ENVEUROPE	%	threshold 20	threshold 30	threshold 40
Nitrate	62	62	67	93	1	1	1
Iron	62	62	67	93	1	1	1
Sulphate	58	58	67	87	1	1	1
Cadmium	55	55	67	82	1	1	1
Lead	48	48	67	72	1	1	1
pH	45	45	67	67	1	1	1
Manganese	45	45	67	67	1	1	1
Air temperature	45	45	67	67	1	1	1
Ammonium	44	44	67	66	1	1	1
Zinc	43	43	67	64	1	1	1
Conductivity	42	42	67	63	1	1	1
Copper	41	41	67	61	1	1	1
Potassium	40	40	67	60	1	1	1
Magnesium	40	40	67	60	1	1	1
Calcium	40	40	67	60	1	1	1
Sodium	38	38	67	57	1	1	1
Vascular plants, ground layer	37	37	67	55	1	1	1
Air relative humidity	34	34	67	51	1	1	1
Nickel	33	33	67	49	1	1	1
Chromium	33	33	67	49	1	1	1
Vegetation structure/ layers	32	32	67	48	1	1	1
Aluminium	32	32	67	48	1	1	1
Wind velocity	30	30	67	45	1	1	1
Phosphate	30	30	67	45	1	1	1
Invasive species	30	30	67	45	1	1	1
Water pH	29	29	67	43	1	1	1
Chloride	29	29	67	43	1	1	1
Indicator species	28	28	67	42	1	1	1
Precipitation	27	27	67	40	1	1	1

Most of the variables presented in table 3 are in fact pollution variables and only 2 are addressing the structure and function of communities and ecosystems (vegetation structure/layers, invasive species) and 3 are climatic variables (air temperature, air relative humidity, and wind velocity). In total 31 variables are measured across more than 40% of the Enveurope sites. It could be seen also that the actual number of sites measuring the same variable is decreasing rapidly. If nitrate is measured by almost 93 % of the EnvEurope sites, the precipitation is being observed in just 40% of the sites (the selected threshold).

Table 4. The 30 % threshold as selection criteria for variables based on Infobase

Count of PARAMETER_NAME			A) Number of sites measuring the same parameters				
PARAMETER_NAME	Total	Number of sites measuring the same parameter	Total sites in ENVEUROPE	%	threshold 20	threshold 30	threshold 40
Topography	26	26	67	39	1	1	0
Soil	26	26	67	39	1	1	0
Alkalinity	25	25	67	37	1	1	0
Vascular plants, trees,	25	25	67	37	1	1	0
Total phosphorous	24	24	67	36	1	1	0
Water dissolved	23	23	67	34	1	1	0
Land Use information	23	23	67	34	1	1	0
Land Cover information	23	23	67	34	1	1	0
Invertebrates, above ground	23	23	67	34	1	1	0
Threatened species	22	22	67	33	1	1	0
Soil type	22	22	67	33	1	1	0
Bryophytes	22	22	67	33	1	1	0
Water anion concentration	21	21	67	31	1	1	0
Total sulphur	21	21	67	31	1	1	0
Total species richness	21	21	67	31	1	1	0
Soil depth	21	21	67	31	1	1	0

Lowering the threshold up to the level of 30 % is bringing another 16 variables into attention. Same of them are not necessary variables but rather more complex (like vascular plants, trees, shrubs or land cover and land use information).

Table 5. The 20 % threshold as selection criteria for variables based on Infobase

Count of PARAMETER_NAME			A) Number of sites measuring the same parameters				
PARAMETER_NAME	Total	**Number of sites measuring the same parameter**	**Total sites in ENVEUROPE**	%	threshold 20	threshold 30	threshold 40
Soil total phosphorous	20	20	67	30	1	0	0
Soil total nitrogen	20	20	67	30	1	0	0
Soil moisture	20	20	67	30	1	0	0
Dissolved organic carbon	20	20	67	30	1	0	0
Water inorganic nutrient content	19	19	67	28	1	0	0
Water cation concentration	19	19	67	28	1	0	0
Soil pH	19	19	67	28	1	0	0
Soil organic carbon	19	19	67	28	1	0	0
Soil bulk density	19	19	67	28	1	0	0
Rainfall chemistry	19	19	67	28	1	0	0
Radiation: incoming surface solar radiation	19	19	67	28	1	0	0
Water dissolved organics	18	18	67	27	1	0	0
Biomass above ground	18	18	67	27	1	0	0
Total nitrogen	18	18	67	27	1	0	0
Soil structure	18	18	67	27	1	0	0
Soil available phosphorus	18	18	67	27	1	0	0
Snow depth	18	18	67	27	1	0	0
Lichens	18	18	67	27	1	0	0
Birds	17	17	67	25	1	0	0
Soil total carbon	17	17	67	25	1	0	0
Soil nutrients	17	17	67	25	1	0	0
Water discharge	16	16	67	24	1	0	0
Total residue	16	16	67	24	1	0	0
Habitat conversion	16	16	67	24	1	0	0
Habitat fragmentation	16	16	67	24	1	0	0
Rainfall quantity	16	16	67	24	1	0	0
Phenology	16	16	67	24	1	0	0
Invertebrates, soil	16	16	67	24	1	0	0
Water surface temperature	14	14	67	21	1	0	0
Algae	14	14	67	21	1	0	0
Total organic carbon	14	14	67	21	1	0	0
PAR	14	14	67	21	1	0	0
Leaf area index	14	14	67	21	1	0	0

If the threshold is lowered up to the level of 20 % of the sites measuring the same variable then 33 more variables are to be added to the exist list (table 5). If we add all the above variables and we consider that only 20 % of sites measuring the same variables as a viable threshold then the total number of selected variables is 80.

No data (metadata) was available (in the Infobase) for the last proposed theme "Human population and economy".

The combined search over habitat cover and parameters (based on meta-data from Infobase) is presented in Annex 2.

Nevertheless using only this selection criterion (number of sites measuring the same variable) and applying only to the datasets that have been collected over the first metadata collection in Alternet (the first Infobase collection) could be misleading. For this reason we have repeated the analysis (as requested in the Action plan of EnvEurope through the Subactivity 3.1.3 - Metadata analysis using new data collected from partners and the involved sites and leading to the Integration of the metadata analysis).

5. 2. Analysis based on A2 Questionnaire

We have used the questionnaire (and data) developed in Action A2. The list of variables available in the mentioned questionnaire was different than those already gathered in Infobase (as the approach was suited more on the request of action A2[6]). Despite this inconvenient the group of variables could be traced back to simpler variables and a comparison is still possible between the Infobase results and the A2 questionnaire.

[6] Just to remember that the action A2 identified a larger poll of variables needed to describe the ecosystem status and that should, in theory at least, be recommended to the LTER sites for further field implementation.

Table 6. The 40 % threshold as selection criteria for variables based on A2 questionnaire *(The abundance could be measured in more sites because it is possible that the abundance was reported for the same site more than once (for different groups).*

				A) Number of sites measuring the same parameters			
	Count of Available(x)						
	ITEM	Total	**Total sites in ENVEUROPE**	%	threshold 20	threshold 30	threshold 40
1	1.Abundance	78	67	116	1	1	1
2	5. Air temperature	60	67	90	1	1	1
3	4. Biodiversity	58	67	87	1	1	1
4	2.Biomass	57	67	85	1	1	1
5	6. Precipitation	55	67	82	1	1	1
6	3. Wind speed (mean and gust)	54	67	81	1	1	1
7	4. Air humidity	49	67	73	1	1	1
8	2. Wind direction (mean and gust)	47	67	70	1	1	1
9	Vascular plants / Aquatic macrophytes	42	67	63	1	1	1
10	1. Soil chemical characteristics (pH, CEC, EC, C and N content, …)	40	67	60	1	1	1
11	2. physical properties (temperature, conductivity etc.)	38	67	57	1	1	1
12	3.Phenology	38	67	57	1	1	1
13	6. Soil solution sampling and measurements: DOC, DON, P, K, Ca, Mg, Na, Cl…(specify)	38	67	57	1	1	1
14	8. global radiation	37	67	55	1	1	1
15	4. Soil physical characteristic	37	67	55	1	1	1
16	1. chemical properties (nutrients, pH, O2,….ecc.)	37	67	55	1	1	1
17	7. Rainfall Chemical analysis (NO2-, NO3-, NH4+, DOC…)	34	67	51	1	1	1
18	Insects	31	67	46	1	1	1
19	19. Temperature soil at 5cm	31	67	46	1	1	1
20	20. Atmospheric pressure	31	67	46	1	1	1
21	Birds	29	67	43	1	1	1
22	4. Biodiversity (incl. species richness, dominance structure, composition)	29	67	43	1	1	1
23	5. Production	28	67	42	1	1	1
24	3. Soil bulk density	28	67	42	1	1	1
25	2. Soil temperature with depth	27	67	40	1	1	1
26	11. Ground temperature	27	67	40	1	1	1
27	1. Soil moisture with depth	27	67	40	1	1	1

Some of the "variables" presented in table 6 could not be included in the selection process as they are too complex and loose in definition like for e.g. "biodiversity" or "birds" and "insects". Other variables are in fact a group of variables like soil physical characteristics or rainfall chemical analysis. As a consequence in fact in table 6 are not listed only 27 variables but rather 37 to 40 or more. The same is for table 7 where the threshold has been also lowered up to the limit of 30% sites measuring that variable.

