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LONG-TERM SOCIO- ECOLOGICAL RESEARCH PLATFORMS: A BEST PRACTICES GUIDE BOOK

A product of eLTER Horizon 2020; Deliverable 10.3

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June, 2019

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Preface – Why a Best Practices Manual for LTSER?

The Best Practices Manual for Long-Term Socio-Ecological Research (LTSER) platforms is the product of a four-year audit of existing European LTSER Platforms within the framework of the Horizon 2020 (INFRAIA 2014-2015) sponsored research infrastructure project “Integrated European Long-Term Ecosystem & Socio-Ecological Research Infrastructure (eLTER H2020)”. In particular, Work Package 10, Task 3 (WP10.3) called for “Integration of ecosystem, social and economic data and strategic recommendations for the socio-ecological component of the LTER infrastructure”. This tasked the research team to “verify the efficacy of multiple LTSER platforms as a transdisciplinary research infrastructure” through (1) “meta-analysis of results from a network of LTSER Platforms [to determine if they] can deliver data and information relevant to problem-solving; (2) “screen site metadata for a small number of the most advanced LTSER Platforms provided through VA”; (3) “perform exemplary integrated diagnoses of green/blue infrastructure functionality and indicators of human well-being across the selected platforms”; and (4) provide “practical recommendations for LTSER Platforms, targeted at strengthening the convergence of LTSER Platforms as use case areas for socio-ecological research across Europe.”

The Deliverable of 10.3 is a “manual for (1) priority data to be provided by LTSER Platforms as a network level service and (2) transdisciplinary research tool-box supporting convergence of LTSER Platforms as use case areas for socio-ecological research across Europe.” Thus, both data collection about socio-ecological systems and how data can be used in management and governance are stressed.

In order to meet these objectives, and provide the necessary foundation for building a “Best Practices Manual”, a variety of comprehensive studies were conducted (most of which have already been published in peer-reviewed journals – see below) and a workshop for LTSER platform managers was held (Kibbutz Ketura, Israel, 2018). The Best Practices Manual relies on the insights derived from these studies and the protocol from the LTSER workshop, all integrated with recommendations of the previous “Best Practices” manual



Figure 1: Intended audiences for the LTSER Best Practices Manual

produced within LTER-Europe (Orenstein, Frenzel, and Neuner 2009) following an LTSER Workshop in Sumava, Czech Republic in 2009.

As such, there are three intended audiences for this report (Figure 1). The first two come from within the LTER-Europe and broader International LTER (ILTER) communities. They are the on-the-ground research and management teams within LTSER platforms, and the central administrating body of LTER-Europe and ILTER (Figure 2). While these two groups frequently overlap, particularly with regard to the scientific research staff of platforms, who also hold positions within the national, continental and international networks, much of our central message throughout the manual refers to various points of friction between bottom-up

expectations and capacities, and top-down expectations for network harmonization. Thus “Best Practices” constantly navigate between these expectations to create and maintain productive research platforms, which, when viewed as a network, can provide all the expected benefits of an international network. The third group includes all interested individuals and groups engaged in transdisciplinary, policy-oriented research. LTSER is just one example of a growing global trend of research oriented towards resolving societal challenges by integrating public stakeholders and a broad range of disciplinary expertise. This document is also for researchers, policymakers and other stakeholders engaged in applied research towards addressing environmental challenges, in hopes that the accumulated wisdom arising from LTER network efforts can also help guide practitioners and researchers to inclusive, scientifically advanced and policy-relevant transdisciplinary, socio-ecological work.

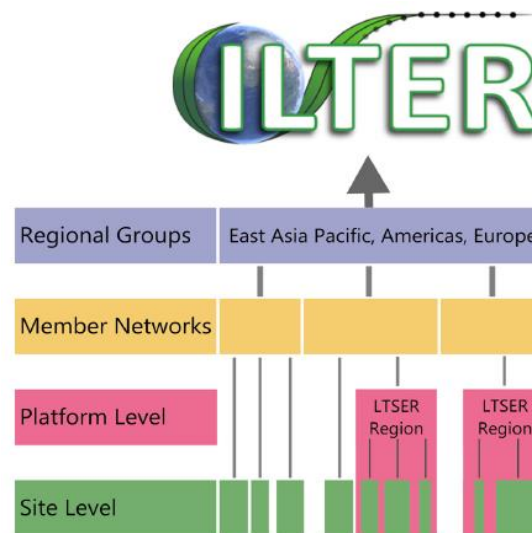


Figure 2: Hierarchical organizational structure of International LTER (from Mirtl et al. 2018)

What is transdisciplinary research and why do we need it?

Transdisciplinary research in general, and LTSER in particular, are needed to engage diverse stakeholders in sustainability research, to use and apply diverse forms of knowledge towards solving complex sustainability challenges, and to produce long-term, policy relevant scientific data and knowledge (Figure 3).

