Chapter 17
Development of LTSER Platforms in LTER-Europe: Challenges and Experiences in Implementing Place-Based Long-Term Socio-ecological Research in Selected Regions

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Abstract This chapter introduces place-based, Long-Term Socio-Ecological Research (LTSER) Platforms conceptually and in practice. LTER-Europe has put strong emphasis on utilising the data legacy and infrastructure of traditional LTER Sites for building LTSER Platforms. With their unique emphasis on socio-ecological research, LTSER Platforms add a new and important dimension to the four pillars of LTER-Europe's science strategy (systems approach, process-oriented, long-term and site-based). In this chapter, we provide an overview of the regionalised or place-based LTSER concept, including experiences garnered from Platform models tested within LTER-Europe, and we discuss the current status of LTSER Platforms on the European continent. The experiences gathered in 6 years of practical work and development of regional socio-ecological profiles as conceptual frameworks in the Austrian Eisenwurzen LTSER Platform will be used to assess weaknesses and strengths of two implementation strategies (evolutionary vs. strategically managed) and to derive recommendations for the future. The chapter represents the close

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of the first substantive loop of LTSER research that began in 2003 from conceptualisation to implementation and, through the introspective analysis here, a reconsideration of the central concepts.

Keywords LTER-Europe • LTSER Platforms • Eisenwurzen LTSER Platform • Socio-ecological research • Socio-ecological profiling • Fuzzy cognitive mapping • Critical ecosystem services

17.1 LTSER as an Intrinsic Element of the LTER-Europe Design

17.1.1 The Development of LTSER in Europe

The emergence of Long-Term Socio-Ecological Research (LTSER) in Europe represented a profound shift in professional perceptions regarding how policy-relevant, proactive research should and could be conducted. The historical development in thinking that led to this paradigm shift and the conceptual background are elaborated in detail by Redman et al. (2004) and in the introduction of this book. The following outline sets the stage for understanding the synergies and linkages between long-term ecosystem research (LTER) and LTSER as a crucial part of the next generation of LTER research.

Up to the 1990s, the LTER programme focused mainly on studying ecological structure and function. Small-scale sites (1 ha to 10 km^2) were selected according to ecosystem-specific design criteria (e.g. hydrological catchments of small rivers and lakes), preferably in semi-natural or natural ecosystems. Based on site measurements, traditional LTER has aimed to document and analyse ecosystem structures and processes in order to detect environmental change and its impacts on ecosystems and their natural resources (Mirtl et al. 2009; Mirtl 2010). Later in the LTER programme, urban LTER Sites were added, such as the US LTER Sites in Phoenix and Baltimore (Hobbie et al. 2003; Grove et al., Chap. 16 in this volume). However, due to the small scale of Sites and biases in Site selection, LTER was constrained in explaining cause-effect relationships and larger scale phenomena such as biodiversity loss, often induced by human activities (Metzger et al. 2010; MEA 2005).

At the end of the twentieth century, national and continental networks for LTER, established in the 1980s and 1990s, were assessed regarding their societal relevance. Reviews scrutinised the efficiency of knowledge dissemination and adequacy of current designs in tackling urgent policy questions, including those related to the sustainable use of ecosystem services and the effects imposed on them by global environmental change (Hobbie et al. 2003). In a review of two decades of US-LTER (2011), the reviewers elaborated a list of 27 recommendations, *inter alia* those to establish interdisciplinary and cross-site projects and comparisons, to focus on synthesis science and, importantly, to include a “human dimension” in LTER.

In response to these reviews and on-going self-evaluations, teams in the USA and Europe started to promote LTSER to consider socioeconomic drivers of ecological change observed in traditional LTER, such as historical changes in the economy, public perceptions of their environment, and land use (Haberl et al. 2006; Mirtl and Krauze 2007; Singh et al. 2010). These efforts also built upon earlier publications advocating interdisciplinary research (IDR) among natural scientific disciplines (Pickett et al. 1999).

Given the timing of the developments outlined above, it became evident to the developing European regional group of the International Long-term Ecosystem Research (ILTER) network, which started in 2003, that they had to seize the window of opportunity in order to integrate socio-ecological research from the start of their activities (ILTER 2011). In Europe, as elsewhere, researchers were increasingly considering their landscapes as the ecological products of human activity – "cultural" landscapes that are contingent upon, and are the historical outcome of, the interplay between socioeconomic and biophysical forces (Wrbka et al. 2004). Thus, it had become widely accepted that current structures and states of the environment across the European continent could not be properly interpreted without taking social, environmental and land-use history into account (EEA 2010). Research demanded a new package of variables, including population density, land ownership settings, and patterns of use of ecosystem services at various scales by diverse and competing stakeholders and interactions with nature protection efforts. Accordingly, a range of applied interdisciplinary research approaches would be required, along with new questions regarding ecosystem valuation (Hein et al. 2006). Thus, the lessons from the aforementioned reviews of LTER found fertile and receptive ground within the European LTER community.

A second key factor facilitated the establishment of LTER-Europe and its LTSER component: The Sixth Research Framework Programme (FP6) of the European Commission, launched in 2004, promoted a new type of project, called "Networks of Excellence" (NoE), which aimed to overcome disciplinary fragmentation and foster interdisciplinary integration in the European Research Area. The NoE A Long-term Biodiversity and Ecosystem Research and Awareness Network (ALTER-Net), focused on biodiversity in the ecosystem context as a topical trigger, and provided a unique framework for (i) integrating the strengths of the existing, but fragmented, LTER infrastructure at the site level, (ii) developing a framework for identifying interdisciplinary research ideas, planning proposals and delivering syntheses on complex socio-ecological problems (Furman et al. 2009) and, (iii) working at the science-policy interface (Anon 2009).

Under the auspices of ALTER-Net, the European regional group of the global LTER network (ILTER website), LTER-Europe, was set up with a strong focus on LTSER. The next step was the establishment of "***LTSER Platforms***" in hot-spot areas of ecological research, which moved LTER-Europe on from conceptualisation to implementation.

17.1.2 Conceptual Common Denominators of LTSER and Traditional LTER

Socio-ecological research utilises inter- and transdisciplinary approaches and adopts a holistic conception of human-nature interactions in scrutinising complex cause-effect relationships and feed-back cycles. It does not necessarily imply a specific spatial scale or administrative level, nor must it necessarily extend over long periods of time. Framework models of socio-ecological research such as Press-Pulse Dynamics (PPD, Collins et al. 2011), the Ecosystem Service Initiative (Shibata and Bourgeron 2011) or the Driver-Pressure-State-Impact-Response scheme (DPSIR; EEA 1999) are – on the contrary – generic concepts that aim to maximise the applicability of the model(s) at varying dimensions in space and time. LTSER in Europe, in contrast, focused on the characteristics of the specific research setting in terms of time and space. Having emanated in the context of evolving the next generation of LTER, LTSER strongly mirrors the conceptual pillars of LTER, including (Mirtl et al. 2009; US-LTER 2011):

- **Systems approach:** LTER contributes to a better understanding of the complexity of natural ecosystems and coupled socio-ecological systems.
- **Focus on process:** LTER's research aims at identifying, quantifying and studying the interactions of ecosystem processes affected by internal and external drivers.
- **Temporally long-term:** LTER dedicates itself to the provisioning, documenting and continuous collection and use of long-term data on ecosystems with a time horizon of decades to centuries.
- **In situ:** LTER generates data at different spatial scales across ecosystem compartments of individual Sites and across European environmental zones and socio-ecological regions.

By definition, socio-ecological research deals with systems and processes beyond the functioning of natural ecosystems (i.e. coupled social-ecological systems), as well interactions with other systems and external factors (Grove et al., Chap. 16 in this volume).

As with the traditional LTER approach, the time dimension is a crucial component of the LTSER framework. Humans have been shaping the land and being shaped by the land throughout history. This interaction is complex, and includes feedbacks and legacies that would be overlooked without proper temporal depth of research. The interaction is dynamic at shorter time scales as well, which emphasises the need for temporally continuous research and data collection over time. Consequently, the paradigms of ecosystem services and sustainability are intrinsically linked with the time dimension (Nelson 2011; Lozano 2008) across human generations and therefore cannot be properly interpreted without consideration of the long term (WCED 1987; Costanza and Daly 1992).

As with time, LTSER research requires large spatial scales to capture drivers and pressures and their long-term impacts, which could not be comprehensively investigated on the spatial scale of hundreds of hectares (even in LTER-Europe's network of over 400 of Sites of that size covering Europe's environmental zones). Aside from large spatial scales, LTSER requires a different focus regarding the location of research sites. In order to support fundamental research on ecosystem processes while attempting to minimise the effects of anthropogenic drivers and management, the selection of locations for traditional LTER Sites was biased in favour of natural or semi-natural ecosystems (Metzger and Mirtl 2008; Metzger et al. 2010). But these anthropogenic drivers, sometimes perceived as 'disturbances' that should be excluded or at least minimised in LTER, are of special interest in LTSER. Thus, the characteristics of the LTER facilities as well as the disciplines involved in research do not suffice to investigate socio-ecological systems (Redman et al. 2004). LTSER research activities need to address spatial units on a sub-regional to regional scale that share a common land-use history and similar environmental conditions. Typically, such regions are in the range of 100–10,000 km^2 and more.

Nonetheless, due to the similarities between LTER and LTSER programmes and the particular evolutionary development of LTSER, it was natural to implement place-based LTSER in the context of LTER, thereby adding a new dimension to the unique combination of the core characteristics above. The interdisciplinary expertise represented by the ALTER-Net consortium catalysed the development of the integrated networks of LTER Sites and LTSER Platforms under the umbrella of LTER-Europe.