Table 7. The 30 % threshold as selection criteria for variables based on A2 questionnaire

				A) Number of sites measuring the same parameters			
	Count of Available(x)						
	ITEM	Total	**Total sites in ENVEUROPE**	%	threshold 20	threshold 30	threshold 40
28	3. Optical properties	25	67	37	1	1	0
29	1. PAR	24	67	36	1	1	0
30	6. Soil contamination (N deposition, ash deposition, heavy metal, …, specify)	21	67	31	1	1	0

The lowering of the threshold is adding 3 other variables (or groups of variables) to the existing list of variables. Some of them being already mentioned in the table 6 (like biodiversity).

Table 8. The 20 % threshold as selection criteria for variables based on A2 questionnaire

				A) Number of sites measuring the same parameters			
	Count of Available(x)						
	ITEM	Total	**Total sites in ENVEUROPE**	%	threshold 20	threshold 30	threshold 40
31	21. Wet/Dry Deposition Collector	19	67	28	1	0	0
32	7. C and N content	18	67	27	1	0	0
33	Other categories: Zooplancton, Meiofauna, Benthic macroinvertebrates	18	67	27	1	0	0
34	5. Ground water quantity / quality / recharge time	16	67	24	1	0	0
35	3. CO2 surface flux	15	67	22	1	0	0
36	9. reflected global radiation	15	67	22	1	0	0
37	22. UV radiation	15	67	22	1	0	0
38	Mosses	14	67	21	1	0	0
39	Microalgae	14	67	21	1	0	0
40	4. Circulation and residence time	14	67	21	1	0	0
41	23. Others, please specify	14	67	21	1	0	0

Finally the 20 % threshold is adding the last 10 group of variables. The total number of variables based on the A2 questionnaire is 40, but many of them are in fact very complex.

A second analysis was done on how the variables are represented based on the habitat types (table 9).

Table 9. Distribution of variables for the first theme "Climate and physical variability" on the Eunis level 1 habitats (based on A2 Questionnaire)

c	Investigated Habitat (EUNIS Habitat Level I)		
ITEM	Aquatic (inland & marine)	Terrestrial	Grand Total
6. Precipitation	5	25	30
4. Soil physical characteristic	1	22	23
2. Soil temperature with depth	0	22	22
19. Temperature soil at 5cm	0	19	19
1. Soil moisture with depth	0	16	16
2. physical properties (temperature, conductivity etc.)	11	5	16
11. Ground temperature	0	11	11
1. PAR	1	9	10
17. Sunshine duration	2	5	7
13. Net sol radiation	1	6	7
15. Net radiation	0	7	7
10. Sky temperature	0	6	6
22. UV radiation	2	3	5
14. Net far radiation	0	5	5
18. Heat flux	0	4	4
16. Diffuse sol radiation	0	3	3
1. Physical characteristics (water content porosity, granul	3	0	3
28. Rain duration	0	1	1
10. Temperature soil	0	1	1
29. Rain intensity	0	1	1
2. Wind direction mean and gust	1	0	1
2. physical properties temperature, conductivity etc.	1	0	1
18. Soil temperature with depth	0	1	1
27. CO2	0	1	1
Grand Total	28	173	201

	Count of Available	Investigated Habitat (EUNIS Habitat Level I)			
	ITEM	**Terrestrial**	**Inland waters**	**Marine**	Grand Total
1	1.Abundance	20	14	1	35
2	Vascular plants / Aquatic macrophytes	27	3	1	31
3	4. Biodiversity	18	6	2	26
4	Insects	24	1		25
5	2.Biomass	12	10		22
6	Birds	20	1		21
7	Mosses	10	1		11
8	Lichens	10			10
9	4. Biodiversity (incl. species richness, dominance structure, composition)	1	8	1	10
10	Reptiles	9			9
11	Fish	1	5	1	7
12	Other Arthropods	6			6
13	Mammals: small mammals	6			6
14	Other categories: Zooplancton, Meiofauna, Benthic macroinvertebrates	1	4		5
15	Molluscs	3	1	1	5
16	9. Population biology parameters	5			5
17	Microalgae	0	3	1	4
18	Fungi	4			4
19	Crustaceans	1	2	1	4
20	mammals: ungulates	3			3
21	6. Other CROWN Condition; Tree growth	3			3
22	Macroalgae	0	2	1	3
23	Amphibians	3			3
24	Spiders	2			2
25	10. Plant diameter	1			1
26	Annelida	1			1
27	Heterotrophic compartment (procaryotic and eucaryotic) Please indicate organism group!	0	1		1
28	14. Ecophysiology of primary producers (tree growth increment, gas exchange,cholophyll flurescens, sap flow)	1			1
29	Insects: Carabidae	1			1
30	Insects: Sciaridae	1			1
31	23. Biodiversity (ground vegetation)	1			1
32	cropping structure/ crop rotation	1			1
33	Mammals	1			1
34	Mammals: foxes and badgers	1			1
35	Mammals: Sciurus vulgaris	1			1
36	20.Abundance (Fagus sylvatica)	1			1
37	Tree	1			1
38	9. Plant transpiration	1			1
39	Microalgae	0	1		1
40	9. Litterfall	1			1
41	21.Biomass (Fagus sylvatica)	1			1
42	25. Vascular plants (ground vegetation)	1			1
43	6. Other: CO2-respiration	1			1
44	Other categories: Zooplankton, Meiofauna, Benthic macroinvertebrates	0	1		1
45	plant protection	1			1
46	Procariots	0	1		1
47	Prokaryotes	0	1		1
48	26. Mosses	1			1
49	12. Litter production	1			1
50	Autotrophic compartment. Please indicate organism group!	0			
	Grand Total	209	66	10	285

*Table 10. Distribution of variables the for the theme "*Structure and function of ecosystems, communities and populations" on the terrestrial, freshwater and marine ecosystems (based on A2 Questionnaire)

No data (metadata) was available (in the A2 Questionnaire) for the last proposed theme "Human population and economy".

5.3 Selection of relevant variables

Concluding, we can say that the selection of relevant variables for long term analysis was a stepwise process that started at the meeting in Rome and continued in Budapest based on the above approach. It took into consideration the
a) Infobase
b) A2 Questionnaire
c) Project proposals

The proposal was open for the addition of new variables by the community and this was also the case for the Bucharest meeting (November 2011). Prior to the meeting a data collection format was sent to beneficiaries to test the future collection of datasets (EnvEurope Data Reporting Format). The data reporting format is in fact containing a list of 65 variables (see attached list).
During the meeting in Bucharest no other variable was added to the list, but a number of project proposals have been submitted (16 project proposals).
For the project development we have proposed the list of available variables allowing addition of new variables as needed in order to test the project hypothesis.

5.4. Final selection of priority variables

Integrating all the above metadata (Infobase, A2 Questionnaire) and taking into consideration the projects needs, conducted finally to a new **priority variable list proposed** (table 11).

Based on the proposed variable list (table 11) tables, for each of the ecosystem types (terrestrial, freshwater and marine) with long term datasets to be collected is proposed.