The advent of the Anthropocene, a geological age in which human activity is considered the most predominant driver of regional and global change, is accompanied by Grand Environmental Challenges. These include anthropogenic climate change, biodiversity

loss, nitrogen loading and unsustainable resource use, all of which threaten continued human well-being on the planet. The imperfect ability of policy, governance and management to adequately address these challenges has led scientists and policy makers to the conclusion that a new approach to environmental problem solving is demanded. Such an approach is predicated on the understanding that, in order to be effective, research must be conducted as a collaborative, iterative and reflective process that engages and exploits multiple forms of disciplinary and stakeholder knowledge. This approach is known as transdisciplinarity.

Transdisciplinarity is distinguished from multi- and interdisciplinary approaches to scientific problem solving in that it transcends disciplinary boundaries and raises new questions and possibilities that, its advocates suggest, could not have been raised by a single discipline, nor by a cross-disciplinary effort lacking coordination, integration, and close communication in a problem-solving context (Klein 2010). It is characterized by its problem-solving orientation, its broad and pluralistic approach to incorporating multiple forms of knowledge that different actors bring to an issue, its inclusivity and integration of these knowledge sources, and its iterative and reflexive nature. Transdisciplinarity connotes a more comprehensive team, higher standards for knowledge integration, and cooperation with non-academic stakeholders, thereby requiring sophisticated team communication and knowledge-sharing (Angelstam et al. 2013; Jahn, Bergmann, and Keil 2012; Klein 2008; Pohl and Hirsch Hadorn 2008).

LTER-Europe, through its development of the Long-Term Socio-Ecological Research (LTSER) Platform, uses the term “transdisciplinarity” to emphasize their mission to address complex, real-world problems, encourage meaningful collaborations, particularly between academic researchers and non-academics, and encourage a pluralistic approach to adapting diverse methodologies for research and problem solving. LTER-Europe also considers that effective communication and translation of knowledge across the science-policy interface and an understanding of how knowledge and policy play out to create social and ecological facts on the ground are needed. The adoption of a socio-ecological research framework within LTER-Europe has occurred in parallel with a transition occurring in other research venues, institutions, networks and initiatives. Over the past several decades, there have been broad trends within academia and within environmental policy and management towards interdisciplinary and transdisciplinary research (e.g., integrating non-academic local knowledge). This trend to integrate a wider base of knowledge offers conceptual and practical advances (Orenstein and Shach-Pinsley 2017; Singh et al. 2013) and is becoming mainstream in European funding (e.g., European Innovation Partnerships). Such trends have also been widespread among environmental research networks, such as, for example, the Community Conservation Research Network (based in Canada), Future Earth (global, funded in part by the UN), the Resilience Alliance (Stockholm, Sweden), the Institute for Social-Ecological Research (ISOE) (Frankfurt, Germany), and the Program on Ecosystem

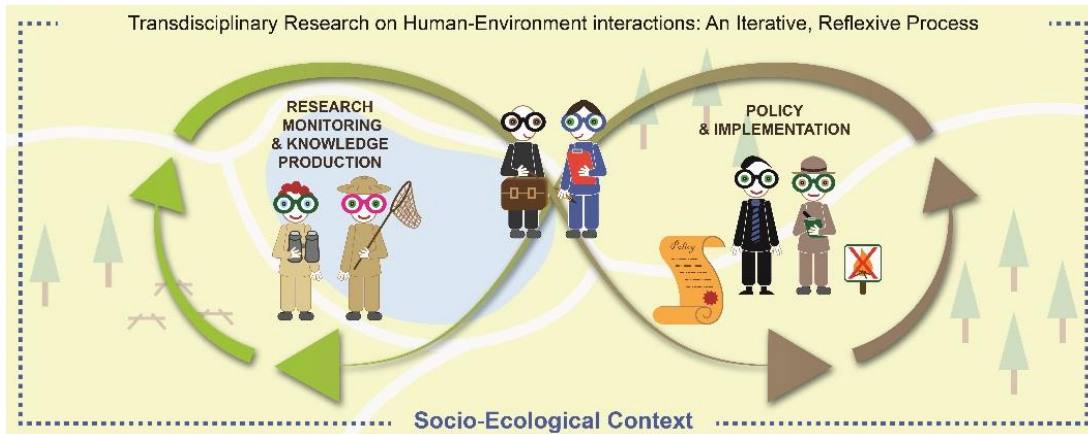


Figure 3: Model of socio-ecological research method integrated stakeholder-driven scientific monitoring and research with evidence-based policy and management. The model reflects the iterative, reflexive, responsive and integrative nature of socio-ecological research. From Holzer et al. 2018.

Change and Society (PECS), supported by the International Council for Science and the United Nations Educational, Scientific and Cultural Organization (UNESCO).

In short, a transdisciplinary research approach is being implemented in LTER-Europe alongside many other research infrastructures, and its adoption is needed to maximize the policy and social relevance of problem-oriented environmental sustainability research.