An additional complimentarity between LTSER and LTER is that the former is context-driven, problem-focused and interdisciplinary (Mirtl et al. 2009). It involves multidisciplinary teams brought together for limited periods of time to work on specific, real-world problems collaboratively with stakeholders of concrete regions. Gibbons et al. (1994) labelled this type of work "**mode 2"** knowledge production as opposed to traditional "**mode 1**" research, which is academic, investigator-initiated and discipline-based knowledge production. By contrast, mode 2 is problem-focused, stakeholder-integrating and interdisciplinary. LTER-Europe, by initiating the LTSER programme alongside and complementing the continuing traditional LTER programme, provides an integrated framework for both types of knowledge production, maximising the use of existing infrastructure and data legacies.

17.2 From Conceptualisation to Regional Application: Place-Based LTSER Platforms

This section focuses on the creation of LTSER Platforms in which principles of socio-ecological research were put to practice in specific geographic regions. "Socio" in this context refers to disciplinary approaches from the economic, social, and cultural sciences as well as the humanities. As the major advance here is the application of socio-ecological research in a specific location, hereafter we distinguish between i) socio-ecological research as a conceptual framework as described in the introduction and part I of this book (concepts and methods) and ii) place-based

LTSER in regions at the scale of European landscapes representing units in terms of environmental history, land use and economic interactions as well as cultural identity (in the range of hundreds to thousands of square kilometres). LTER-Europe contributes to both by implementing LTSER on a regional scale and iteratively feeding practical experiences back into conceptual work.

Regionalising socio-ecological research in LTSER Platforms signifies a paradigm shift regarding the methods and goals of research. This shift is not on the level of individual research projects, but refers to the cooperative and collective goal of developing a detailed and holistic understanding of how spatially explicit socio-ecological systems work by integrating many projects across disciplines and over long time periods. This, of course, includes the investigation of socioeconomic components of the system and their interaction with the environment. The knowledge that the research aims to generate pertains to (1) sustainable use of resources and (2) development of adaptive policies for study regions whose systems are changing due to anthropogenic local and global environmental change (e.g. climate change adaptation).

The quest for this knowledge leads to one of the fundamental components of LTSER: the two-directional flow of information between actors in the region (stakeholders) and researchers (scientists). The actors are any members of the regional population, or those who are not from the region but have a distinct interest in the region's ecosystem services. They include any individuals or groups who have a vested interest in the area under research – whether that is economic, political, or social. The role of such stakeholders in LTSER is threefold: Firstly, the subjectively perceived knowledge gaps regarding sustainable use of ecosystem services have to be collected across actor groups (which is a scientific challenge in itself, and distinguishes the two major approaches of LTSER implementation in Europe discussed further below). Secondly, stakeholders assist in defining the key research questions, such that these questions are not solely generated from the scientific point of view of individual disciplines, but in the framework of an agreed interdisciplinary and stakeholder-informed research agenda. Thirdly, in order to identify realistic options and limitations for dealing with global changes (e.g. climate change) at the regional/local level, the region's social and economic environment must be identified and analysed (threshold interactions across scales and sectors, see below). This final step responds to the apparently contradictory requests for regionalisation on the one hand and internationalisation on the other, both on the continental European scale and internationally. Developing ILTER global comparisons are attracting increasing interest as the LTSER approach is adopted and implemented by a growing range of networks (national LTERs and other LTER regional groups, Global Land Project).

The process of moving from conceptualising LTSER to the implementation of actual regionalised research platforms has proven to be profoundly challenging. In fact, each phase of implementation carries with it its own unique challenges, from identifying appropriate regions and defining their boundaries to developing the common language indispensable for proper interdisciplinary research (Furman et al. 2009). In many cases, even the underlying concepts of LTSER are revisited and modified by regional teams. Thus, the physical implementation of LTSER Platforms has been a major long-term effort and requires both a shared vision and a division of tasks on the European scale.

At the network level, the strategic research intention of the LTSER component in LTER-Europe was to establish an infrastructure to facilitate and strengthen socio-ecological research capacity in the European Research Area. The major socio-ecological systems of the European continent (see socio-ecological stratification below, Metzger et al. 2010) would be represented by at least one LTSER Platform each, where exemplary research could take place including the participation in assessments and forecasts of changes in structure, functions and dynamics of ecosystems and their services, and defining the socio-ecological implications of those changes. Regionalised LTSER also has as a goal to define and address key management issues according to local and regional settings. Aside from the research goals emphasised above, regionally implemented LTSER should support testing and further development of tools and mechanisms for the communication and dissemination of knowledge across different cultural contexts and social gradients.

It is important to note that several additional research bodies have advocated the establishment of such a socio-ecological, place-based research programme (Carpenter et al. 2009). The interdisciplinary Programme on Ecosystem Change and Society (PECS) of the International Council of Science (ICSU website) has recently advocated "Place-Based Long-Term Social-Ecological Research" as being key in investigating society-nature interactions. In co-operation with UNESCO, this concept shall be fostered according to a 10-year action plan (ICSU 2010, Programme on ecosystem change and society (PECS) – A 10-year research initiative of ICSU and UNESCO – Workplan 2010: draft technical paper, Steve Carpenter, chair of PECS, personal communication).

17.3 Functional Components of LTSER Platforms

Analysing the challenges outlined above, physical infrastructure, actors and stakeholders, research activities and co-ordination/management have been identified as key components in the design of LTSER Platforms (Fig. 17.1).

In a nutshell, LTSER Platforms are regional hot spots of data and expertise, where infrastructure and monitoring, multiple research projects and regional stakeholders interact synergistically in order to (i) increase knowledge of socio-ecological interactions relevant for a sustainable use of environmental resources and (ii) feed this knowledge into local and regional decision making and management in the pursuit of long-term sustainability. This implies a high level of co-ordination embedding individual projects in a research framework and supporting them with data and relevant contacts.

The required components of LTSER Platforms are defined according to broad research demands to represent functionally and structurally relevant scales and levels on the one hand and characteristics specific to the region on the other. Specifically, the definition of the components depends on individual regions' landscape, habitat

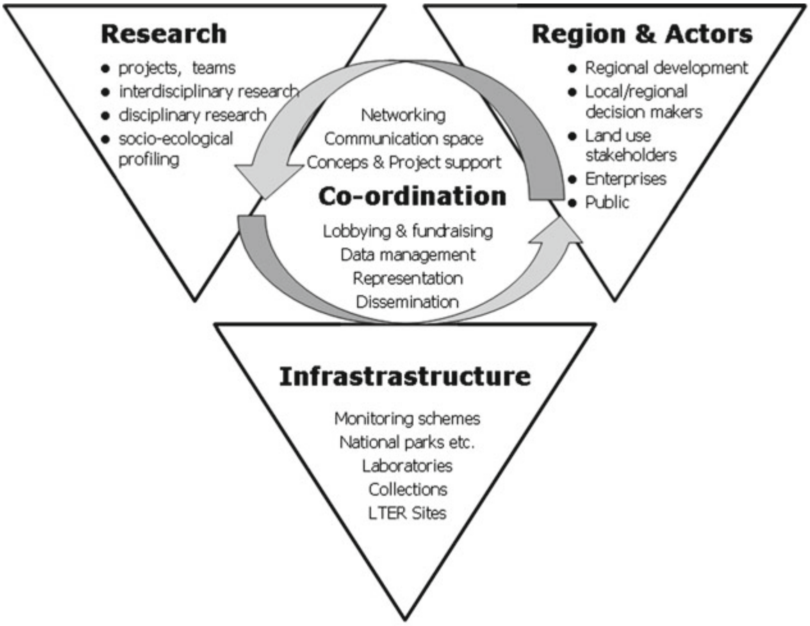

Fig. 17.1 The functional components of LTSER Platforms

types and administrative structures as well as economic, social and natural gradients within the target region.

The designs of LTSER Platforms that have been established so far in principle combine elements of these four functional components with varying priorities reflected in several chapters on regionalised LTSER in part II and part III of this book (Lavorel et al., Peterseil et al., Tappeiner et al., Furman and Peltola in Europe and Grove et al. and Chertow et al. in the USA). These priorities and the relative importance of individual components also reflect existing settings of research (e.g. data availabilities) and the complexity of targeted issues.

17.3.1 Physical Infrastructure and Spatial Design

Regarding physical infrastructure, LTSER Platforms represent clusters of facilities supporting LTER activities and providing data. In much previous socio-ecological research, studies designed to address interactions between society and natural resources suffered from a mismatch between the observed spatial units and the related spatial scale of management and political response (Dirnböck et al., Chap. 6 in this volume). LTSER Platforms seek to avoid these flaws by developing nested, scale- and level-explicit designs according to comprehensive socio-ecological profiles (example below).

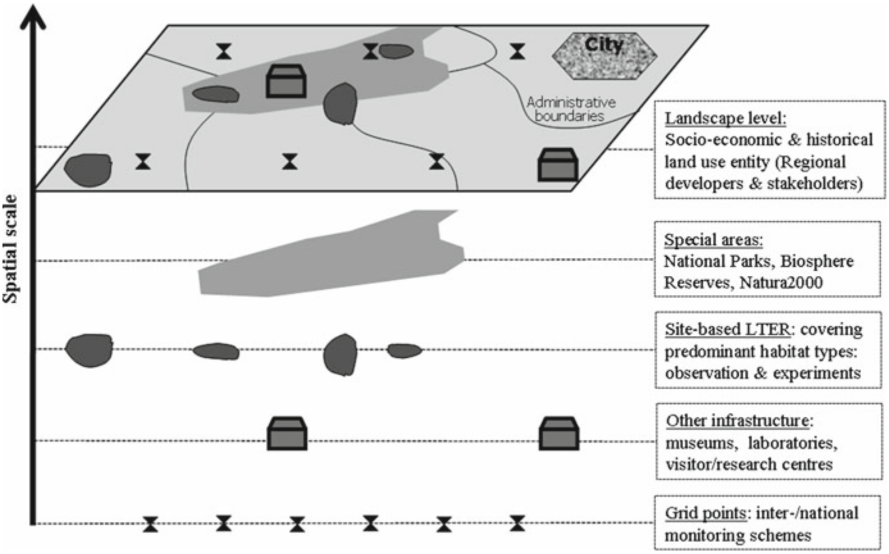

Fig. 17.2 Infrastructural elements of LTSER Platforms across spatial scales within a LTSER Platform region

With respect to infrastructure, LTSER Platform design distinguishes between (i) grid points of regional, national or international monitoring schemes, (ii) local infrastructure, such as research centres, museums or laboratories (iii) site-level activities representing in-depth ecological research and monitoring in primary habitat types of the Platform region, containing specific sampling or experimental plots at finer spatial scales, (iv) intermediate-scale elements such as national parks, biosphere reserves or meso-catchments, and finally (v) landscapes (Fig. 17.2). The hierarchical design from the site- to the landscape-level and cascaded, harmonised sampling and parameter sets enable the systematic assessment of the representativeness of individual plots or sites. Elements belonging to higher scale activities, including national and international monitoring schemes, are functionally linked for further up- and downscaling and crosswise validation (e.g. biodiversity indicators).