Priority level	No.	LISTSUB	SUBST	Terrestrial	Freshwater	Marine	Human systems *	Site chracteristics*	Name	Description	Group	CAS Code	included/changed
1	1	*	AB	1	1	1			abundace of	groups; to be specified by user; to be described in the metadata	10		2000-06-16 15:39:00.000
1	3	*	BIOMASS	2	2	2			biomass of	groups; to be specified by user; to be described in the metadata	10		2000-06-16 15:39:00.000
1	5	DB	BPP	3	3	3			Biological primary production net		10		2000-06-16 15:39:00.000
1	10	IM	COVE_B	4					species cover bottom layer	mean cover of layer/species (%) in the bottom layer per vegetation plot; byrophytes and lichens	10		2000-06-16 15:39:00.000
1	11	IM	COVE_F	5					species cover field layer	mean cover of layer/species (%) in the field layer per vegetation plot; trees and shrubs <1m and other plants irrespective of height	10		2000-06-16 15:39:00.000
1	12	IM	COVE_S	6					species cover shrub layer	mean cover of layer/species (%) in the shrub layer per vegetation plot; trees 1-5m, morphological shrubs >1m	10		2000-06-16 15:39:00.000
1	13	IM	COVE_T	7					species cover tree layer	mean cover of layer/species (%) in the tree layer per vegetation plot; trees >5m	10		2000-06-16 15:39:00.000
1	14	DB	CP		4	4			Chlorophyll a		10		2000-06-16 15:39:00.000
1	25	*	HAGESTR				1		age structure	human population	10		2000-06-16 15:39:00.000
1	26	*	HDENSITY				2		density	human population	10		2000-06-16 15:39:00.000
1	27	*	HECONACT				3		main economic activity	human population	10		2000-06-16 15:39:00.000
1	29	*	HINCOME				4		average income	human population	10		2000-06-16 15:39:00.000
1	30	*	LANDCOV					1	land cover		10		2001-01-16 09:51
1	31	*	LANDUSE					2	land use		30		2001-01-16 09:56
1	45	DB	NTOT	8	5	5			Total nitrogen		30		2000-06-16 15:39:00.000
1	47	DB	O2D		6	6			Dissolved oxygen		30		2000-06-16 15:39:00.000
1	50	DB	PH	9	7	7			pH		40		2000-06-16 15:39:00.000
1	53	DB	PREC	10	8	8			Precipitation		10		2001-12-07 12:34
1	54	DB	PTOT	11	9	9			Total phosphorous				
1	55	DB	SDT		10	10			Secchi disc transparency		30		2002-10-18 14:59
1	56	*	SPNB	12	11	11			number of species	groups; to be specified by user; to be described in the metadata			
1	57	DB	SS		12	12			Suspended solids				
1	59	DB	TEMP	13	13	13			Temperature				
1	60	*	THP				5		total population in the site	human population			
1	64	DB	TS		14				Total solids				
1	58	DB	TC						Total carbon				
2	46	DB	O2						Oxygen		30		2000-06-16 15:39:00.000
2	65	DB	TURB						Turbidity				
2	66	DB	WEIGHT						Weight				
2	67	DB	WL						Water level				
2	68	DB	WLL						Water level local level	Water level compared to a local point.			
2	69	DB	WLS						Water level sea level	Water level compared to the sea.			
1	70	SI		14					Silicates				
1	71	SA		15					Salinity				
	70	Add											
2	2	DB	ALK						Alkalinity		10		2000-06-16 15:39:00.000
2	4	DB	BOD						Biochemical oxygen demand	Essential to state incubation time - see pretreatment list: Incubation.	10		2000-06-16 15:39:00.000
2	6	DB	BPY						Biological primary productivity net		10		2000-06-16 15:39:00.000
2	7	DB	CODCR						Chemical oxygen demand COD-Cr		10		2000-08-14 15:23:00.000
2	8	DB	CODMN						Chemical oxygen demand COD-Mn		10		2000-08-14 15:23:00.000
2	9	DB	COND						Conductivity		10		2000-06-16 15:39:00.000
2	15	DB	DC						Dissolved carbon		10		2000-06-16 15:39:00.000
2	16	DB	DEPTHB						Depth of sampling from bottom		10		2000-06-16 15:39:00.000
2	17	DB	DEPTHS						Depth of sampling from surface		10		2000-06-16 15:39:00.000
2	18	DB	DEPTHT						Depth to bottom		10		2000-06-16 15:39:00.000
2	19	DB	DIC						Dissolved inorganic carbon		10		2000-06-16 15:39:00.000
2	20	DB	DISCH						Discharge		10		2000-06-16 15:39:00.000
2	21	DB	DOC						Dissolved organic carbon		10		2000-06-16 15:39:00.000
2	22	DB	DOD						Direct oxygen demand		10		2000-06-16 15:39:00.000
2	23	DB	EH						Redox potential		10		2000-08-14 15:24:00.000
2	24	DB	FLOW						Flow		10		2000-06-16 15:39:00.000
2	28	DB	HH						Humidity		10		2000-06-16 15:39:00.000
2	32	DB	LDEP							litterfall amount (oven dry weight)	30		2000-06-16 15:39:00.000
2	33	DB	LENGTH						Length		30		2000-06-16 15:39:00.000
2	34	DB	NH3						Ammonia		30		2000-06-16 15:39:00.000
2	35	DB	NH4						Ammonium		30		2000-06-16 15:39:00.000
2	36	DB	NH4N						Ammonium as nitrogen		30		2000-06-16 15:39:00.000
2	37	DB	NKJ						Kjeldahl nitrogen		30		2000-06-16 15:39:00.000
2	38	DB	NO2						Nitrite		30		2000-06-16 15:39:00.000
2	39	DB	NO23						Nitrite nitrate	Nitrite + nitrate	30		2000-06-16 15:39:00.000
2	40	DB	NO23N						Nitrite nitrate as nitrogen	Nitrite + nitrate as nitrogen	30		2000-06-16 15:39:00.000
2	41	DB	NO2N						Nitrite as nitrogen		30		2000-06-16 15:39:00.000
2	42	DB	NO3						Nitrate		30		2000-06-16 15:39:00.000
2	43	DB	NO3N						Nitrate as nitrogen		30		2000-06-16 15:39:00.000
2	44	DB	NOXNDO						Nitrogen oxides as NO2		30		2000-06-16 15:39:00.000
2	48	DB	O2S						Oxygen saturation	The amount of oxygen dissolved in the water compared to what theoretically can be dissolved at the same temperature expressed in percent.	40		2000-06-16 15:39:00.000
2	49	DB	P						Phosphorus		40		2000-06-16 15:39:00.000
2	51	DB	PO4						Phosphate		30		2000-06-16 15:39:00.000
2	52	DB	PO4P						Phosphate as phosphorous		30		2000-09-05 12:08:00.000
2	61	DB	TIC						Total inorganic carbon				
2	62	DB	TOC						Total organic carbon				
2	63	DB	TOD						Total oxygen demand				

Table 11. List of selected variables for long term analysis (with prioritization, for all ecosystem types – terrestrial, freshwater and marine)

Cause/Drivers/pressures
Biological effect
Human systems
Site charactersits

If we consider only the list of **priority variables for long term analysis** then the total list of variables (to be collected from all the EnvEurope – LTER sites) is, in fact, no **more than 50 variables (table 12)**. The recommendation to the EnvEurope partners is to first populate with long term datasets (> 10 years) the identified priority variables, the aggregation level should be month or yearly data. In specific cases the aggregation level could be different. After submitting the datasets for the priority variables the partners should also consider the extended list. If the partners do not have the datasets for the priority variables but they have datasets for other variable from the extended list, they should report datasets for those variables.

Table 12. Priority list of variables for all the ecosystem types

No.	LISTSUB	SUBST	Terrestrial	Freshwater	Marine	Human systems *	Site characteristics**	Name	Description
1	*	AB	1	1	1			abundace of	groups; to be specified by user; to be described in the metadata; the groups/species could be also fauna
3	*	BIOMASS	2	2	2			biomass of	groups; to be specified by user; to be described in the metadata/ the groups/species could be also fauna
5	DB	BPP	3	3	3			Biological primary production net	
10	IM	COVE_B	4					species cover bottom layer	mean cover of layer/species (%) in the bottom layer per vegetation plot; byrophytes and lichens
11	IM	COVE_F	5					species cover field layer	mean cover of layer/species (%) in the field layer per vegetation plot; trees and shrubs <1m and other plants irrespective of height
12	IM	COVE_S	6					species cover shrub layer	mean cover of layer/species (%) in the shrub layer per vegetation plot; trees 1-5m, morphological shrubs >1m
13	IM	COVE_T	7					species cover tree layer	mean cover of layer/species (%) in the tree layer per vegetation plot; trees >5m
14	DB	CP		4	4			Chlorophyll a	
25	*	HAGESTR				1		age structure	human population
26	*	HDENSITY				2		density	human population
27	*	HECONACT				3		main economic activity	human population
29	*	HINCOME				4		average income	human population
30	*	LANDCOV					1	land cover	
31	*	LANDUSE					2	land use	
45	DB	NTOT	8	5	5			Total nitrogen (water, sediments and soil)	to be specified by user
47	DB	O2D		6	6			Dissolved oxygen	
50	DB	PH	9	7	7			pH	
53	DB	PREC	10	8	8			Precipitation	
54	DB	PTOT	11	9	9			Total phosphorous	
55	DB	SDT		10	10			Secchi disc transparency	
56	*	SPNB	12	11	11			number of species	groups; to be specified by user; to be described in the metadata
57	DB	SS		12	12			Suspended solids	
59	DB	TEMP	13	13	13			Temperature	
60	*	THP				5		total population in the site	human population in LTSER sites
new addition	*	SI		14	14			Silicates	
new addition	*	SA		15	15			Salinity	
Total no	50		**13**	15	15	5	2		

Cause/Drivers/pressures
Biological effect
Human systems
Site characterists

This total list of variables is further divided by ecosystem type – Terrestrial, Freshwater and Marine. Finally, for e.g. we arrive at **13 variables defining terrestrial ecosystems** (at this list we can add, depending on the characteristics of the LTER site- human systems characteristics (like density of the human population in the area of interest, average income, total population in the site or the main economic activity) and the site characteristics (like land cover and land use). In the end, the **variable list for terrestrial systems including human and site characteristics comprises 20 variables.**

Please note that the human systems variables are manly based on the understanding (definitions) that researchers have on their site (if the site is very limited in space then in fact it is based more on the ecological and biological variables, but if the it is large enough then it could also allow the integration between ecological and social data) (Vadineanu 2002, Dirnböck et al., 2012).

The variables have been categorized also as describing i) cause/drivers/pressures, ii) biological effect (if the (i) variable is having an effect on biological systems (including here are also ecosystems) iii) human systems, iv) site characteristics and v) general descriptors (precipitation, Secchi depth, temperature (water, air, soil), silicates, salinity).

5.5 Priority variable list for terrestrial systems

- the final list is comprising 20 variables (8 – biological effects; 3 - cause/drivers/pressures; 5 - human systems ; 2 site characterizes; 2 descriptors (that could be used also as climate change indicators)) (see table 13).