“Social” in International Long-Term Ecological Research

Historical development of social research in LTER

Long-Term Socio-Ecological Research Platforms (LTSER) comprise the research infrastructure developed to actualize a historical process within LTER-Europe and ILTER networks towards transdisciplinary, socio-ecological research. The first long-term ecological research (LTER) network, established nearly 40 years ago in 1980 in the United States, was purely ecological in character. But already in the late 1990s, LTER scientists began advocating a more interdisciplinary approach to research and monitoring within the network, to reflect the growing realization that in the realm of environmental problem-solving, natural and human systems could not be viewed as separate entities (Aronova, Baker, and Oreskes 2010; Redman, Grove, and Kuby 2004). In 2011, about 30 years after the founding of the LTER network in the United States, the U.S. National Science Foundation reiterated this claim in their evaluation of the national LTER program and its strategic plan. Their conclusions highlighted the importance of LTER collecting and synthesizing social science data along with environmental data in order to produce knowledge useful for addressing complex environmental challenges such as climate change, sustainable development, biodiversity loss, ecosystem management, and environmental hazards (Michaels and Power 2011).

The ILTER network was founded in 1993 and was funded in its early years by the National Science Foundation (Vanderbilt and Gaiser 2017). In the following two decades, ILTER became increasingly committed to the mission of conducting research with both natural and social dimensions, thereby making socio-ecological research an objective of national networks world-wide. This emphasis in the ILTER network has significantly strengthened over the last decade, reflecting the desire to produce knowledge particularly useful for addressing complex environmental challenges emerging from nature-society interactions and feedbacks (Michaels and Power 2011; Redman, Grove, and Kuby 2004; Singh et al. 2013; Sier and Monteith 2016).

The LTER-Europe network was established in 2007 and made its transdisciplinary approach explicit from the beginning by creating a new concept for research infrastructure, the LTSER platform (Mirtl and Krauze 2007; Mirtl et al. 2013). These platforms encompass classic LTER sites, but also include the broader geographic area that contains them, along with cultural, administrative, historic, economic and other social dimensions of the region. Further, through the Sixth Research Framework Programme of the European Commission in 2004, a Long-term Biodiversity and Ecosystem Research and Awareness Network (ALTER-Net) was launched, which, among its other initiatives, strengthened LTER-Europe with an LTSER approach (Mirtl and Krauze 2007; Mirtl et al. 2013). Notable advances in LTER-Europe's socio-ecological approach include the publication of an influential article which advocated for a comprehensive shift from LTER to LTSER, set out the theoretical justification for this shift, and developed a blueprint for the physical structure of LTSER platforms (Haberl et al. 2006). This work was followed up by additional publications, including an edited volume focusing entirely on emerging experiences of LTSER platforms across Europe and socio-ecological work done in LTER-US sites (Singh et al. 2013).

The LTSER concept, theory, application

Socio-ecological research, as defined within ILTER, utilizes interdisciplinary and transdisciplinary methods to examine complex cause-effect relationships and feedback cycles occurring between natural and human ecosystems and, intentionally, treating them as an integrated coupled (socio-ecological) system (Collins et al. 2011; Haberl et al. 2006; Mirtl et al. 2013; Singh et al. 2013). Further, socio-ecological research transcends a disciplinary research agenda by explicitly striving to be more relevant to policymaking and to society at large. Several researchers (e.g. Haberl et al. 2006; Redman, Grove, and Kuby 2004; Singh et al. 2013) outline the characteristics intrinsic to SE research in general, and LTSER research in particular. These include:

- Focus on knowledge production useful for addressing and solving sustainability challenges;

- Promotion of interdisciplinary collaborations between ecologists and social scientists, and transdisciplinary collaborations between scientists and non-scientist stakeholders;
- Focus on interaction processes between social and natural systems and integration of socioeconomic concerns with ecological monitoring and analysis;
- Application to multiple spatial, temporal, and organizational scales, with interactions between scales;
- Investigation of general themes of “socioecological metabolism, land use and landscapes, governance, and communication” (Haberl et al. 2006).

An LTSER platform should be defined by a majority of these characteristics and were designed as such. LTSER platforms are meant to be multi-scale and multi-level hot spots for interdisciplinary research and data collection characterized by four core attributes: (1) use of a systems approach, (2) focus on ecological processes, (3) temporally long term, and (4) in-situ at different spatial scales (Mirtl et al. 2013).

As noted previously, the planetary boundaries for how intensively humans can use ecosystems are increasingly exceeded. Efforts to improve inclusion of the state and trends of natural capital into political and economic decision-making across governance levels and spatial scales are therefore needed. This implies an urgent need to take into account knowledge about both ecological and social systems, and to integrate them. This requires place-based collaboration among researchers, stakeholders and citizens in an explicitly defined landscape or a region. Long-Term Socio-Ecological Research (LTSER) platforms represent a concept and a network aimed at advancing holistic understanding of coupled social and ecological systems, and to support the development of solutions that can be scaled up to address threats to natural capital and human well-being.