The adequacy and appropriate composition of existing research infrastructures is assessed by means of land cover statistics, habitat and landscape type distributions, and environmental parameter gradients (e.g. predominant land use sectors like agriculture ought to be covered by applied research on the effects of current and alternative management practices).

In terms of socio-ecological interactions, administrative units such as municipalities, districts and provinces offer alternatives for delineating the boundaries of the LTSER Platform, or research units within them. The target is to provide correlating economic, demographic and environmental data with best possible resolution, better than the European Units for Territorial Statistics geocode standard NUTS-3 (Nomenclature d'Unités Territoriales Statistiques; 0.15–0.8 Mio inhabitants) and preferably LAU-2, representing the level of individual municipalities (NUTS 2011). In one promising example, the project IP SENSOR (Sixth Research Framework Programme, European Commission) has managed to collate and integrate national census data with national environmental monitoring data on the scale of the entire Eisenwurzen LTSER Platform. Based on that matching, project researchers have developed sustainability indicators for former mining areas (Putzhuber and Hasenauer 2010).

17.3.2 Actors and Stakeholders

Actor/stakeholder integration into research is one of the most important characteristics that distinguish LTSER research from LTER work. In order to identify relevant actors and stakeholders, the geographic extent of the LTSER must be identified, as discussed in the section above and in further practical detail below. Actor analyses identify the corresponding interest groups engaged in regional and local decision-making, management, administration, regional development, education, monitoring, primary research, enterprises, and stakeholders of predominant economic and land use sectors. In consultation with key actors/stakeholders, socio-ecological profiling (see below) is used to reveal key ecosystem services, environmental and economic sectors and social factors and trends driving changes in the system. Structured access to these key groups allows for the efficient identification of research demands. Special attention should be given to established social networks and multipliers (e.g. regional development associations) and their media, which can provide substantive support in recruiting stakeholders, as well as disseminating research findings to the public.

Through the integration of stakeholders, LTSER Platforms encourage a process of reconciling national and international top down research priorities and policies with bottom up, stakeholder-defined research needs of the particular region with regard to nature protection, economic development, and assessment and reporting of environmental conditions. Collaboration is essential at every stage of the process of identifying knowledge gaps, defining research needs, analysing results and translating results into policy recommendations. Considering that environmental policy making is a social process that should reflect political realities, social values and economic needs in order to maximise potential for success (Cohen 2006), the importance of integrating stakeholders into LTSER (ranging from local decision makers to regional developers to global conservation institutions) is self-evident.

17.3.3 The Research Component of LTSER Platforms

The research component of LTSER Platforms consists of research projects with best possible complementarity (Fig. 17.3), ranging from specific disciplinary projects to

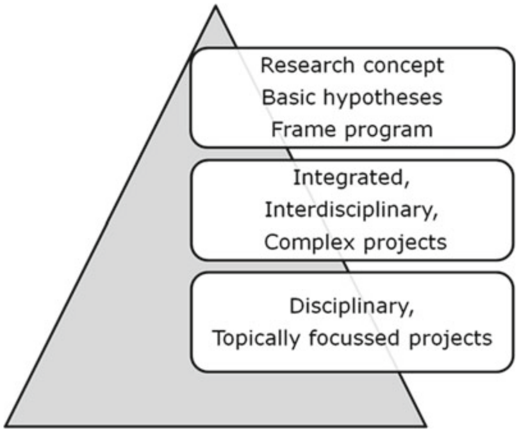

Fig. 17.3 Hierarchy of research projects in LTSER Platforms

complex synthesis projects, both anchored in a research framework customised for the socio-ecological profile of a specific region (see section on socio-ecological profiling below).

LTSER's two major principles guiding its research programme are i) transdisciplinarity, i.e. the involvement of non-scientific stakeholders into the research process aiming to support regional decisions towards sustainability (Haberl et al. 2006, Haas et al., Chap. 22 in this volume) and, ii) interdisciplinarity, integrating natural sciences, social sciences and the humanities. Transdisciplinarity is particularly important in the definition phase of projects and in the translation of results into knowledge-based guidelines for administration and management, which might be supported by accessory implementation projects funded from sources other than the research itself (e.g. LEADER, LIFE+, Interreg in Europe). LTSER Platforms and their multidirectional space for communication are specifically constructed for developing interdisciplinary research (IDR) on complex socio-ecological questions. The research programmes of Platforms involve more than one disciplinary approach and their research teams closely scrutinise the particular roles of each discipline and, crucially, their interlinkages. ALTER-Net has developed a framework for identifying interdisciplinary research ideas, planning proposals and delivering syntheses (Furman et al. 2009). This framework can be used when developing research strategies in the LTSER Platforms.

Thematic areas of research in LTSER Platforms include (i) process-oriented ecosystem research (basic scientific research; investigation of functionally and structurally important ecosystem components; long-term impacts of drivers and combinations of drivers upon ecosystem functions and services), (ii) biodiversity and conservation research (documentation of the status, trend and functional relationships of species; safeguarding the long-term survival of species, their genetic diversity, and ecological integrity; functionality of habitats and ecosystems) and (iii) socio-ecological research (basic socio-ecological research: Society-nature interaction, socio-ecological transitions; land-use/land-cover change; social perceptions of environment and environmental change, changes in resource utilisation; environmental history and historical sustainability research; transdisciplinary and participative research; integrated socio-ecological modelling and scenarios) (Mirtl et al. 2010).

Hardly any project of one thematic area does not overlap with others when dealing with socio-ecological questions (e.g. the impact of game management on tree regeneration and forest species composition). In this sense, LTSER is an approach which challenges and changes the routines of academia. Although there have been many mainly programmatic discussions about these principles for decades, ("mode 2-", "mode 3-" and "post-normal science", e.g. Funtowitz and Ravetz 1992), major parts of the scientific community in general still remain sceptical regarding the potential for interdisciplinary research to contribute to our understanding of the world. Inter- and transdisciplinarity are sometimes seen as competing against disciplinary excellence (experiences from the ALTER-Net project mentioned above and managers of European LTSER Platforms, according to the LTSER workshop held in Helsinki, June 2011). LTSER Platforms have the potential to serve as experimental laboratories in which classic disciplinary research is combined with inter- and transdisciplinary research towards both scientific excellence and relevance to real-life challenges. Continuous accompanying research (Kämäräinen 1999) within LTSER Platforms is one of the key instruments to enable that combination and to support researchers from different disciplines and stakeholders from several societal groups in moving LTSER forward.

In contrast to conventional evaluation processes, accompanying research within LTSER should be seen as the common responsibility of all researchers and stakeholders involved and should focus on integration rather than on quantifying output. The responsibility for stimulating integration can be assigned to several individual researchers, who would be required for a certain time to travel and, by means of participant observation, to learn about the main points of research at different Sites. Although LTSER focuses on research relevant to its geographic area, coordination between LTSER Platform teams is crucial for maintaining a minimal level of comparability between Platforms. Project teams within and between LTSER Platforms should observe each other, looking for potentially conflicting basic assumptions and for paradigms underlying their research, and functioning as an internal "quality control" body. Further, teams should attempt to maintain a degree of commonality between the Platforms, which is crucial to the larger continental and global goals of comparability and assessing the impact of global processes in the local setting (Mirtl et al. 2009).

Conventional evaluation processes measure the scope of scientific output (e.g. published papers in academic journals). LTSER Platforms could and should be evaluated with conventional instruments of this kind. However, the appropriate evaluation and competitive chances of LTSER projects are constrained, as long as the ability of LTSER to generate realistic environmental/natural resource policy recommendations for stakeholders – based on both their input and research results – is not, in addition to that, acknowledged based on its societal relevance.

17.3.4 LTSER Platform Management, Co-ordination and Communication Space

It has been recognised by the LTER community that LTSER requires a Platform management and co-ordination team, secured for the long term and providing a wide range of services implied from the sections above. Amongst these services are communication space (meetings, website, bilateral contacts, local to global contacts), conceptual work (see following chapter "Socio-ecological profiling"), project development, networking across interest groups, disciplines and stakeholders both nationally and internationally, results dissemination, communication with the broader public, education, youth and researcher training, data integration and policy, data management, development and provisioning of IT tools, representation (nationally, internationally), lobbying and fundraising. An example for how these services have been implemented in detail is given by Peterseil et al. (Chap. 19 in this volume).

Successful LTSER depends strongly on internal factors, and first and foremost on the quality and content of scholarly exchange within the community. The conscious design of communication processes between different disciplines and between science and the public is crucial. Therefore, the "platform communication space," must be a multidimensional environment that allows for people from different technical and cultural backgrounds to understand one another. It uses a variety of media and communication formats to support the implementation of the transdisciplinary and participatory approaches necessary to adopt research agendas to regional and local needs and to achieve access to and involvement of the regional population, key stakeholders and decision-makers, all of whom can be seen as beneficiaries of the knowledge produced.