No.	LISTSUB	SUBST	Terrestrial	Human systems *	Site chracteristics**	Name	Description
1	*	AB	1			abundace of	groups; to be specified by user; to be described in the metadata; the groups/species could be also fauna
3	*	BIOMASS	2			biomass of	groups; to be specified by user; to be described in the metadata/ the groups/species could be also fauna
5	DB	BPP	3			Biological primary production net	
10	IM	COVE_B	4			species cover bottom layer	mean cover of layer/species (%) in the bottom layer per vegetation plot; byrophytes and lichens
11	IM	COVE_F	5			species cover field layer	mean cover of layer/species (%) in the field layer per vegetation plot; trees and shrubs <1m and other plants irrespective of height
12	IM	COVE_S	6			species cover shrub layer	mean cover of layer/species (%) in the shrub layer per vegetation plot; trees 1-5m, morphological shrubs >1m
13	IM	COVE_T	7			species cover tree layer	mean cover of layer/species (%) in the tree layer per vegetation plot; trees >5m
25	*	HAGESTR		1		age structure	human population
26	*	HDENSITY		2		density	human population
27	*	HECONACT		3		main economic activity	human population
29	*	HINCOME		4		average income	human population
30	*	LANDCOV			1	land cover	
31	*	LANDUSE			2	land use	
45	DB	NTOT	8			Total nitrogen (water, sediments and soil)	to be specified by user
50	DB	PH	9			pH	
53	DB	PREC	10			Precipitation	
54	DB	PTOT	11			Total phosphorous	
56	*	SPNB	12			number of species	groups; to be specified by user; to be described in the metadata
59	DB	TEMP	13			Temperature	
60	*	THP		5		total population in the site	human population in LTSER sites
Total no	20		**13**	5	2		

Cause/Drivers/pressures
Biological effect
Human systems
Site characterists

Table 13. Priority variable list for terrestrial systems

5.6. Priority variable list for freshwater systems

- the final list is comprising 22 variables (5– biological effects; 5 - cause/drivers/pressures; 5 - human systems ; 2 site characterizes; 5 descriptors (that could be used also as climate change indicators)) (see table 14).

No.	LISTSUB	SUBST	Freshwater	Human systems *	Site characteristics**	Name	Description
1	*	AB	1			abundace of	groups; to be specified by user; to be described in the metadata; the groups/species could be also fauna
3	*	BIOMASS	2			biomass of	groups; to be specified by user; to be described in the metadata/ the groups/species could be also fauna
5	DB	BPP	3			Biological primary production net	
14	DB	CP	4			Chlorophyll a	
25	*	HAGESTR		1		age structure	human population
26	*	HDENSITY		2		density	human population
27	*	HECONACT		3		main economic activity	human population
29	*	HINCOME		4		average income	human population
30	*	LANDCOV			1	land cover	
31	*	LANDUSE			2	land use	
45	DB	NTOT	5			Total nitrogen (water, sediments and soil)	to be specified by user
47	DB	O2D	6			Dissolved oxygen	
50	DB	PH	7			pH	
53	DB	PREC	8			Precipitation	
54	DB	PTOT	9			Total phosphorous	
55	DB	SDT	10			Secchi disc transparency	
56	*	SPNB	11			number of species	groups; to be specified by user; to be described in the metadata
57	DB	SS	12			Suspended solids	
59	DB	TEMP	13			Temperature	
60	*	THP		5		total population in the site	human population in LTSER sites
new addition	*	Si	14			Silicates	
new addition	*	Sa	15			Salinity	
Total no	22		15	5	2		

Cause/Drivers/pressures
Biological effect
Human systems
Site characterists

Table 14. Priority variable list for freshwater systems

5.7. Priority variable list for marine systems

- the final list is comprising 22 variables (5– biological effects; 5 - cause/drivers/pressures; 5 - human systems ; 2 site characterizes; 5 descriptors (that could be used also as climate change indicators)) (see table 15).

Table 15. Priority variable list for marine systems

No.	LISTSUB	SUBST	Marine	Human systems *	Site chracteristics**	Name	Description
1	*	AB	1			abundace of	groups; to be specified by user; to be described in the metadata; the groups/species could be also fauna
3	*	BIOMASS	2			biomass of	groups; to be specified by user; to be described in the metadata/ the groups/species could be also fauna
5	DB	BPP	3			Biological primary production net	
14	DB	CP	4			Chlorophyll a	
25	*	HAGESTR		1		age structure	human population
26	*	HDENSITY		2		density	human population (depends on the definition of the site- if it is defined based on a subcatchament approach then Human systems variables could be included)
27	*	HECONACT		3		main economic activity	human population -see above
29	*	HINCOME		4		average income	human population - see above
30	*	LANDCOV			1	land cover	see above
31	*	LANDUSE			2	land use	see above
45	DB	NTOT	5			Total nitrogen (water, sediments)	to be specified by user
47	DB	O2D	6			Dissolved oxygen	
50	DB	PH	7			pH	
53	DB	PREC	8			Precipitation	
54	DB	PTOT	9			Total phosphorous	
55	DB	SDT	10			Secchi disc transparency	
56	*	SPNB	11			number of species	groups; to be specified by user; to be described in the metadata
57	DB	SS	12			Suspended solids	
59	DB	TEMP	13			Temperature	
60	*	THP		5		total population in the site	human population in LTSER sites
new additi	*		14			Silicates	
new additi	*		15			Salinity	
Total no	22		15	5	2		

5.8. Possible research activities/ long term analysis based on the general datasets

One of the most frequent question formulated since the start of the EnvEurope project was linked with the use of the collected datasets, or in other terms: What analysis should be performed with the existing/collected datasets in the near future?

The response, as already mentioned, was a design of action A3 in several layers; due to the fact that despite many sites have declared that they have long term datasets for different variables, actually no real data has been analyzed in common, and as a consequence we thought that the first step is the collection of long term datasets and in the second phase we should develop the research questions for interdisciplinary and integrative sites analysis.

As a second layer was the proposal of projects based on hypothesis and involving long term datasets.

The third layer proposed was the use of meta-analysis (not addressing the datasets itself but published results) even if this will require development of new methods for meta-analysis (Young et al. 2006, Dirnböck 2008).

In an attempt to explore the possible future analysis based on general data gathering we are presenting some of the possible analysis for long term datasets using the selected priority variables. In the same time we have analyzed some of the possible cause-effect relationships to be considered with the priority variables proposed.

Tables 16 (for terrestrial systems), 17 (for freshwater) and 18 (for marine) are summarizing these possible analyses and the linkages with actions A2 – possible use of variable in the ecological integrity indicators - and in A5 – parameters considered in the field testing activities.

Based on the information on the available datasets at different sites and on the above analysis we identified 4 main research topics (grand challenges) that are very important to the EnvEurope project and the EU-LTER network.

I) Research and monitoring on biogeochemical processes, climate change and changes in biodiversity

II) Ecosystem processes and disturbances (impact of eutrophication - N and P - on primary production, biomass and/or species richness across sites, soil N and P and relationship with biomass, species richness)

III) Ecosystem services (net primary production, primary producers structure and diversity, use of NPP, impact on local average income etc)

IV) Socio-economic pressures on the functioning of the ecosystems (e.g. land cover, land use)

All of the above research topics are supported by the variables gathered by the EU-LTER sites and already presented.

Taking into consideration the final priority variable list we distinguished two kind of analysis: a) possible activities for long term analysis that could be supported with the available datasets on one hand and b) possible cause-effect relationships analysis.

For terrestrial sites the possible research topics are comprising for e.g. with direct link to the abundance of…. (different taxonomic groups) for: a) “Investigating the "Distribution-abundance Relationship" across ecosystem types” and

b) 1.Changes in species' abundance in response to climate change 2.impact of different stressors on the abundance - investigate the stressors across network (TN, TP, pH) 3. Land-Use Change on Species abundance; 4. change of ratio of natural/alien species over time 5. changes in alien species abundance, 6. general trend of alien species invasions in different ecosystems/habitat. (see table 16 for more information).

Table 16. Terrestrial sites: Possible research activities and long term analysis (using the long term datasets from the LTER/LTSER sites), (table 16 is also presented in annex with more information, including the links with A2 (ecological integrity indicators) and A5 (measurement in the field). Color code: red- Cause/Drivers/pressures- green – Biological effect; blue - Human systems; brown - Site characteristics

No.	Variable name	Possible activities/long term analysis/ please add (consider) other possible activities	Possible cause-effect relationships analysis to be investigated/please add (consider) other possible activities
1	abundace of	1.Investigating the "Distribution-abundance Relationship" across ecosystem types	1. Changes in species' abundance in response to climate change 2. Impact of different stressors on the abundance - investigate the stressors across network (TN, TP, pH) 3. Land-Use Change on Species Abundance 4. Change of ratio of natural/alien species over time 5. Changes in alien species abundance 6. General trend of alien species invasions in different ecosystems/habitat
2	biomass of	1.biomass change across different ecosystem types 2.trend in biomass (regardless of species or groups) across ecosystems types (terrestrial, freshwater, marine) 3. Space for time substitution for biomass change (analysis of systems in different succession stages); 4. Relationship between biomass of different species and across ecosystem types	1. Impact of Total Nitrogen and Total Phosphorus on biomass and biomass change of different groups/species; 2. Impact of pH on biomass/biomass change 3. Impact of climate change on biomass of (specific groups, or in general)
3	Biological primary production net	1.Net primary production (NPP) change in time and space/ Trend in NPP (regardless of species and groups) 2. NPP change over different species and groups/ 3. Space for time substitution for NPP change (analysis of systems in different succession stages)	1.Impact of controls (land use; land cover) and trends of PPN at regional scale; 2. Comparison between modeled PPN (regional) and measured at local scale; 3. Investigation about the possibility to scale up 4. Environmental factors controlling NPP
4	species cover bottom layer	1. Relationship between PPN, biomass and species cover	1.Relationship between species cover and environmental controlling factors