The following are fundamental characteristics of an LTSER platform:

<i>Responsive</i>	LTSER platforms and their research scientists are committed to addressing societal needs, determined by civil society stakeholders and conveyed to the LTSER team through collaborative forums.
<i>Relevant</i>	LTSER research is designed to provide data required for policy formulation and uptake.
<i>Reflexive</i>	LTSER research includes self-reflexivity with regard to both the efficacy of research outcomes and to the commitment of staff to the needs of the community they are representing.
<i>Iterative</i>	Long-term research allows for much needed assessment of the efficacy of policy changes brought about by LTSER research. Long-term data observation should provide insights into the impact of policy changes. LTSER is committed to environmental sustainability over long timescales.
<i>Transdisciplinary</i>	The LTSER research process demands the participation of multiple stakeholders and the integration of multiple forms of knowledge. The participatory aspect of LTSER fulfills commitments to multiple characteristics, including responsiveness, relevance and reflexivity.

The establishment of LTSER platforms and implementation of the socio-ecological research program integrates the conceptual pillars of LTER-Europe and ILTER, which include long-term observation, in-situ research, process orientation, and a systems approach (Mirtl et al. 2018).

Navigating local obligations and limitations with network-scale expectations for standardization.

Although the emphasis of LTSER platforms is consistently on in-situ, place-based transdisciplinary research, recognized platforms are also part of the LTER-Europe Research Infrastructure. LTER-Europe offers several advantages to its members, to policymakers and to the scientific community based on its identity as a network of sites and platforms across European ecosystems and socio-ecological systems (Figure 4). These advantages include, among others, coordinated research across ecosystem gradients (Djukic et al. 2018; Shibata et al. 2015), access to ecological data across the continent (Wohner et al. 2019), and the potential for studying local impacts of EU policy across socio-ecological contexts. Holzer and colleagues (Holzer et al. 2018) delineated the advantages for LTSER researchers to be part of such a network. These include participation in an epistemic community of researchers, sharing of expertise and data,

and opportunities for collaborative research funding. Importantly, the central LTER-Europe offices advocate for socio-ecological research approaches within the administrative units of the European Union, opening up new funding opportunities to address research that, due to its transdisciplinary and long-term nature, is often challenged financially (see below). More recently, the research infrastructure of Europe-LTER (eLTER RI) is developing central data services which may be able to provide participating platforms with spatial and other forms of data for which the local platforms may not have the professional or funding capacities to procure on their own.

LTER-Europe platforms will also necessarily fulfill certain obligations regarding participation in the continental network and the systematic provision of long-term data. However, beyond these expectations, place-based platforms are diverse in their objectives, funding mechanisms, subject/research focus and their

relationship with local communities and institutions. LTER-Europe is necessarily pluralistic with regard to the staffing, research and activities of individual platforms, as it is understood that local context (political, economic, demographic, personal) heavily influence the conduct of the platform, and that local research teams are best situated to adapt the LTSEr concept to local constraints and opportunities.

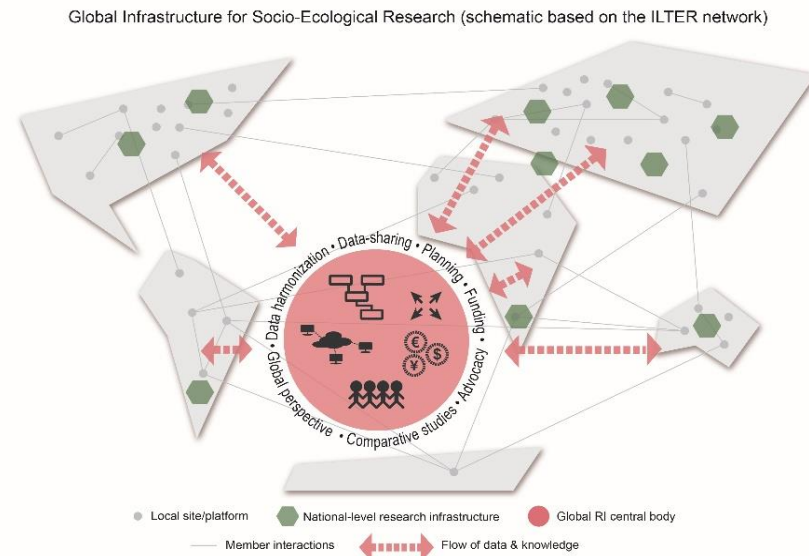


Figure 4: Interactions between place-based LTSEr platforms and the international LTSEr network (From Holzer et al. 2018).