The same is true for science when it comes to the required data access and data flows. Without central facilitation, providing required data for complex LTSER projects alone would exhaust individual projects, even if these data were available for free. LTSER requires quick data exchange, ideally based on IT solutions, and the integration of dispersed data sources (ontologies, tools for semantic mediation). The LTSER Platform must therefore secure funding for numerous aspects of management, initiating, supporting and documenting research. Basic funding has to be ensured by the committing institution or by national funding programmes. Additional funding may be necessary for instrumentation, data and projects running on the Platform. Once the LTSER Platform is up and running, periodic funding will also be needed for synthesis projects.

17.4 Socio-ecological Profiling – Applying Tools and Various Conceptual Models to Socio-ecological Systems

The initiation of an LTSER Platform is aided by the adoption of conceptual models through which a socio-ecological profile can be developed. Such a profile distils the multiple social and ecological variables and their complex interactions operating within the Platform into the primary components important to study. These components are defined primarily through expert knowledge of the LTSER team and the local knowledge accrued through stakeholder mapping. The process of creating the profile can be considered as part of the scientific co-ordination activities of the Platform management. As a collective approach involving all actor groups, it is a typical outcome of the Platform's communication space. Participants perceive it as a common reference point to anchor their activities and projects.

Mapping the socio-ecological profile of a LTSER Platform region with the assistance of several conceptual models has increased the robustness of the profile in terms of acceptance and collective ownership by different disciplines and stakeholders. Unifying concepts increase the potential to parameterise additional socio-ecological models and helps establish a common research denominator across Platforms. Last but not least, the qualitative and semi-quantitative knowledge represented by several regionalised conceptual models form a sound basis for inter-Platform comparisons, nationally, continentally and on the global scale. This is exemplified below for the case of Eisenwurzen LTSER Platform in Austria (Peterseil et al., Chap. 19 in this volume), where researchers have shown how a regional socio-ecological profile can facilitate the identification of system properties (e.g. relevant ecosystem services) as well as similarities with other socio-ecological systems.

17.4.1 Overview

The entire research community and several stakeholders were involved in at least one of the following steps extending over 3 years:

Step 1: Fuzzy cognitive mapping was used to develop an integrated view of key elements and their interactions (direction, strength), based on mindmaps of individual actors and stakeholders. The results of the cognitive mapping reflected a collective perception of the region, which then served as a primary input for parameterising an Integrated Science for Society and Environment (ISSE) model (Collins et al. 2007).

Step 2: Critical ecosystem services: Identification of the critical ES, direction of change, primary drivers of change, public awareness of the ES, and institution(s) that manage the ES.

Step 3: The **ISSE model** (Integrated Science for Society and the Environment): This framework has been proven to provide an excellent basis for interdisciplinary teams working in a region (Collins et al. 2007, 2011; Grove et al., Chap. 16 in this volume). As the Eisenwurzen Platform showed, an LTSER Platform is unlikely to conduct just one project covering all socioeconomic and ecological systems. More likely there will be several potential projects on defined interfaces between the socioeconomic and the ecological system. The framework accentuates the shortcomings of disciplinary sciences. With the model available to all participants, the "bigger picture" of the system becomes clearer and linkages can be drawn by the scientists between their fields and their work.

Step 4: Threshold interactions: Identification of threshold interactions between environmental and socioeconomic dynamics at multiple scales, and forecasting the effects of these interactions on ecosystem services and ecological resilience (Kinzig et al. 2006; Holling 2001).

Step 5: Use of the robust socio-ecological profile in other conceptual models (e.g. DPSIR) and comparative assessments.

Steps 2–4 were done in the frame of the Ecosystem Services Initiative (ESI) within the ILTER Network. The Millennium Ecosystem Assessment utilised an approach to quantify ecosystem services in order to understand the value of ecosystems to humans (MEA 2005). In a similar vein, the ILTER Science Committee commenced the ESI to develop and apply threshold interaction models for selected biomes across the world. The initiative includes ISSE, Critical Ecosystem Services and Threshold Interactions as models and approaches for the understanding and rating of ecosystem services (Shibata and Bourgeron 2011). These models were applied in LTSER Platforms and LTER Sites across Europe (Kiskunság, Hungary; Donana, Spain; Eisenwurzen, Austria; Gascogne, France; Leipzig-Halle, Germany; Uckermark, Germany; Lake Päijänne, Finland; Central Poland, Poland). A synthesis within and among biomes of culture-specific, socioeconomic dynamics leading to increases or decreases in resilience of ecosystems is still ongoing.

We now expand on each of these steps as applied in the case of Eisenwurzen LTSER Platform in Austria.

17.4.2 Step 1: Fuzzy Cognitive Mapping: Collecting Socio-ecological Data from Stakeholders

Fuzzy cognitive mapping is a participatory modelling approach which allows the depiction of causal relations between important elements of coupled society-nature systems as they are perceived by stakeholders. A cognitive map like a Fuzzy Cognitive Map describes a system by showing the central factors and their causal relations, represented by weighted arrows, as a *directed graph.* Fuzzy cognitive maps are drawn by the stakeholders in an interview setting. Maps of different stakeholders can be merged to gain a broader system view. Combined maps can also be used to run scenario-analysis (Kosko 1986; Özesmi and Özesmi 2004). From autumn 2007 to spring 2009, six case studies were conducted in different LTSER Platforms across Europe using Fuzzy Cognitive Mapping. In order to analyse the fuzzy cognitive maps a freely available software was developed (www.fcmapper.net). In the context of the study the LTSER Platforms proved to be excellent working environments for this purpose due to established communication structures and good access to stakeholders (Wildenberg et al. 2010).

Figure 17.4 shows a simplified FCM derived from two interviews in the Eisenwurzen LTSER Platform. If the 'area under intensive farming' increases, the 'income of farmers' will increase and 'biodiversity' is expected to decrease. On the other hand 'biodiversity' is influenced positively by a 'diverse landscape structure'

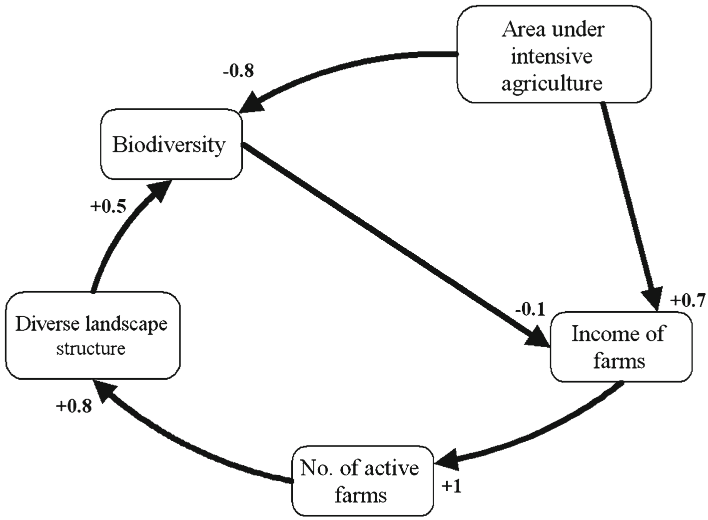

Fig. 17.4 Schematic fuzzy cognitive map derived from two interviews in the Eisenwurzen LTSER Platform – Austria

which itself depends on the 'number of active farmers'. The relatively weak link between 'biodiversity' and the 'income of farmers', which drives the 'number of farmers', reflects a low level of subsidies for using extensive farming techniques.

Experiences from using FCM in the LTSER Platform context showed that it is a promising explorative method for LTSER, as it depicts complex socio-ecological systems in terms of the perceptions and mind models offered by people living in an area. They represent a vital component in every linked human-nature system. Another strength of FCM is its interactive and social learning component and its ability to handle all kinds of knowledge systems, making it suitable for "mode 2 research" (Gibbons et al. 1994) and stakeholder involvement for conservation planning or educational purposes. In the case of Eisenwurzen, FCM contributed to the development of decision trees for an agent based model (Gaube and Haberl, Chap. 3 in this volume) and the conceptual models presented below.

Figures 17.5, 17.6, 17.7 and 17.8 are schematic representations of diverse conceptual models. All were parameterised for the Eisenwurzen LTSER Platform region to assist in organising, clarifying and identifying the important elements and feedbacks within the socio-ecological system of the montainous post-mining area (described in detail by Peterseil et al., Chap. 19 in this volume).

We selected one critical process in the region, a case study, as trigger to demonstrate the stepwise elaboration and structured description of elements and their interactions across the models.