5	species cover field layer	1. Plant abundance vs. species cover	
6	species cover shrub layer		
7	species cover tree layer		
8	age structure	1. Change in age structure	
9	density	1.Relationships between net primary productivity and human population density across systems (a problem of scale) 2. Relationship between land use and density of human population 3. Relationship between density of human population and species richness	
10	main economic activity	1. Relationship between changes in biomass and or changes in net primary production, and economic production 2. Management impact; management activity	
11	average income	1.Changes/trend in the average income in selected sites	1. Relationship between biodiversity (biomass, PPN, abundance, species richness) and human system characteristics (land use, land cover, human density, main economic activities)
12	land cover	1. Land cover changes	
13	land use	1. Land use change and impact on biodiversity structure and functions (biomass, NPP, species richness, abundance)	
14	Total nitrogen (water, sediments and soil)	1. Characterize spatial and temporal changes/trend in nitrogen along LTER sites	1. Relationships between ecosystem functions and biogeochemical cycles (TN, TN);
15	pH	1. Long term trend	1. Climate change impact on acidification
16	Precipitation	1.Long term trends	
17	Total phosphorous	1.Characterize spatial and temporal changes/trend in phosphorus along LTER sites	

18	number of species	1. Relationship between PPN and species number 2.Long term trend of species richness 3) Investigating the "Distribution-abundance-richness Relationship" across ecosystem types	1. Impact of climate change on species richness; 2. Impact of controlling factors on species richness - stressors across network (TN, TP, pH) 3) Land-Use Change on Species Abundance/Richness
19	Temperature		
20	total population in the site		

We have identified a series of possible activities/long term analysis as well as possible cause –effect relationships between different variables for the freshwater sites. These are ranging from distribution-abundance relationship across different ecosystem types to changes in alien species abundance or general trend of alien species in different ecosystems/habitats. Some of the possible research activities are listed in table 17.

Table 17. Freshwater sites: Possible research activities and long term analysis (using the long term datasets from the LTER/LTSER sites), including the links with A2 (ecological integrity indicator) and A5 (measurement in the field). Colour code: red- Cause/Drivers/pressures- green – Biological effect; blue - Human systems; brown - Site characteristics

No	Variable name	Possible activities and term analysis	Possible cause-effect relationships analysis to be investigated
1	abundace of	1.Investigating the "Distribution-abundance Relationship" across ecosystem types	1.Changes in species' abundance in response to climate change 2.impact of different stressors on the abundance - investigate the stressors across network (TN, TP, pH) 3. Land-Use Change on Species Abundance 4. Change of ratio of natural/alien species over time 5. Changes in alien species abundance 6. General trend of alien species invasions in different ecosystems/habitat

2	biomass of	1. biomass change across different ecosystem types 2.trend in biomass (regardless of species or groups) across ecosystems types (terrestrial, freshwater, marine) 3. Space for time substitution for biomass change (analysis of systems in different succession stages) 4. Relationship between biomass of different species and across ecosystem types	1. Impact of Total Nitrogen and Total Phosphorus on biomass and biomass change of different groups/species; 2. Impact of pH on biomass/biomass change 3. Impact of climate change on biomass of (specific groups, or in general)
3	Biological primary production net	1. Net primary production (NPP) change in time and space/ Trend in NPP (regardless of species and groups) 2. NPP change over different species and groups 3. Space for time substitution for NPP change (analysis of systems in different succession stages)	1.Impact of controls (land use; land cover) and trends of PPN at regional scale; 2. Comparison between modeled PPN (regional) and measured at local scale; 3. Investigation about the possibility to scale up 4. Environmental factors controlling NPP
4	Chlorophyll a	1.trend analysis over long time 2. Space for time substitution for biomass change 3. Relationship between NPP and chlorophyll in marine and freshwater systems; 4. Relationship between primary productivity chlorophyll a and euphotic zone depth.	1. Eutrophication (factors controlling phytoplankton biomass) 2. Relationship between phytoplankton biomass and land use 3. Impact of climate change on chlorophyll a
5	age structure	1. Change in age structure	
6	density	1.Relationships between net primary productivity and human population density across systems (a problem of scale) 2. Relationship between land use and density of human population 3. Relationship between density of human population and species richness	
7	main economic activity	Relationship between changes in biomass and or changes in net primary production, and economic production	
8	average income	1.Changes/trend in the average income in selected sites	1. Relationship between biodiversity (biomass, PPN, abundance, species richness) and human system characteristics (land use, land cover, human density, main economic activities)
9	land cover	1. Land cover changes	

10	land use	1. Land use change and impact on biodiversity structure and functions (biomass, NPP, species richness, abundance)	
11	Total nitrogen (water, sediments and soil)	1. Characterize spatial and temporal changes/trend in nitrogen along LTER sites	1. Relationships between ecosystem functions and biogeochemical cycles (TN, TN)
12	Dissolved oxygen	1. Long term trends of dissolved oxygen	1. Impact of climate change on dissolved oxygen
13	pH	1. Long term trends	1. Climate change impact on acidification
14	Precipitation	1. Long term trends	
15	Total phosphorous	1.Characterize spatial and temporal changes/trend in phosphorus along LTER sites	
16	Secchi disc transparency	1. Trends of transparency and euphotic zone depth	
17	number of species	1. Relationship between PPN and species number 2. Long term trend of species richness 3) Investigating the "Distribution-abundance-richness Relationship" across ecosystem types	1. Impact of climate change on species richness 2. Impact of controlling factors on species richness - stressors across network (TN, TP, pH) 3) Land-Use Change on Species Abundance/Richness
18	Suspended solids		1. Relationship between land use and suspended solids in catchments
19	Temperature		
20	total population in the site		
21	Silicates	Long term trends	Relationship with changes in inputs from land and sediments; impact on species composition (i.e. Phytoplankton)
22	Salinity	Long term trends	Relationships with river and atmospheric inputs; Impact of climate change on salinity

We have identified also a series of possible activities/long term analysis as well as possible cause –effect relationships between different variables for the marine sites. These are ranging from distribution-abundance relationship across different ecosystem types to changes in alien species abundance or general trend of alien species in different ecosystems/habitats. Some of the possible research activities are listed in table 18.

Table 18. Marine sites: Possible research activities and long term analysis (using the long term datasets from the LTER/LTSER sites), including the links with A2 (ecological integrity indicator) and A5 (measurement in the field). Colour code: red- Cause/Drivers/pressures- green – Biological effect; blue - Human systems; brown - Site characteristics

No.	Variable name	Possible activities/long term analysis/ please add (consider) other possible activities	Possible cause-effect relationships analysis to be investigated/please add (consider) other possible activities
1	abundace of	1. Investigating the "Distribution-abundance Relationship" across ecosystem types	1.Changes in species' abundance in response to climate change 2. Impact of different stressors on the abundance - investigate the stressors across network (TN, TP, pH) 3. Land-Use Change on Species Abundance 4. Change of ratio of natural/alien species over time 5. Changes in alien species abundance 6. General trend of alien species invasions in different ecosystems/habitat.
2	biomass of	1. Biomass change across different ecosystem types 2. Trend in biomass (regardless of species or groups) across ecosystems types (terrestrial, freshwater, marine) 3. Space for time substitution for biomass change (analysis of systems in different succession stages) 4. Relationship between biomass of different species and across ecosystem types	1. Impact of Total Nitrogen and Total Phosphorus on biomass and biomass change of different groups/species; 2. Impact of pH on biomass/biomass change 3. Impact of climate change on biomass of (specific groups, or in general)
3	Biological primary production net	1.Net primary production (NPP) change in time and space/ Trend in NPP (regardless of species and groups) 2. NPP change over different species and groups 3. Space for time substitution for NPP change (analysis of systems in different succession stages)	1.Impact of controls (land use; land cover) and trends of PPN at regional scale; 2. Comparison between modeled PPN (regional) and measured at local scale; 3. Investigation about the possibility to scale up 4. Environmental factors controlling NPP

4	Chlorophyll a	1. Trend analysis over long time 2. Space for time substitution for biomass change 3. Relationship between NPP and chlorophyll in marine and freshwater systems; 4. Relationship between primary productivity chlorophyll a and euphotic zone depth.	1. Eutrophication (factors controlling phytoplankton biomass) 2. Relationship between phytoplankton biomass and land use 3. Impact of climate change on chlorophyll a
5	age structure	1. Change in age structure	
6	density	1.Relationships between net primary productivity and human population density across systems (a problem of scale) 2. Relationship between land use and density of human population 3. Relationship between density of human population and species richness	
7	main economic activity	Relationship between changes in biomass and or changes in net primary production, and economic production	
8	average income	1.Changes/trend in the average income in selected sites	1. Relationship between biodiversity (biomass, PPN, abundance, species richness) and human system characteristics (land use, land cover, human density, main economic activities)
9	land cover	1. Land cover changes	
10	land use	1. Land use change and impact on biodiversity structure and functions (biomass, NPP, species richness, abundance)	
11	Total nitrogen (water, sediments)	1. Characterize spatial and temporal changes/trend in nitrogen along LTER sites	1. Relationships between ecosystem functions and biogeochemical cycles (TN, TN)
12	Dissolved oxygen	1. Long term trends	1, Impact of climate change on dissolved oxygen
13	pH	1. Long term trends	1, climate change impact on acidification
14	Precipitation	1.Long term trends	
15	Total phosphorous	1.Characterize spatial and temporal changes/trend in phosphorus along LTER sites	
16	Secchi disc transparency	1. Trends of transparency and euphotic zone depth	

17	number of species	1. Relationship between PPN and species number 2.Long term trend of species richness	1. Relationship between PPN and species number 2. Long term trend of species richness 3) Investigating the "Distribution-abundance-richness Relationship" across ecosystem types
18	Suspended solids		1. Relationship between land use and suspended solids in catchments
19	Temperature		
20	total population in the site		
21	Silicates	Long term trends	Relationship with changes in inputs from land and sediments; impact on species composition (i.e. Phytoplankton)
22	Salinity	Long term trends	Relationships with river and atmospheric inputs; Impact of climate change on salinity

5.9. Possible research activities/ long term analysis based on the proposed projects

The projects should be focused on the analysis of historical (consider gathering long term datasets from different sites) and new ecosystem monitoring data coming from a series of LTER sites: aims at evaluating the status, the trends and the cause-effect relationships at different spatial and temporal scales, in different ecosystems; to provide statistical information for improving the network design (action A4 of EnvEurope); to use long-term ecological data to describe and analyze the main temporal and spatial changes in ecosystems and to define a set of key indicators.