Starting an LTSEr platform

When establishing an LTSEr platform, or when periodically assessing an existing platform, there are several aspects to consider (Figure 5). These include issues related to the initiation process, formulation of the bureaucratic structure, funding mechanisms and research program, and operationalization, including communication tools, observation and research protocol and evaluation procedures.

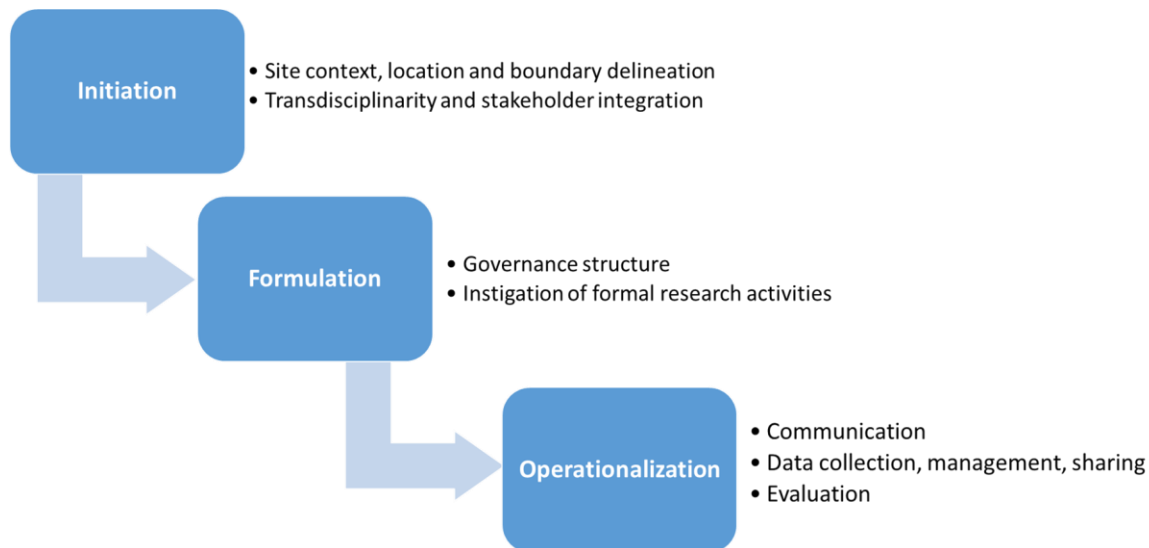


Figure 5: Aspects to consider when establishing a new LTSE platform or assessing an existing platform.

Site context, location and boundary delineation (for new platforms)

In this section we discuss the site context, location and boundary delineation for new platforms. Previous discussions among LTSE scientists suggested that the primary driver of site selection is the local and regional demand for place-based sustainability research and the character of the platforms was heavily impacted by the institutional and professional affiliations of the platform initiators (Orenstein, Frenzel, and Neuner 2009). Understandably, most existing platforms were created by local research teams – often LTER site teams that desired to scale up the spatial and disciplinary focus to allow for policy-relevant sustainability research and to integrate human societies with ecosystem processes and functions and study their interactions.

In eLTER H2020, we further studied the context for LTSE platform establishment among existing European platforms, loosely adopting the analytical framework used by Grove and colleagues (Grove et al. 2013) in their narrative of the establishment of the Baltimore Urban LTER in the US. In their recent analysis of these factors regarding European LTSE platforms, Angelstam and colleagues (Angelstam, Manton, et al. 2019) defined three trajectories that led to the establishment of platforms. They include (1) national (top-down) initiatives to establish LTSE platforms to “enable integrative research about ecosystem services together with stakeholders”; (2) platforms formed by national parks, municipalities and regional planning units that “realized the need for integrated land planning to cope with socio-economic pressures and the landscape as social-ecological systems, and (3) bottom-up initiatives to establish platforms to fulfill the need for knowledge production regarding sustainability challenges. A fourth trajectory, represented by the Cairngorms LTSE in Scotland, is a research community that, recognizing the need for collaborative work with regional stakeholders, initiated the establishment of the platform.

From an international network perspective, assuring LTSER coverage of relevant socio-ecological regions (political, economic, and social systems) is also a concern for networks (Angelstam, Manton, et al. 2019). For instance, Metzger and colleagues (Metzger et al. 2010) suggest that LTER-Europe coverage is underrepresented in urban and disturbed regions and in Mediterranean ecosystems (partially rectified by 2018, according to Mollenhauer and colleagues (Mollenhauer et al. 2018)). Inclusion of non-EU countries would not only expand socio-ecological region coverage, but it would also benefit research on the role of different governance arrangements (Figure 6). As such, the selection of the location of a new LTSER platform is subject to local considerations and constraints, on the one hand, balanced with the desire to meet the needs of the European RI and its spatial coverage, on the other.