Due to: (i) the decline of the iron producing industry with its high energy demand, historically served by timber, and current low timber prices and (ii) land abandonment caused by depopulation, forests have been continuously reclaiming the central

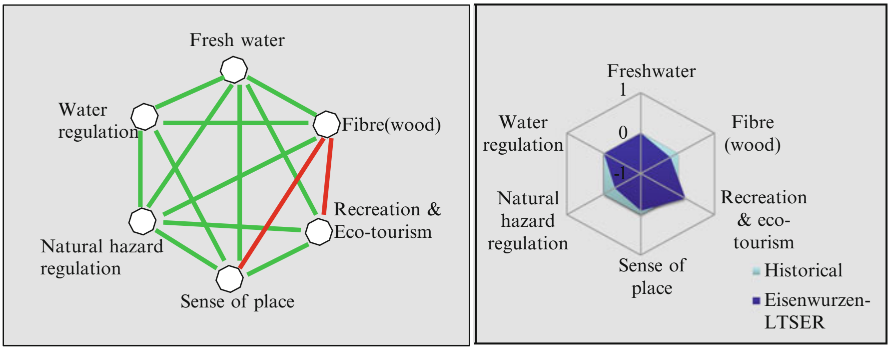

Fig. 17.5 Simplified model of the Critical Ecosystem Services of the Eisenwurzen LTSER Platform and their interaction *left*: *green* = positive, *red* = negative) and scenario of their future importance (*right*: light *blue* = historical situation, dark *blue* = current situation) (Austrian contribution to the ILTER Ecosystem Service Initiative)

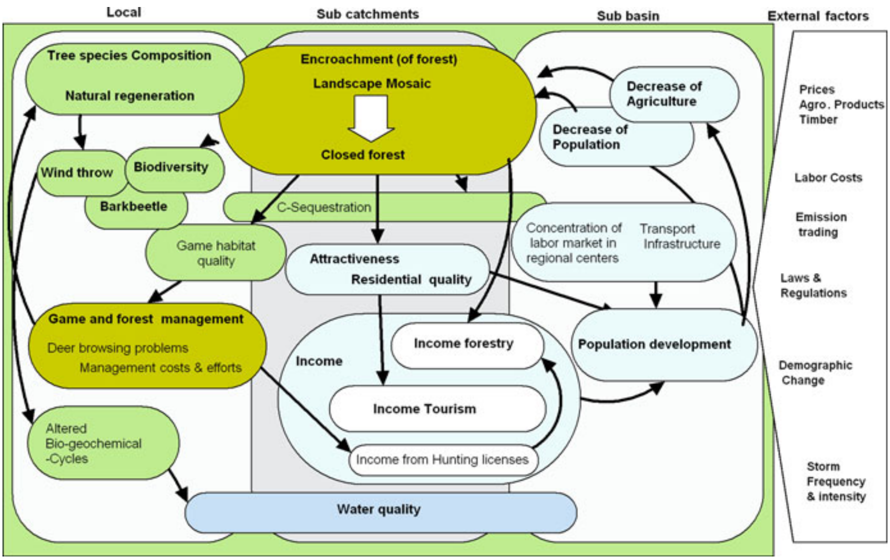

Fig. 17.6 Interactions of key elements and factors in the socio-ecological system across sectors (environment in *greens* and *blue*, economy and society in *white* and *grey*) and scales in the LTSER Eisenwurzen (Austrian contribution to the ILTER Ecosystem Service Initiative)

parts of the Eisenwurzen region since the nineteenth century. Relying on the scenic cultural landscape, tourism has become an important alternative source of income. However, closed forests reduce the beauty of the area as it is subjectively perceived by tourists and also give local inhabitants the impression of being "overgrown by forest", a situation which is interpreted as signifying loss of importance and marginalisation.

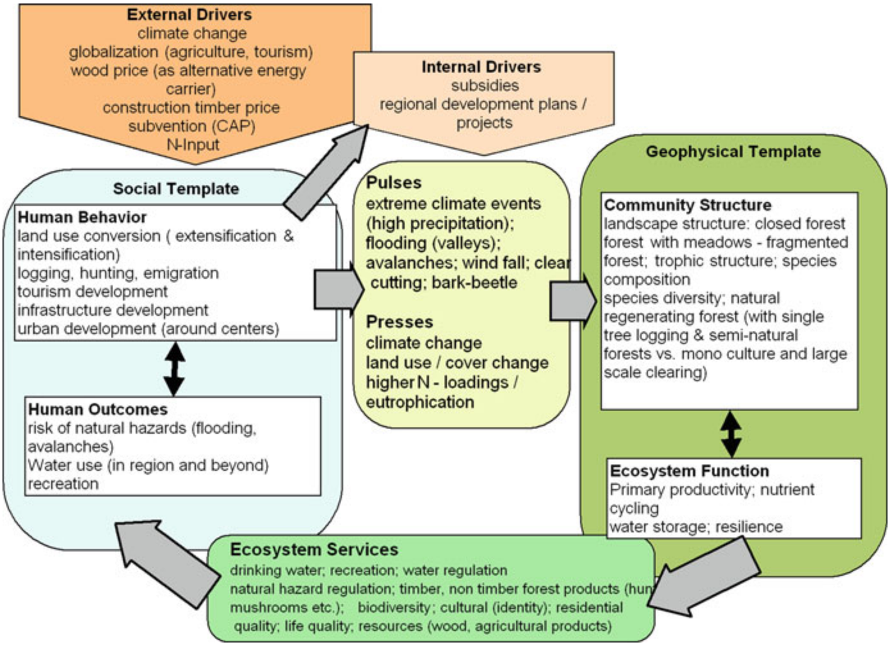

Fig. 17.7 Socio-ecological profile of the LTSER Eisenwurzen Platform according to the ISSE/PPD framework (Collins et al. 2007, 2011): The conceptual elements, described by Grove et al. (Chap. 16 in this volume) are parameterised based on comprehensive analyses combining disciplinary scientific expertise and primary stakeholders perception (Fuzzy Cognitive Mapping)

17.4.3 Step 2: Critical Ecosystem Services

Ecosystem Services (ES) are widely regarded by LTSER teams as excellent common currency for cross-Platform comparisons (Dick et al. 2012). ES are appropriate in several ways to trigger interactions in socio-ecological systems. They represent objects of concern to stakeholders, and they are the conceptual link in models between the human and the natural sphere (Costanza et al. 1997). Key ecosystem services or "Critical Ecosystem Services" of the Eisenwurzen region were identified and scenarios for their relative importance in the future were developed, *inter alia*, by the use of information on relative importance, form of interaction and stakeholder expectations for the future from the Fuzzy Cognitive Mapping in combination with interdisciplinary expert knowledge (see above).

In terms of our case study, we can identify the negative relations between fibre production and recreation and local identity (feeling at home) (Fig. 17.5, left). Competing ecosystem services and related concerns of the local population with respect to afforestation are clearly reflected in the right part of Fig. 17.5, showing that sustainable income is, in the future, expected from eco-tourism rather than from timber production (Gaube and Haberl, Chap. 3 in this volume)

The concept of ecosystem services can be used to link social and ecological systems into an integrated, multi-scaled socio-ecological system. In preparation for

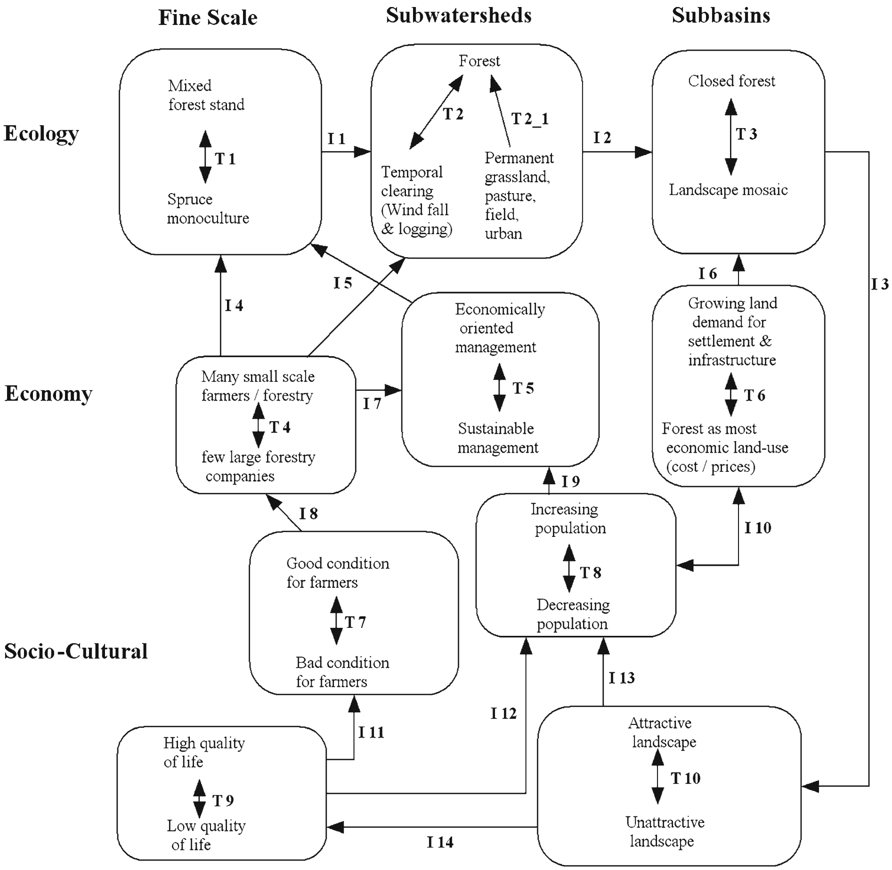

Fig.17.8 Thresholds (T) and their interactions (I) across sectors (environment, economy, society) and scales in the Eisenwurzen LTSER region (Austrian contribution to the ILTER Ecosystem Service Initiative according to Kinzig et al. (2006))

regionalising the ISSE model for the Eisenwurzen region, the interactions of key elements and factors in the socio-ecological system were mapped across sectors. The interplay described in our **case study** between forest encroachment, residential quality and income from tourism and forestry is again evident in the upper and central part of Fig. 17.6, but is now embedded in the broader context of human-nature interactions of the region. External drivers such as demographic change and transport infrastructure become visible (to the right).

17.4.4 Step 3: ISSE/PPD Feedback Loop Model

The ISSE (Integrative Science for Society and Environment) feedback loop model framework was developed in 2007 under the US-LTER strategic research initiative

"Integrative Science for Society and the Environment" (ISSE, Collins et al. 2007) and further developed into the PPD (Pulse and Pressure Dynamics) model (Collins et al. 2011). Graphs and a detailed theoretical overview are given by Grove et al. (Chap. 16 in this volume). The framework identifies two fundamental linkages between social and ecological systems. On the one hand, the social system, encapsulating political, economic and demographic trends among others, has a direct impact on ecological systems via presses (steady long-term changes, such as agricultural and urban expansion) and pulses (profound, non-routine changes, like wildfires and oil spills). On the other hand, modifications of ecological systems result in a change in the amount and types of ecosystem services provided to human societies. External factors, such as natural climate cycles, are also driving change in the ecological systems and therefore ecosystem services.