Three types of projects are promoted: i) Projects focused on long term dataset analysis (with the support of individual partners); this could also include new datasets in conjunction with action A5; ii) Meta-analysis projects (Projects not focusing on data from sites but on existing results from literature or on a mixture of data from sites and existing results from literature); iii) A combination of the above project types.

Up to know the list of projects submitted and in course to be implemented comprises 16 titles:

1. Nitrogen deposition and vegetation change in LTER sites: testing critical load exceedance
2. Eutrophication and climate change in EU-LTER sites
3. Temporal patterns of phytoplankton diversity on a European scale
4. Spatio-temporal assessments of ecosystem functions and services across different LTER Europe sites
5. Effects of meteorological parameters and air pollution on trees growth in EnvEurope forest sites
6. Imprints of priming effects on soil organic matter isotope signatures
7. Tree-ring chronologies in relation to past human and natural disturbances
8. Response of forest ecosystem to synergetic effect of climate and air pollution changes
9. Birds communities as indicators of ecological integrity in LTER sites
10. Environmental factors as drivers of mast seeding in tree species across Europe
11. Phenological variations in response to climate change
12. Long term development in the ecological status of large lakes
13. HANPP as estimate of nutrient load from the catchment to fresh and coastal waters
14. Net primary production at LTER Europe sites
15. Recent changes in tree demographic rates in European forests: patterns and possible causes

16. Variation of litter decomposition across a European gradient

The projects will be implemented using the available datasets coming from different sites and covering the heterogeneity of different gradients at European scale. It is possible that during implementation some of the projects will not reach their full potential due especial to data constrains. Many of the hypotheses of these projects are requiring long term data series coming from range of sites distributed across Europe in order to be tested, so it is possible that in the end not all of the above projects will actually become reality.

There are numerous positive aspects to be considered when developing projects and working together in defining aims and hypothesis for long term research activities (many of them have been already mentioned). One important drawback of this approach is linked with the need to have a common approach and common grand challenges (16) (like for e.g. US NEON program: 1. Biodiversity 2. Biogeochemical cycles; 3. Climate change; 4. Ecohydrology; 5. Infectious disease; 6. Invasive species; 7. Land use) defined by the research community involved in long term socio-ecological research.
We could nevertheless use the different interest of different researchers in defining (table 19) the "great research and grand challenges".

Table 19. Projects names, promoter, aims and main hypothesis.

No.	Project name	Promoter	Aim of the project	Hypothesis
1	Nitrogen deposition and vegetation change in LTER sites : testing critical load exceedance	Dirnböck Thomas	1. Develop time series of biological parameters and use them in conjunction with environmental data; 2.Comparison with pressure indicators (Critical Loads)	1) We hypothesize that by using long-term, plot based data of species changes, shifts in composition and/or diversity can be related to a) the sensitivity of habitats to nitrogen deposition (the critical load of nitrogen) and b) the strength of nitrogen deposition during the last decades (the exceedance of the critical load). We further hypothesize that these changes occur for different organisms (vascular plants, lichens) and ecosystems (forests, grassland).
2	Eutrophication and climate change in EU-LTER sites	Mihai Adamescu	3. Develop time series of eutrophication parameters and use them in conjunction with climate datasets; 4 the project could be developed across eco-domains (from aquatic to terrestrial systems).	2) Climate change can affect temperature regimes in different ecosystems and cause important responses from the biotic communities.

3	Temporal patterns of phytoplankton diversity on a European scale	Károly Pálffy and Lajos Vörös	5. To assess temporal changes of phytoplankton community composition and to reveal cause-and-effect relationships between the observed trends, patterns and environmental variables. 6. To make a cross-site comparison/analysis of the putative relationships.	3) Define a functional classification scheme suitable for monitoring and comparing phytoplankton diversity patterns among the sites and revealing any relationship with a number of variables (geographical location, elevation, trophic state, water temperature, etc.).
4	Spatio-temporal assessments of ecosystem functions and services across different LTER Europe sites	Benjamin Burkhard, Cornelia Baessler, Felix Müller , Ricardo Díaz-Delgado	7. To investigate the comparative development of ecosystem service supply and demand of various European LTER sites at the landscape level, to develop methods and indicators for respective assessments, to produce regional statistics and to provide ecosystem service maps of LTER regions.	
5	Effects of meteorological parameters and air pollution on trees growth in EnvEurope forest sites.	Tomasz Staszewski	8. The aim of the project is to show the level and differences in effects of meteorological parameters and air pollutants on trees growth in relation to climatic zones and altitude at the European scale.	4) Weather conditions and air pollution influence tree growth across Europe and this effect depends on climatic conditions, site altitude and tree species
6	Imprints of priming effects on soil organic matter isotope signatures.	Rebecca Hood	12. The experimental setup of the Multi-site Experiment II: Variation of litter decomposition across a European Gradient provides an ideal opportunity to study the impact of excess dissolved nitrogen and carbon on the so called priming effect and to determine whether changes in isotopic signatures and SOM quantity and quality are detectable over relatively short time scales (< 5 years).	5) We propose to investigate whether it is possible to detect early changes in organic matter quantity and quality due to priming effects using stable isotope signatures of bulk soil and possibly easily extractable OM fractions.
7	Tree-ring chronologies in relation to past human and natural disturbances	Stefan Neagu	13. Analyze of tree ring chronologies in relation to human and natural disturbances in order to identify trends of physiological growth	

8	Response of forest ecosystem to synergetic effect of climate and air pollution changes	Algirdas Augustaitis	14. to Develop time series of biological parameters and use them in conjunction with environmental data; 15. to Develop time series of physical and chemical parameters to explain changes in health, productivity and biodiversity of terrestrial ecosystem (first of all forest); 16. To check critical loads of pollutants (S, N, O3) in conjunction with areas location and climate change intensities.	
9	Birds communities as indicators of ecological integrity in LTER sites	Livia Zapponi	17. Create a cross-domain monitoring program for the assessment of ecosystem integrity through the analysis of the composition of avian assemblages, vegetation structure and landscape composition; 18. Develop a new time series related to the target group and integrate it with other existing environmental datasets	6) How do different species and guilds respond to local and landscape variables? 7) How does the integrity of an ecosystem influence the degree of specialization of a community? 8) Is the richness of specialist and generalist species determined by different variables? 9) Do breeding, non-breeding and wintering species respond to the same habitat and landscape variables?
10	Environmental factors as drivers of mast seeding in tree species across Europe	Ignacio M. Pérez-Ramos & Teodoro Marañón	19. To describe temporal changes in tree seed production across Europe using long-term data from LTER sites. 20. To identify which environmental factors or resources better explain the interannual variation in seed production (i.e., mast seeding) along a wide gradient of environmental conditions across Europe. 21. To test the adaptive (the "resource matching") vs. the non-adaptive (the "economy-of scale") hypotheses for masting for each of the selected sites. 22. To evaluate the magnitude of variation in seed production among sites as a function of their resource availability. 23. To detect recent changes in tree seed production that could be related with global change drivers (climate change, land use change, air pollution).	10) Supporting masting as a selective response to processes such as wind pollination or predator satiation (the economy-of-scale hypothesis) postulate that environmental factors or resources only act as synchronizing cues for individual plants, driving high and low seed crops at regular periods of time.

11	Phenological variations in response to climate change	Italian LTER network	24. Identify critical phenological signals at LTER sites. 25. Compare changes in these signals across sites and ecosystems. 26. Collect new parameter for spatialize ground truth information. 27. Obtain useful data for the implementation of the GMES initiative	
12	Long term development in the ecological status large lakes	Kimmo Tolouen, Timo Marjormaki, Juha Karjalainen		
13	HANPP as estimate of nutrient load from the catchment to fresh and coastal waters	Kinga Krauze		
14	Net primary production at LTER Europe sites	Giorgio Matteucci	31. Status and trends of NPP at LTER/EnvEurope sites 32. Evaluation of the sites within the NPP range and map values in Europe (sort of representativeness) 33. Changes in NPP in the last 10 years 34. Potential of the LTER/EnvEurope network to be considered for analysis of NPP changes in relation to pressures (e.g. climate change, land-use pattern, intensification) 35. NPP is an ecological "parameter" that is relevant to all ecosystem domains (terrestrial, river and lakes, marine): potential for cross-domain analysis analysis of drivers of NPP across Europe (if sufficient ancillary parameters will be available)	