There are two practical options for delineating borders of a platform: societal, using administrative borders (e.g. cities, counties or states) and/or ecological boundaries (e.g. watershed). Both have inherent advantages and disadvantages regarding subsequent research and stakeholder integration processes. Selecting platform boundaries to coincide with administrative boundaries has the advantage of clear political stakeholders and leadership, and the de facto division of socio-economic data collected for administrative units. Such regions are often also delineated by a common socio-economic and environmental history. On the other hand, selecting ecological boundaries allows for a tighter coupling of socio-economic and ecological trends, such as when land use changes directly impact the chemical composition of river flow in a watershed.

In the boundary delineation process, it is best practice to consider boundaries that already exist in order to enhance the acceptance of people from the region, and also to exploit boundaries that have been utilized in previously funded research and development programs which are related to specific areas, e.g. EU funded Leader Community Initiatives. The selection of a location will also be influenced by several pre-existing conditions affecting launching and maintaining an LTSER platform. These may include a priori knowledge and activities of the region, available data bases, funding priorities, political access, interest/desire expressed by local stakeholders, policymakers and/or funding agencies, and other local considerations. It will be useful to approach researchers who have been active in the area in the past. This may lead to potential collaborations, in addition to gaining knowledge about particular regions. Finally, new platform initiators should dedicate thought and planning regarding the added value of a new platform would be to the LTER-Europe network (e.g., is it located in an under-represented socio-ecological zone; see Metzger et al. 2010; Mollenhauer et al. 2018; Angelstam et al. 2013).

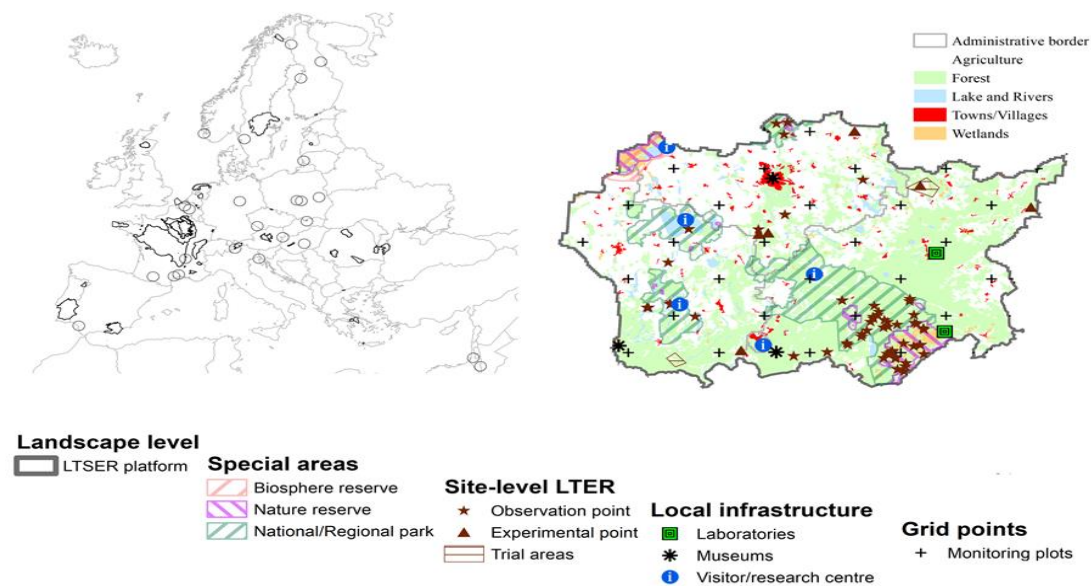


Figure 6: Illustration (right) of 67 European LTSEr. On the left is a fictive platform within the boundaries of which are nested special areas such as Biosphere Reserve and National Park, LTER sites that focus on ecosystem observation comprising highly instrumented Master Sites, Regular Sites and Satellite Sites, as well as local infrastructure and monitoring grid points. (From Angelstam et al. 2019)

Transdisciplinarity and Stakeholder integration

Engaging and integrating stakeholders is one of the most important characteristics that distinguish LTSEr research from LTER work. LTSEr science is conducted in the service of the local community, on the one hand, and ecological sustainability, on the other. Local, participatory agenda-setting and decision-making lie at the foundation of sustainability theory and application of good governance, and thus a precursor to any successful sustainability initiative (Ostrom 2009; Dietz, Ostrom, and Stern 2008; Reed 2008).

Stakeholders, broadly, include any individuals or groups who have a vested interest in the area under research – whether that is ecological, economic, political, or social. The integration of stakeholders is an iterative process which occurs concurrently with the defining of LTSEr platform goals. Even at an early stage – before the geographical site has been defined – the LTSEr team should be surveying potential stakeholders, networking and defining their needs and concerns. Once the location of the platform is selected, more formal and systematic contact and consultation with stakeholders should be made. It is recommended that the LTSEr team conduct an a priori mapping of stakeholders. Stakeholder mapping is a professional endeavor unto itself, and there are multiple resources available on the web to assist the LTSEr coordinators.