Regarding the case study, the elements presented needed to be assigned to the above categories. As seen in Fig. 17.7, land cover such as closed forests belong to the ecosystem structure (biophysical template to the left) providing the ecosystem services of timber production and recreation (bottom). The social template on the left contains the use of the services, including generation of income from tourism and creation of infrastructure, such as streets for commuting. These contribute to the disturbance regimes (pulses and presses) in the centre. Depopulation and changes in land use act as long-term presses that impact upon biophysical components such as land cover, which closes the loop. External drivers, such as market prices for timber and steel, seen above complete the ISSE modelling of the case study.

17.4.5 Step 4: Threshold Interactions

Even though ISSE is a feedback loop model, it still provides a static picture of the socio-ecological system. Socio-ecological profiling, however, aims at identifying potentially irreversible system alterations. Most accounts of thresholds between alternate regimes involve a single, dominant shift defined by one, often slowly changing variable in an ecosystem. Kinzig et al. (2006) develop a "general model" of threshold interactions in socio-ecological systems across spatial scales. Their generalized model of threshold interactions as parameterised for the Eisenwurzen region (Fig.17.8. 8) shows all possible combinations of domains and scales and the possible interactions between regime shifts for various domain-scale combinations.

Revisiting the case study, we identify the transition between closed forest and a landscape mosaic on the top right (box T 3). This interacts (arrow I 3 to the right) with the threshold between attractive and unattractive landscape (T 10, bottom right) impacting (I 14) upon quality of life (T 9) at the bottom. Population density (T 8, second row from bottom) drives timber use and land cover (T 5 and T 6) above. The generic picture in Fig. 17.5 has been detailed and structured to a level enabling systematic documentation and comparisons with other systems. Moreover, strengths of interactions and critical system conditions (thresholds) can be specified based on empirical regional knowledge (e.g. the critical level of forest coverage).

The elaboration of the Eisenwurzen LTSER socio-ecological profile represented a cornerstone in developing common ground for the LTSER community and regional stakeholders. Individual project leaders acknowledged the framework's value in anchoring their respective projects within the system context and affirming and reinforcing the social and policy relevance of the work. We stress that these models were either commandeered by or developed specifically to suit the research needs of LTSER. In this way, LTSER has served as a laboratory for the increasingly emphatic demand for societally relevant ecological research.

17.5 Implementation of Individual LTSER Platforms – Process and Experiences

Although the LTSER concept is still in its infancy, the European LTER network has accrued significant experience over the past decade in setting up LTSER Platforms. In this section, we present best-practice guidelines for establishing Platforms, based on the accumulating experience of Platform management teams across Europe.

Selecting a suitable region for the LTSER Platform is recommended as a first step, and such decisions are often made due to practical, rather than theoretical considerations (outlined in previous sections). Historically, the development of LTER-Europe was, at the request of the European Commission, to be based on existing infrastructure wherever possible. So it was logical that the first step in defining potential areas for LTSER capitalised on inventories of existing infrastructures at the national level such as LTER Sites, well-equipped sites of ecosystem monitoring schemes, protected areas, National Parks, Biosphere Reserves etc. carrying out traditional ecosystem research in habitats typical for the region (Mirtl and Krauze 2007; Mirtl et al. 2009, Mirtl 2010). LTSER Platforms are often, but not exclusively, established by building on existing LTER Sites, thus benefiting from the data legacy and associated facilities.

Selection criteria for appropriate LTSER Platform regions beyond the infrastructural component are:

- Well-documented land-use history, cultural and socioeconomic unity;
- Active, well-established institutions (research institutions, non-governmental agencies, private sector, and government agencies);
- Research covering ecosystem services of relevance for the region;
- Research on alternative management practices;
- Availability of reference areas (undisturbed natural habitat(s), or at least the most undisturbed possible, typical for the region);
- Coverage of socio-ecological gradients of the biogeographical regions;
- Interest among local stakeholders, government and policy makers for policy-oriented research;
- Eventual closure of network gaps on the European scale (see below).

Once potential localities for Platforms have been identified, further pre-selection ought to consider (i) the LTER-Europe criteria/descriptors for LTSER Platforms (comprising aspects of infrastructure, data and data availability, access to key actor groups and streamlined activities) (LTER-Europe website, key documents), (ii) the scientific interests and strengths of the national and local research communities and (iii) the importance of the environmental zone which the area represents (pressures, conflicts, ecosystem services). From the European perspective, national networks are expected to help improve the coverage of the network as far as possible and eventually all environmental zones (EnS) and socio-ecological zones (LTER Socio-Ecological Regions) should be represented by LTER Sites and LTSER Platforms. The coverage of European LTER facilities across 48 socio-ecological strata was tested by Metzger et al. (2010) and gaps identified. Each national decision on a new Platform enables the possible closure of such gaps in the network.

After the location of a new LTSER Platform is selected, the boundaries of the Platform region must be delineated. Because Platforms are to capture socio-ecological systems and their interactions, social (as well as ecological) boundaries must be considered. Therefore, Platforms may be delineated by political/administrative borders or by other existing borders (e.g. biospheres or national parks). Alternatively, the boundaries may be left only vaguely determined, and allow for individual research questions to determine boundaries.

In order to ensure the long-term administrative and economic stability of the Platform, a consortium of major regional research and policy institutions (e.g. universities, government agencies, major NGOs) often form the core group promoting and implementing LTSER Platforms. As their mission usually stretches over decades, they offer ideal settings for hosting LTSER Platform management. Ideally the Platform management is funded by the main beneficiaries of its services. Through promotional campaigns, workshops, and meetings with individuals and institutions, the LTSER concept and goals are advertised in relevant communities in order to invite interested parties and expand the LTSER Platform consortium. A Memorandum of Understanding (MoU) is written with the input of the growing management team and consortium, which should address the scientific and practical goals, governance structure and data policy of the Platform. Stakeholders may receive a feeling of empowerment and “buy-in” if they can contribute to the memorandum. This document will be useful, not only to clarify positions and aims, but also to lobby for the Platforms. The MoU will also guide the LTSER Platform management in setting up and providing specific services as specified in the document.

Spatial delineation will also drive data collection. As empirical socio-ecological research capitalises on data and information from different realms, these data need to refer to the same spatial units. In most cases the best available economic and census data are provided with a resolution at the level of municipalities. However, when moving from LTER Sites to LTSER Platforms, problems arise when ecological and social borders do not match. The Platforms, with boundaries also delineated by research questions and policy needs, provide a flexible framework to deal with this problem.

Defining the goals and scope of the LTSER Platform is a most crucial phase in the establishment of the Platform. While the entire process should be flexible and iterative, a careful set of research goals will assist the LTSER team in remaining focused on their objective, as well as in expressing themselves articulately to potential partners, funders and stakeholders. The LTSER team should match goals to the capacity of their team – academically, monetarily and taking uncertainties into account. A set of "meta-goals" will supplement and frame the local goals. These meta-goals shall serve as a common denominator for the comparison of data across LTSER Platforms. Meta-goals will be informed by the recommendations of the LTER-Europe Expert Panel Science Strategy and the international LTSER research agenda. This is crucial in the context of being part of a network, and for building the foundation for harmonisation of research activities and comparability of experiences and research results across regions. Two concepts important for LTSER goal-setting are that LTSER research programmes should adhere to the principles of sustainability science, and that LTSER research should be conducted using a common conceptual model (see previous sections).

There are two basic approaches in implementing LTSER Platforms:

- Strategically managed and all inclusive: as outlined above, especially in cases of high complexity in terms of Platform size, number of participating institutions, actor groups, etc., the inclusion of stakeholders from the beginning is important for developing a user-oriented research agenda. This approach requires substantial resources for co-ordination and central services.
- Project-based, evolutionary: An alternative approach is to start from the bottom in a project-oriented and iterative way. Here mainly research institutions develop a research strategy, plan research activities jointly and, if possible, build the monitoring infrastructure necessary for the planned research. This approach is particularly beneficial where innovations in research approaches are required. One risk of a top-down approach dominated by one group, e.g. traditional ecological research is that the framing of the research might not open space and build motivation for other disciplines to enter into LTSER research.

The LTSER Platforms established so far vary considerably in composition, size and targets. Whereas some follow an integrated regional approach considering the entire policy cycle from user-oriented knowledge generation to management and political measures, others are rather clusters of site-based research concentrated in a specific area. There is clear evidence of a trend towards integrated approaches. As pointed out earlier, only structured – and where necessary, formalised – access to key actor groups allows for the identification of research demands as regionally perceived and for the dissemination and implementation in practice of research findings.

17.6 LTSER Platforms Across Europe – Status of the LTER-Europe Network on the Continental Scale

Although implementing even a single LTSER Platform is a complex challenge, the European ambition was to build place-based socio-ecological research capacity in the European Research Area, where each of the major socio-ecological systems of the European continent (see below) would be represented by at least one LTSER

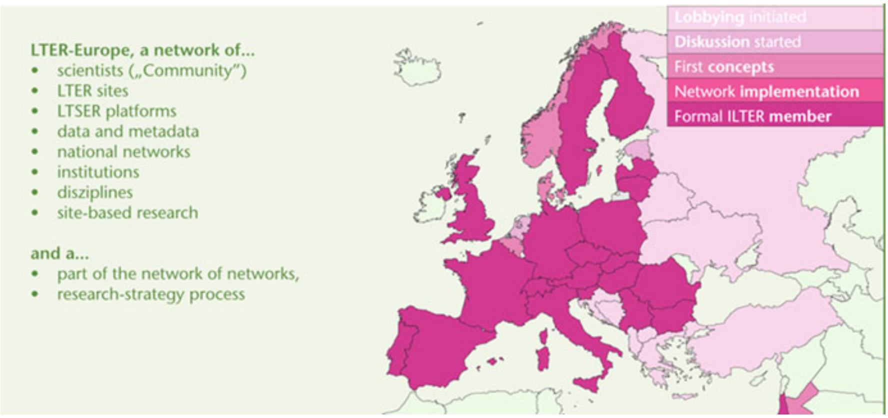

Fig. 17.9 Geopolitical coverage of LTER-Europe (as of 2010; Mirtl et al. 2010)

Platform in order to exemplarily investigate socio-ecological interactions. LTER-Europe currently comprises formal national networks in 21 countries and emerging networks in about 5 countries (Fig. 17.9). The physical network consists of about 400 LTER Sites and 31 LTSER Platforms (as of 2010).