15	Recent changes in tree demographic rates in European forests: patterns and possible causes	Lorena Gómez Aparicio, IRNAS-CSIC (Spain)	36. Determine whether systematic changes in tree demographic rates (mortality and recruitment) have recently occurred in European forests. 37. Identify possible causes of those changes, mainly exogenous environmental drivers (changes in climate and soil fertility) vs. endogenous structural drivers (increases in tree density and competition for resources).	11) Background mortality rates have increased rapidly in recent decades in European forests, as found for tropical and temperate forests across large areas in South America (Phyllips et al. 2008) and Western US (van Mantgem et al. 2010). 12) Recruitment rates do not necessarily have paralleled the increase in mortality rates, potentially causing a decrease in turnover rates. This decrease is more likely to occur in those European forests where species are already growing at the limit of their physiological tolerance (e.g. *Pinus sylvestris* forests in Spain, Vilá-Cabrera et al. 2010). 13) Changes in demographic rates of tree species is probably the consequence of abiotic (e.g. climate, soil properties) or biotic changes (e.g. stand densification) in the environment of European forests over recent decades.
16	Variation of litter decomposition across a European gradient	Jutta Stadler, Mark Frenzel		14) Decomposition rate shows a humped-shaped distribution along the geographic gradient: in boreal as well as Mediterranean ecosystem decomposition will be lower than in Middle Europe due to climatic constraints. 15) Increase in nutrient availability will increase decomposition rate along the bio-geographic gradient in a non-linear way. 16) There is a positive relationship between C/N ratio of substrate and decomposition rate (The contrast between fast and slow decomposing litter species will be lower in constrained environments)

5.10. Need for other data types not currently gathered by the EU-LTER network

After a carefully analysis of the existing datasets (in fact of the reported metadata on the datasets) we can say that at site level there are multiple variables measured, and in fact this is not necessary the problem. The real problem is the selection of a set of core variables measured with standardized methods that could respond to fundamental real societal questions. One problem that we tried to approach during the implementation of the EnvEurope project was to identify the existing common datasets that would allow us to address the (e.g.) questions mentioned in tables 16-18 and to implement projects like the ones mentioned in table 19.

For terrestrial ecosystems the priority list comprises 20 variables: abundance of…, biomass of …, net biological primary production, species cover bottom layer, species cover field layer, species cover shrub layer, species cover tree layer, age structure, density, main economic activity, average income, land cover. land use, Total nitrogen (water, sediments and soil), pH, Precipitation, Total phosphorous, number of species, Temperature, total population in the site.

For freshwater ecosystems the priority list comprises 22 variables: abundance of…,biomass of…, net biological primary production, Chlorophyll a, age structure, density, main economic activity, average income, land cover, land use, Total nitrogen (water, sediments), Dissolved oxygen, pH, Precipitation, Total phosphorous, Secchi disc transparency, number of species, Suspended solids, Temperature, total population in the site, Silicates, Salinity.

For marine ecosystems the priority list comprises 22 variables: abundance of…, biomass of…, net biological primary production, Chlorophyll a, age structure, density, main economic activity, average income, land cover, land use, Total nitrogen (water, sediments), Dissolved oxygen, pH, Precipitation, Total phosphorous, Secchi disc transparency, number of species, Suspended solids, Temperature, total population in the site, Silicates, Salinity.

The proposed lists of priority variables for each of the ecosystem types (terrestrial, freshwater, marine) is addressing the problem of identifying real variables for long term measurement that have been collected by most of the LTER sites over the years and allows now the development of different comparative studies across sites and on long term. This datasets could be also used for modelling approaches such as species distribution modelling.

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Annex 1 LTER sites per country in EnvEurope *(please note that 3 sites from Romania are not actually included)*

Country	Name	Total
Austria	Zöbelboden	
	Achenkirch-Mühleggerköpfl	
	Hochwechsel	
	Lunz_WaterCluster	
Austria Total		**4**
Bulgaria	Mesta river	
	Petrohan (BG02)	
	Sozopol	
	Srebarna	
	Yundola	
Bulgaria Total		**5**
Finland	02 Lake Paijanne	
Finland Total		**1**
Germany	Darss-Zingst Bodden	
	DE01 Bornhoved	
	LH-Friedeburg	
	LH-Greifenhagen	
	LH-Schafstaedt	
	LH-Wanzleben	
	NP Eifel	
	Rhein-Main-Observatorium	
	Uckermark	
	DE-01-LH-WL	
Germany Total		**10**
Hungary	Balaton	
	KISKUN LTER	
	Sikfokut LTER	
	hu_sik	
Hungary Total		**4**
Italy	IT06 CAL1 Piano Limina	
	08 Southern Alpine Lakes	
	10 Lake Sardinia	
	Apennines	
	Appenino settentrionale	
	Biferno litorale di Campo Marino	
	Bosco Fontana	
	Foce Saccione Bonifica Ramitelli	
	Golfo di Trieste	

	Golfo di Venezia	
	Gran Sasso	
	Lagoon of Venice	
Italy Total		**12**
Lithuania	LT-01 Aukstaitija	
	LT-03 Zemaitija	
	LT-04 Nagliai, Curonian Spit NP	
Lithuania Total		**3**
Poland	Bialowieza National Park, SI001458	
	Brenna	
	Czarny Staw & Morskie Oko lakes in Tatrzański National Park	
	Karkonoski National Park	
	Mikołajskie Lake	
	Pilica	
	Słowinskii National Park	
	Tatrzański National Park	
	Kampinoski National Park	
Poland Total		**9**
Romania	Braila Islands	
	Neajlov catchment	
	RO01 Bucegi P. Craiului NP	
	RO1	
	RO2	
	RO3	
Romania Total		**6**
Spain	Illas Atlánticas	
	Aigüestortes	
	Collserola / Barcelona (ES-SNE)	
	Doñana	
	Ordesa	
	Sierra Nevada	
	SR1	
	SR2	
	SR3	
Spain Total		**9**
Sweden	Aneboda	
	Gammtratten	
	Gårdsjön	
	Kindla	
Sweden Total		**4**

Total		**67**

Annex 2. List of variables measured across EnvEurope sites (based on the metadata in Infobase)

Count of PARAMETER_NAME		
EUNIS	PARAMETER_NAME	Total
		41
Total		41
Sites not mentioning any habitat	Vegetation structure/ layers	26
	pH	25
	Bryophytes	21
	Air temperature	21
	Vascular plants, ground layer	20
	Precipitation	20
	Vascular plants, trees, shrubs	19
	Land Use information	18
	Land Cover information	18
	Air relative humidity	15
	Biomass above ground	15
	Phenology	15
	Wind velocity	14
	Total species richness	14
	Birds	14
	Topography	13
	Invertebrates, above ground	13
	Invasive species	13
	Water inorganic nutrient content	12
	Soil type	12
	Soil temperature	12
	Conductivity	12
	Soil depth	11
	Indicator species	11
	Water discharge	10
	Soil total phosphorous	10
	Soil total nitrogen	10
	Soil texture	10
	Snow depth	10
	Rainfall chemistry	10
	Habitat fragmentation	10
	Habitat conversion	10
	Water anion concentration	9

	Soil surface characteristics	9
	Soil organic carbon	9
	Soil moisture	9
	Soil bulk density	9
	Mammals	9
	Lichens	9
	Vascular plants, aquatic	8
	Soil total carbon	8
	Soil structure	8
	Soil saturated hydraulic conductivity	8
	Soil pH	8
	Soil nutrients	8
	PAR	8
	Invertebrates, aquatic	8
	Water surface temperature	7
	Water sediment load	7
	Water dissolved organics	7
	Water dissolved carbon	7
	Water cation concentration	7
	Tourism	7
	Threatened species	7
	Dead organic matter dynamics	7
	Fish	7
	Soil heavy metals	7
	Soil exchangeable potassium	7
	Soil exchangeable aluminium	7
	Soil exchangeable acidity	7
	Soil cation exchange capacity	7
	Invertebrates, soil	6
	Water storage fluxes	6
	Water heavy metals	6
	Chemical profile of biological tissues	6
	Dry deposition of nitrate and sulfate	6
	Soil rooting depth	6
	Nature conservation programmes	6
	Aerosols	6
	Evapotransporation	6
	Snow cover area	6
	Water turbidity	5
	Lake and river freeze-up and break up	5
	Population statistics	5
	Land use history	5
	Radiation: incoming surface solar radiation	5

	Environmental pollution statistics	5
	Cloud cover	5
	Fungi, macro	5
	Fungi, micro, soil	5
	Soil available phosphorus	5
	Snow water equivalent	5
	Agriculture	4
	Water concentration of dissolved solids	4
	Vascular plants	4
	Traffic	4
	Forestry	4
	Reptiles	4
	Soil moisture storage capacity	4
	Water trace elements	3
	Other	3
	Soil calcium carbonate	3
	Amphibians	3
	Ozone	3
	Leaf area index	3
	Cold cloud duration	3
	Economic core indicators	3
	Income structure	3
	Chlorophyll	3
	Regional development programmes	3
	Zooplankton	2
	Fertilizer use	2
	Pollinator species	2
	Rainfall quantity	2
	Water sodium adsorption rate	2
	Radiation: Outgoing long-wave radiation	2
	Water organic contaminants	2
	Bacterial	2
	Dissolved organic carbon	2
	Dissolved oxygen	2
	Carbon dioxide flux	2
	Ground water storage fluxes	2
	Radiation: Surface reflected short-wave radiation	2
	Subsidies	2
	Net ecosystem productivity	2
	Spectral vegetation greenness indices	2
	Net primary productivity	2
	Surface roughness	2
	Soil infiltration rate	1