Steps in stakeholder identification and characterization include:

- Stakeholder mapping – compiling a broad list of all the possible interested people and institutions and their relationships to one another and the bio-physical environment (Figure 7).

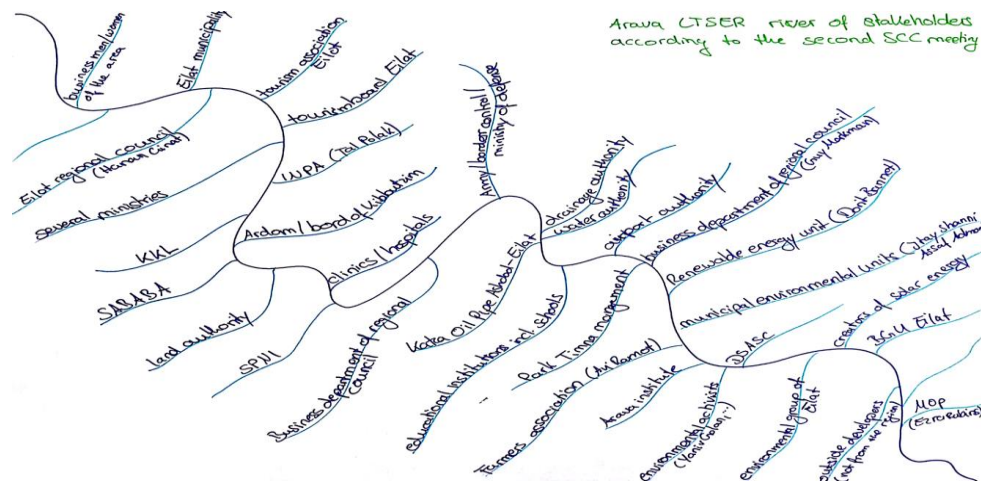


Figure 7: Mapping of institutional stakeholders for the Arava LTSE platform (courtesy of Dr. Jessica Schaeckermann). This “River of Life” activity, introduced by Dr. Kinga Krauz, encourages platform coordinators to map all the various stakeholders, represented as tributaries contributing to the “river of life” of the LTSE platform.

- Stakeholder ranking and prioritization – assessing the broad list to determine whose interests and activities are directly related to the goals and objectives of the LTSE platform (including those who are self-defined as stakeholders).
- Stakeholder meetings and introductions – organizing initial meetings present the concept and goals of the LTSE platform and to learn about the interests and concerns of stakeholders.
- Definition of stakeholder needs – in-depth explorations (interviews, focus group discussions, fuzzy cognitive mapping) of stakeholder concerns, understandings and interest in sustainability, natural resource, ecosystem service and other ecological issues.

Note that there are different scales and levels of governance of stakeholders (e.g. local residents, land use managers, funding agencies, academic institutions, and policy makers at local to continental (European) scale, and approaches to integrating them will differ in each case. Initial meetings with stakeholders can be done on a one-on-one basis or in small groups. This may be different when informing and negotiating collaborations with administrative agencies (e.g. environmental, agricultural agencies). These meetings allow the LTSE team to listen to the thoughts and concerns of individual stakeholders. After multiple stakeholders have been met on an individual basis, the LTSE team can organize collective stakeholder meetings.

When a general stakeholder meeting is convened, it is recommended to use an expert moderator or facilitator. The moderator should not be put into the role of a moderator

and a stakeholder. It is important to find a suitable facilitator that can communicate to multiple stakeholders and bring them towards a common agenda (even if they disagree on priorities).

How does one engage stakeholders in the LTSER research program? Their willingness to participate may be stimulated by applying the following recommendations. LTSER managers should:

- Rely on the concept of ecosystem services and do so for three reasons: 1) they are a natural interface between people and nature, 2) they matter to stakeholders and their wellbeing, and 3) they allow us to promote sustainability in a language that people can understand (for example: pollinators, soil erosion, clean water, tourism value). Many LTSER platforms have utilized ecosystem service mapping as a tool for simultaneously engaging stakeholders in LTSER establishment, and identifying and prioritizing ecosystem services from the perspective of beneficiaries (Maass et al. 2016; Orenstein and Groner 2015).
- Present themselves to stakeholders as those who provide quality knowledge that matters to the stakeholders and that the future platform activities will rely largely on stakeholder input to set the research and policy agenda (note that this is often a new concept for stakeholders, but it is vital for them to be engaged in the process).
- Stress that in the LTSER platform, stakeholders (including the research team) are equal partners – with everyone defining the role they provide (e.g. scientists provide knowledge). This should be an iterative process – a co-evolution.
- Listen to the stakeholders and be willing to adapt your research program according to those issues that matter most to them. *Note that one of the recurring challenges of stakeholder-driven science and policy agendas is that they may not always coincide with the research agenda of the leading scientists, nor may they always demand the scientific expertise of that researcher or of scientific input in particular.*

The goals and scope of the LTSER platform and the interface between research and region

Defining the goals and scope of the LTSER platform is a most crucial phase in the establishment of an LTSER platform. While the entire process should be flexible and iterative, a careful set of research goals will assist the LTSER team in expressing themselves articulately to potential partners, funders and stakeholders, as well as assisting in keeping the team focused on their objectives. The LTSER team should match goals to the capacity of their team – academically, financially and considering uncertainties.