For the LTER Socio-Ecological Stratification (LTER-SER, Metzger et al. 2010), the European environmental zones (EnS) used in the Millennium Assessment (Metzger et al. 2005; Jongman et al. 2006) were combined with a newly developed socioeconomic stratification based on an economic density indicator. This enabled the LTER team to overcome both the limitations in data availability at the 1 km^2 resolution across Europe and in distortions caused by using administrative regions (NUTS 2011). The resulting 48 socio-ecological systems are reflected in the map of Europe depicted below in Fig. 17.10.

In recent years, the LTSER component of LTER-Europe has developed quickly; In 2008, only 23 LTSER Platforms (5 as emerging) were registered in the LTER-Europe Infobase (LTER-Europe website/information management). The 31 LTSER Platforms that are now operating are spread over 17 countries (Fig. 17.10) and cover all 48 socio-ecological regions (some Platforms are big enough to contain more than one socio-ecological region). A gap analysis in 2008 showed weak coverage in the Atlantic North because the few remaining countries without LTER were concentrated in this area (Belgium to Norway, see Fig. 17.9). Another gap in the Mediterranean South has started to close with the strong LTSER involvement of Israel. In addition, desert environments are now included through LTSER Platforms in Jordan (emerging network) and Israel.

According to the rules and governance of LTER-Europe, the national LTER networks are responsible for choosing the LTER Sites and LTSER Platforms in their respective countries. LTER-Europe provides a framework to assist in national network building and decision-making. Under the auspices of ALTER-Net, a set of criteria for LTER networks, LTER Sites and LTSER Platforms was developed in 2005 and formally adopted in 2008 (LTER-Europe website/key documents). Criteria

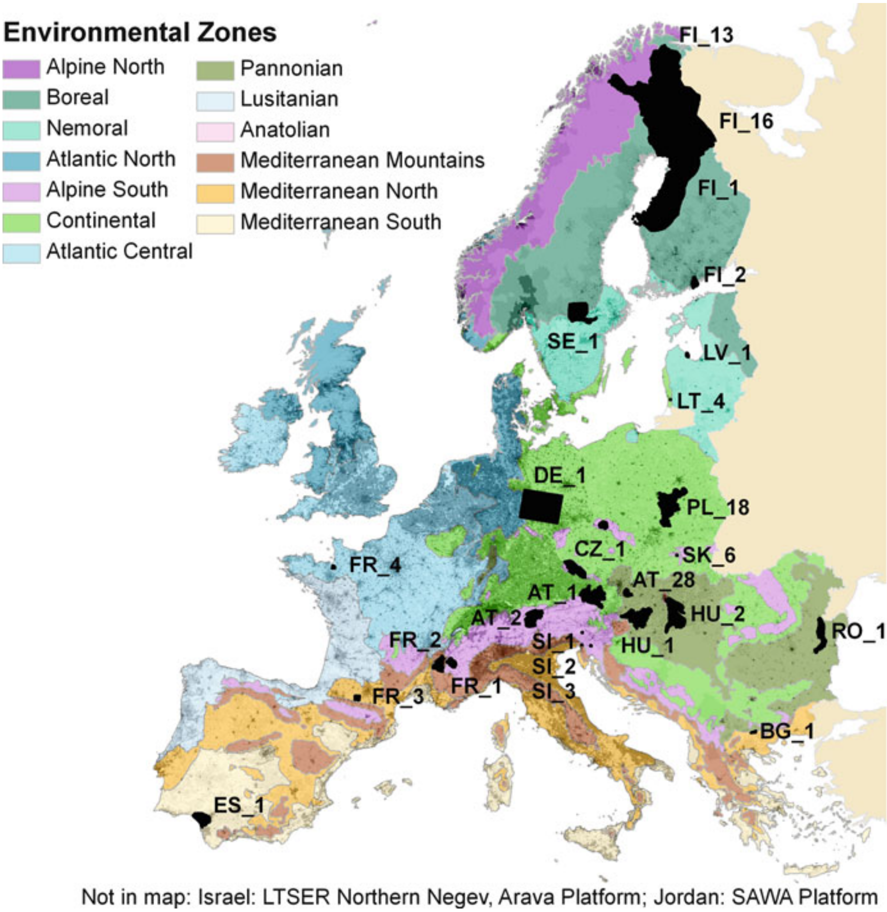

Fig. 17.10 Location of 31 European LTSER Platforms in 2010 (including five preliminary Platforms). The map reflects the 48 socio-ecological systems of Europe (Metzger et al. 2010). Environmental zones are colour-coded. The brightness of each colour varies according to the economic density, varying between < 0.1 Mio €/km² (lightest) and > 0.1 Mio €/km² (darkest). The Platform labels are the unique LTER-Europe site codes. According to these site codes, details for each Platform can be found in Table 17.1

are continuously updated according to accumulated experiences on feasibility and identified weaknesses. In the case of LTSER Platforms and given the early stage of the application of the LTSER concept, these "criteria" have so far been applied as "descriptors", supporting comparative description of LTSER Platforms rather than as hard selection criteria.

LTER-Europe also provides cross-country analyses to promote decisions that optimise the division of tasks within the European Research Area. LTSER- and IDR-issues within LTER-Europe are governed by the Expert Panel on LTSER (www.lter-europe.net, Mirtl et al. 2009).

Table 17.1 Overview of European LTSER Platforms, status as of 2010. The labels of platforms in Fig. 17.10 refer to the column "Site_Code" in this table

LTER_ Europe_ Site_Code	LTSER Platform name	Country	Biogeographic region	Ecosystem type	Size km^2
AT_001	LTSER Platform Eisenwurzen (EW)	Austria	Alpine	Forest	5,780
AT_002	LTSER Platform Tyrolean Alps (THA)	Austria	Alpine	Montane	3,689
AT_028	LTSER Neusiedler See-Seewinkel	Austria	Pannonian	Fresh water	634
BG_002	Belasitsa	Bulgaria	Sub-mediterranean	Forest	111
CZ_001	LTSER Silva Gabreta (LTSER Silva Gabreta)	Czech Republic	Continental	Temperate forest	3,337
CZ_006	LTSER Krkonose/ Karkonosze (LTSER Krkonoše/Karkonosze)	Czech Republic	Continental	–	871
FI_001	Bothnian Bay LTSER Platform	Finland	Boreal	Coastal	58,439
FI_002	Helsinki Metropolitan Area	Finland	Boreal	Coastal	879
FI_008	Northern LTSER Platform	Finland	Boreal	Forest	118,656
FI_013	Kilpisjärvi LTSER	Finland	Alpine	–	3,691
FI_016	Kuusamo LTSER	Finland	Boral	–	5,790
FR_001	Alpes-Oisans	France	Alpine	Montane	1,037
FR_002	Alpes-Vercors	France	Mediterranean	Montane	1,890
FR_003	Côteaux de Gascogne	France	Atlantic	Agriculture	441
FR_004	Pleine-Fougères	France	Atlantic	Agriculture	132
DE_001	LTSER Leipzig-Hall	Germany	Continental	Fresh water	22,781
HU_001	Balaton LTER	Hungary	Pannonian	NONE	5,767
HU_003	KISKUN LTER	Hungary	Pannonian	Praire	7,270
IL_005	LTSER Northern Negev	Israel	Mediterranean	Desert	–
IL_015	Araval Platform (ARV)	Israel	Mediterranean	Desert	981
JO_001	SAWA Platform	Jordan	Mediterranean	Desert	–
LV_001	LTSER Engure	Latvia	Boreonemoral	–	178
LT_004	Lithuanian Coastal Site (LT-04 Nagliai, Curonian Spit NP)	Lithuania	Boreal	Coastal	–
PL_018	UNESCO/UNEP the Pilica River Demonstration Site	Poland	Continental	–	9,256
RO_001	Danube Delta Biosphere Reserve	Romania	Steppic	Wetland	3,120
SK_006	Tatra National Park	Slovakia	Alpine	Forest	–
SI_001	Kras	Slovenia	Continental	Montane	–
SI_002	Karst in the Ljubljanica River Basin	Slovenia	Continental	Montane	–
SI_003	Alpine Karst	Slovenia	Alpine	Montane	–
ES_001	Doñana/Huelva-Sevilla (ES-SNE)	Spain	Mediterranean	Wetland	2,732
SE_001	Nora LTSER	Sweden	Boreal	–	6,648

17.7 Lessons Learned and Outlook

By establishing LTSER Platforms in 17 European countries, both implementation approaches, "strategically managed all inclusive" and "project based evolutionary bottom up", could be tested. Here we summarise experiences as well as critical points and give recommendations. Figure 17.11 shows examples of conflicting priorities and purposes that LTSER Platforms are facing. Implementation of LTSER Platforms has to navigate between these poles.

LTSER Platforms represent a huge potential for both science and practice. The large number of Platform-specific projects and publications, also reported by several authors in this volume provide evidence of how this potential has been used scientifically in spite of the short operating time of LTSER Platforms to date. However, translating knowledge into practice presents a continuing, formidable challenge that is discussed further below.