	Specific leaf area	1
	Invertebrates, benthic	1
	Surface temperature	1
	Temperature	1
	Diameter at breast height	1
	Soil composition	1
	Height to crown base and crown width	1
	Soil chemical parameters	1
	Phosphate	1
	Transpiration	1
	Tree height	1
	Tree mortality and removal	1
	Phytoplankton	1
	Firn temperature	1
	Biomass below ground	1
	Albedo	1
	Abundance	1
	Fluorescence	1
	Water BOD	1
	Radiation: Outgoing long-wave radiation	1
	Shrub layer cover	1
	Soil annual loss from erosion	1
	Land use changes	1
	NDVI	1
	NH4-N	1
	Coenological cover	1
	Pattern of employment	1
	Air pressure	1
	Soil respiration	1
	NO3-N	1
	NO2-N	1
	Frequency_counts_of_taxa_in_the_herb_layer	1
	Cation concentration	1
	Wind direction	1
	Respiration	1
_unknown Total		937
Constructed	Topography	1
	Abundance	1
	Biomass	1
	Cloud cover	1
	Radiation: Outgoing long-wave radiation	1
Constructed Total		5
Grassland	Coenological cover	10

	Vegetation structure/ layers	5
	Alkalinity	5
	Threatened species	5
	Soil temperature	5
	Invasive species	5
	Aluminium	4
	Ammonium	4
	Soil available nitrogen	4
	Litter	4
	Lead	4
	Chromium	4
	Land Cover information	4
	Indicator species	4
	Habitat fragmentation	4
	Zinc	3
	Vascular plants, trees, shrubs	3
	Vascular plants, ground layer	3
	Total species richness	3
	Total nitrogen	3
	Foliar litter	3
	Habitat conversion	3
	Copper	3
	Cadmium	3
	Conductivity	3
	Sulphate	3
	Calcium	3
	Iron	3
	Sodium	3
	Air temperature	3
	Land Use information	3
	Precipitation	3
	Potassium	3
	Chloride	3
	Phosphate	3
	Magnesium	3
	Manganese	3
	pH	3
	Nitrate as nitrogen	3
	Nitrate	3
	Nickel	3
	Density	2
	Mosses cover	2
	Dissolved organic carbon	2

	Arsenic	2
	Soil moisture	2
	Soil available phosphorus	2
	Mercury	2
	Kjeldahl nitrogen	2
	Snow cover area	2
	Lichens	2
	Rainfall quantity	2
	Nitrification	1
	Root phosphatase activity	1
	Seedbank	1
	Snow chemistry	1
	Radiation: incoming surface solar radiation	1
	Snow water equivalent	1
	Cloud cover	1
	Soil annual loss from erosion	1
	Litter decomposition	1
	Photosynthetic max. capacity	1
	Soil bulk density	1
	Soil calcium carbonate	1
	Soil depth	1
	Soil exchangeable acidity	1
	Phenology	1
	Soil organic carbon	1
	Soil pH	1
	Soil respiration	1
	Soil solution composition	1
	Soil structure	1
	Soil surface characteristics	1
	Microbial biomass	1
	Soil total phosphorous	1
	Soil type	1
	Invertebrates, soil	1
	Biomass above ground	1
	Topography	1
	Herb layer cover (1 to 5 relative scale)	1
	Dominant species	1
	Diversity	1
	Permafrost active layer	1
	Carbon_content	1
Grassland Total		203
Habitat complexes	Species list	3
	Habitat fragmentation	2

	Habitat conversion	2
	Birds	1
	Coenological cover	1
	Land Cover information	1
	Land Use information	1
	Lichens	1
	Mosses cover	1
	Plant species list	1
Habitat complexes Total		14
Heathland	Vascular plants, trees, shrubs	1
	Air temperature	1
	Indicator species	1
	Soil cation exchange capacity	1
	Soil rooting depth	1
	Soil texture	1
	Soil total nitrogen	1
	Total species richness	1
	Vascular plants, ground layer	1
Heathland Total		9
Inland unvegetated	Topography	1
	Air temperature	1
	Soil temperature	1
Inland unvegetated Total		3
Inland water	Composition	8
	Biomass	7
	pH	5
	Water BOD	4
	Air relative humidity	4
	Dissolved oxygen	4
	Abundance	4
	Total phosphorous	3
	Spatial distribution	3
	Phosphate	3
	NO3-N	3
	NO2-N	3
	Chlorophyll	3
	Anion concentration	3
	NH4-N	3
	Amphibians	3
	Wind velocity	2
	Dissolved organic carbon	2
	Water oxygen saturation	2
	Water dissolved organics	2

	Water dissolved carbon	2
	Hardness	2
	Water discharge	2
	Water concentration of dissolved solids	2
	Conductivity	2
	Water cation concentration	2
	Water anion concentration	2
	Cation concentration	2
	Primary production	2
	Species list	2
	Species (systematic)	2
	Biomass index	2
	Evapotranspiration	1
	Size distribution	1
	Soil available phosphorus	1
	Size (number of cell and/or colonies)	1
	Size (length)	1
	Rainfall quantity	1
	Temperature	1
	TON	1
	Age distribution	1
	UV	1
	Vascular plants, aquatic	1
	Radiation: incoming surface solar radiation	1
	Albedo	1
	Air pressure	1
	Water colour	1
	Chemical parameters	1
	Density	1
	Invertebrates, aquatic	1
	Growth rate	1
	Water heavy metals	1
	Water inorganic nutrient content	1
	Water organic contaminants	1
	Fish	1
	Water sediment load	1
	Water surface temperature	1
	Wind direction	1
Inland water Total		121
Marine	Water surface temperature	6
	PAR	6
	Air temperature	6
	Algae	6

	Water turbidity	5
	Water inorganic nutrient content	5
	Water dissolved oxygen	5
	Chlorophyll	5
	Conductivity	5
	pH	5
	Wind velocity	4
	Invertebrates	4
	Air relative humidity	4
	Indicator species	4
	Invasive species	4
	Radiation: incoming surface solar radiation	4
	Water dissolved carbon	4
	Water discharge	4
	Net primary productivity	2
	Total species richness	2
	Bacteria	2
	Threatened species	2
	Vascular plants	1
	Rainfall quantity	1
Marine Total		96
Regularly cultivated	pH	2
	Vascular plants, ground layer	1
	Biomass below ground	1
	Fertilizer use	1
	Invertebrates, above ground	1
	Air temperature	1
	Soil available phosphorus	1
	Soil pH	1
Regularly cultivated Total		9
water	Algae	8
	Alkalinity	3
water Total		11
Woodland	pH	17
	Total nitrogen	15
	Total organic carbon	14
	Sodium	14
	Vascular plants, ground layer	12
	Air temperature	12
	Magnesium	12

	Lead	12
	Cadmium	12
	Total phosphorous	11
	Air relative humidity	11
	Leaf area index	11
	Iron	11
	Calcium	11
	Zinc	10
	Wind velocity	10
	Water dissolved carbon	10
	Water cation concentration	10
	Water anion concentration	10
	Rainfall quantity	10
	Ozone	10
	Manganese	10
	Crown condition	10
	Copper	10
	Water dissolved organics	9
	Total sulphur	9
	Topography	9
	Soil type	9
	Soil total phosphorous	9
	Soil total nitrogen	9
	Soil total carbon	9
	Soil structure	9
	Soil pH	9
	Soil organic carbon	9
	Soil nutrients	9
	Soil depth	9
	Invertebrates, above ground	9
	Invertebrates, soil	9
	Soil calcium carbonate	9
	Soil bulk density	9
	Soil available phosphorus	9
	Rainfall chemistry	9
	Potassium	9
	Lichens	9
	Nickel	9
	Threatened species	8
	Soil temperature	8
	Indicator species	8
	Invasive species	8
	Soil moisture	8

	Snow depth	8
	Radiation: incoming surface solar radiation	8
	Chromium	8
	Aluminium	7
	Ammonium	7
	Total inorganic carbon	7
	Mercury	7
	Arsenic	7
	Wet weight	6
	Weight	6
	Conductivity	6
	Sulphate	6
	Strontium	6
	Molybdenum	6
	Kjeldahl nitrogen	6
	Nitrate	6
	Boron	5
	Vanadium	5
	Dissolved organic carbon	5
	Alkalinity	5
	Nitrate as nitrogen	5
	Chloride	5
	Total residue	4
	Total carbon	4
	Phosphate	4
	Soil cation exchange capacity	4
	Soil exchangeable acidity	4
	Precipitation	3
	Silicadioxide	3
	Nitrite	3
	Cobalt	3
	Dominant species	3
	Fluoride	3
	BSB5	2
	Birds	2
	Copper	2
	Carbon dioxide flux	2
	Vascular plants, trees, shrubs	2
	Truebe_FNU	2
	Hydr_Carb	2
	Profile temperature	2
	BasNeutKap	2
	Soil chemical parameters	2

	BasNeutKap_BX	2
	Radiation	2
	Soil biochemical parameters	2
	Bryophytes	1
	Titanium	1
	Soil annual loss from erosion	1
	Moisture	1
	P_HClO4_TM_BX	1
	Temperature	1
	Biomass above ground	1
	Structural biotic parameters	1
	Land Use information	1
	Total species richness	1
	Species (systematic)	1
	Species (functional)	1
	Selenium	1
	Oven dry sample weight of 1000 needles / 100 leaves [g]	1
	Evapotranspiration	1
	Vegetation structure/ layers	1
	Vertical structure	1
	Soil physical parameters	1
	Mammals	1
	Barium	1
	Habitat conversion	1
	Water inorganic nutrient content	1
	Aerosols	1
	AOX	1
	Height	1
Woodland Total		730
Grand Total		2182