So far, no comparable network has been set up to regionalise socio-ecological research and involve infrastructure, interdisciplinary research and regional actors and stakeholders in a collective process. However, setting up such a complex system is time- and resource-demanding. The complete "production cycle" of typical LTSER Platform products, from prioritising research questions to getting a research project accepted, producing the scientific findings, translating them into applicable measures, disseminating these recommendations in accompanying implementation projects and assessing the effects in terms of increased sustainability of ecosystem service use, might stretch over a decade. The more complex regions and questions

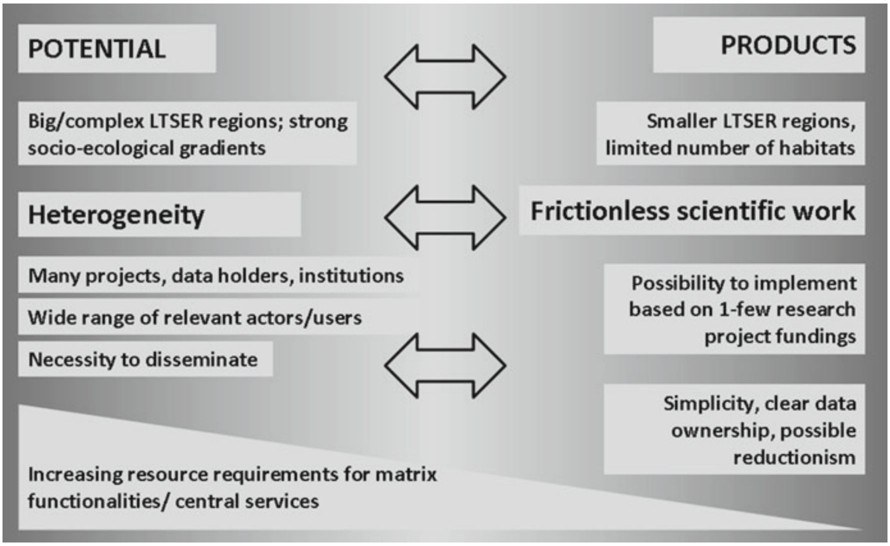

Fig. 17.11 Conflicting priorities in LTSER Platform implementation. *Left side*: Cases requiring complex approaches in creating the framework for socio-ecological research. *Right side*: Less demand for matrix functionalities and supporting services due to simpler settings

are, the longer the latency period for tangible "products", if the successful establishment and operation of LTSER Platforms in itself is not accepted as a "product" in terms of increased scientific entropy.

Big and/or complex LTSER Platform regions featuring a wide variety of habitats, land-use forms, complementary stakeholders and use conflicts pose numerous interesting research questions. On the other hand, complexity hampers (i) quick progress in setting up a complete Platform communication space (comprising all relevant actors), (ii) agreement on the research framework and (iii) smooth division of tasks (e.g. competing research teams within the Platform). In smaller LTSER Platform regions, which cover less internal environmental, social and economic gradients, key problems might be more evident and could be tackled by one or a few institutions well integrated in the region and holding existing data without substantial additional efforts to establish a LTSER Platform.

The trade-off between frictionless scientific work and coping with heterogeneity could not be more evident than in LTSER Platforms:

- Up to a certain complexity of interdisciplinary research questions, the number of institutions and a few research projects, overhead costs and required central services can be kept to a minimum. Responsible and accessible funding instruments are clearer when questions are less complex and interdisciplinary. There are other advantages to smaller Platform teams. For example, established teams in one or a few institutions will most probably already have an interdisciplinary working culture established, reducing efforts needed to achieve a common language across disciplinarily specialised institutions. When requisite data are mainly kept within one institution, necessary information management will be broadly covered by the general institutional data infrastructure, including data use rights. If the research institutions involved are located in or closely connected to the concerned region, the required stakeholder interfaces might be few and may have already been developed by the institution, including communication spaces and mechanisms for information dissemination.
- With increasing heterogeneity, "small solutions" hit the wall due to increasing demand for services (actor analysis, stakeholder involvement, establishment of a transdisciplinary communication space, development of interdisciplinary research teams across institutional borders, data management and integration). There is a threshold size of LTSER Platforms for covering regional processes (e.g. commuting), heterogeneity of habitats, land use and related management practices. Large Platforms and a lack of substantial funding may lead to a lack of projects covering the entire region and the risk of scattered activities across scales, hampering possibilities of upscaling, downscaling and extrapolation. Research findings might not fit the scale of management measures and/or the level of local, sub-regional and regional decision-making.

The multiple experiences in setting up LTSER Platforms, with their pronounced heterogeneity of initial conditions across Platform regions and countries, suggest that no general formula regarding the "right" way to initiate a platform can be provided at this stage. Nevertheless, mid-term implications of chosen approaches and bottlenecks have become evident and merit precautionary advice and re-assessment of how LTSER Platforms are organised, managed and communicated:

- LTSER seems to be plausible and attractive to many stakeholders, but also has a tendency to create unrealistic expectations in terms of delivery time. Moreover, expectations of what LTSER can and can't deliver can vary wildly depending on the stakeholder. Regional development managers might after 2–3 years want to assess the relevance of project findings for sustainable regional development and the cost-efficiency of proposed alternative management practices. Provincial governments could after 2 years of work request a report on regional impact as a precondition for the continuation of funding, whereas a village mayor – inspired by a facilitated LTSER workshop with stakeholders – might expect customised delivery of results supporting the application for an additional bus stop in the village (compilation and analysis of related national statistics), and might ask in disappointment why he cannot find this on the Platform website.
- If performance criteria focus solely on the usual scientific output (publications, impact points per year) from the beginning, the project-based approach will support a traditional academic work routine. Only by considering the innovation and added values such as relevance for management, focus on stakeholder concerns, or open access to Platform data, will long-term, dependable support of the LTSER approach be assured. Because LTSER is not "traditional" science, Platform managers are encouraged to establish funding mechanisms and calls for tender specifically customised for the unique and innovative approach and goals of LTSER. Funding mechanisms must consider, for example, the intrinsic time lag between project implementation and the point at which society and – in the long term – science will benefit. Such a lag exists due to the unique combinations of expertise and data inherent in long-term, interdisciplinary socio-ecological research.
- Universities and other academic institutions have neither the resources nor the scope by themselves to provide Platform management and services. Neither do individual research projects foresee being able to pay for such services. Therefore, formalisation and institutionalisation are to some extent unavoidable in order to secure operation in the long term.
- The transdisciplinary component of LTSER requires a special skills portfolio for a wide range of non-scientific activities, which need to be carried out by specialists educated in communication, facilitation, and public relations. In LTSER, Platform scientists typically overstretch themselves with non-scientific work such as dissemination beyond scientific publishing, translation, production of stakeholder-specific material, participatory activities and lobbying beyond research proposals. Particularly idealistic and visionary people are therefore prone to self-exploitation, unrealistic planning assumptions and overload.
- Efforts in team building, integration between disciplines and institutions are hampered by competition between scientists applying for projects in the same funding mechanisms. Moreover, natural scientists or sociologists might perceive themselves as not receiving their due credit in interdisciplinary research, both in

terms of conceptual ownership and funding. This highlights the need for a truly open, inclusive and respectful working environment.

In conclusion, we offer the following abbreviated advice to the LTSER novice:

- Avoid unrealistic expectations with regard to both research and management goals and what topics can be successfully covered at which scale;
- Obtain a reliable picture of available funding for co-ordinating LTSER Platforms in the mid- to long-term to choose the most appropriate implementation model: What level of central services can be maintained over the long term?;
- Ensure that there is a critical mass of and balance between central services (e.g. data management) and the number of supported research projects ("products");
- Formalisation and institutionalisation are greatly assisted through the use of existing structures in the region (communication, dissemination);
- It is helpful to involve institutions with interdisciplinary teams that are already established (easier to achieve internally than across formal institutional borders due to common institutional language) – or very few flagship institutions with preferably one located in the region;
- Broaden the community and actively involve specialists in the required disciplines (e.g. allow a sociologist to develop the sociological component of LTSER). It is crucial not to assume that an ecologist, for example, can adequately apply the research and conceptual tools of an anthropologist. Respect all the participants in an interdisciplinary collaboration;
- Draw the line: you cannot please everyone (or meet their expectations) all the time;
- Co-operate internationally, taking advantage of experiences, tools and material developed in other LTSER Platforms;
- Regionalisation and transdisciplinarity do not work without toeholds in the region: identify key multipliers open to LTSER and involve scientists with personal connections to the region.

The identified weaknesses provide evidence that the research environment, performance indicators and scientific reward system still fail to provide the necessary framework for producing knowledge according to societal and political needs at the necessary pace. The interdisciplinary Programme on Ecosystem Change and Society (PECS) of the International Council of Science (ICSU website) addresses "Place-Based Long-Term Social-Ecological Research" as key to investigate society-nature interactions (ICSU 2010, Programme on ecosystem change and society (PECS) – A 10-year research initiative of ICSU and UNESCO – Workplan 2010: draft technical paper, Personal communication of PECS Chair, Steve Carpenter). So far, LTSER Platforms and their interdisciplinary teams are the only European test case for regionalised or place-based LTSER at the level of a continental network.

The LTSER concept was born in the midst of two profound upheavals. The first is the rapidly changing global environment as a result of unprecedented large human populations consuming an unprecedented amount of the earth's resources. The second, inspired in part by the first, is a major scientific paradigm shift away from traditional disciplinary approaches to environmental problem solving to an interdisciplinary, place-based science. Place-based LTSER Platforms confront global environmental challenges at the local and regional levels. They do so without compromising academic standards, but may be contributing to paradigm shifts in some areas. Not only does LTSER advance the state of knowledge, but it produces knowledge that matters to people and that is then translated into tangible environmental and natural resource policies for local and regional implementation. With less than a decade of practical experience, LTSER Platforms are emerging as living laboratories for socio-ecological research and a major contributor of policy/management relevant knowledge.

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