The first questions that should be answered are: Why, What and How. **Why** are you interested in setting up an LTSER platform? **What** are the underlying motives and ideas

inspiring the need for LTSER in your region? **What** are the goals of your LTSER research and activities? Are goals reflective of stakeholders? Are they ecologically informed? Do they combine socio-economic drivers and feedbacks? And, **how** will you go about defining and addressing the central questions relevant to your platform? A first priority will be to answer these questions with relevance to the local and regional needs. Local considerations that influence your goal setting may include the academic and geographic expertise of your research team, the opinions of local stakeholders, and the goals set out for previously funded projects on which you intend to build upon (e.g. Man and Biosphere, UNESCO Sevilla Strategy) or local goals, such as those of a national park.

A set of “meta-goals” will supplement and frame the local goals. These meta-goals shall serve as a common denominator for the LTSER platforms to have comparable data sets across boundaries. Meta-goals should be informed by the LTSER research agenda, and in particular, ILTER and LTER-Europe’s four grand environmental challenges (Mirtl et al. 2018), including climate change, loss of biodiversity, eutrophication, and pollution. This is crucial in the context of being part of a network, and for building the foundation for harmonization of research activities and comparability of experiences and research results across regions. Two concepts important for LTSER goal-setting are that LTSER research programs should adhere to the principles of sustainability science (Kates et al. 2000), and that LTSER research should be conducted using a common conceptual model. The LTSER network will also have established certification guidelines which will determine the suitability of each LTSER platform to join the international network.

Governance structure of the LTSER platform

As LTSER platforms aim for long-term observation and research, a governance structure and clear rules for engagement between stakeholders (including scientists) is essential. If platform fall geographically within an existing administrative boundary, there may already be a governance/administrative structure which can be adapted. Alternatively, a new collaborative governing body may be required. Either way, it is important to consider the administrative maintenance costs of establishing and maintaining a new entity and ensuring its long-term viability.

Collectively, the participating groups should draft memoranda of understanding. These should include the overall aims of the collaboration and should therefore be written in collaboration with relevant stakeholders. Care should be taken to focus the MoU broadly, to assure flexibility and longevity, without sacrificing the overall aim of collaboratively addressing sustainability challenges. For instance, the participation of funding agencies may have a strong impact on research goals, which can change with time (e.g. towards more applied research), so the language of the MoU should not be too restrictive. Researchers from different disciplines will have quite diverse research backgrounds, and the memoranda of understanding can help in establishing a common research process, while a separate document can address a more immediately (e.g. 5-year) research plan. Stakeholders may receive a feeling of empowerment and “buy-in” if

they can contribute to the memoranda. This document will be useful, not only to clarify positions and aims, but also to lobby for the platforms as so many stakeholders are working towards a common cause. The participants in writing such a memorandum may vary depending on the local characteristics and constraints of a platform. In the case of the Scottish Cairngorms National Park LTSER, the MoU was signed between five research institutes (Avriel-Avni and Dick 2019) to “foster holistic, interdisciplinary research approaches that can better inform park management and regional conservation efforts”. For an example, see Appendix 4, “Cairngorms National Park Long-Term Ecological Research Platform, Memorandum of Understanding”.

Initiation of formal research activities

There are two major threads of socio-ecological research within LTER-Europe and ILTER. The first is research focused on the interactions between social and ecological systems, as modeled by Collins and colleagues (Collins et al. 2011). This type of research (Figure 8) utilizes a whole-systems approach, which necessitates studying the feedbacks within the holistic social-ecological system as expressed by presses and pulses (social impact on biophysical systems) and ecosystem services (proxies for impact of biophysical system change on social systems) (Haberl et al. 2013; Gaube and Haberl 2013). The second is research that focuses on stakeholder integration, citizen science, and stakeholder perceptions, either as a process, or as a means towards sustainable resource management (Angelstam, Manton, et al. 2019; Bretagnolle et al. 2018; L’Astorina et al. 2018). Singh and colleagues (Singh et al. 2013) provided the most comprehensive collection of LTSER research papers and provides insights into the breadth of innovative research possibilities within the LTSER conceptual framework. More recently, European LTSER researchers engaged in cross-platform research as means of assessing the performance of research platforms, but also to catalyze synergistic research activities between the platforms (Holzer et al. 2018, 2019; Dick et al. 2018; Angelstam et al. 2018; Angelstam, Manton, et al. 2019; Angelstam, Elbakidze, et al. 2019). We report on the relevant results of these studies in Appendix 1.

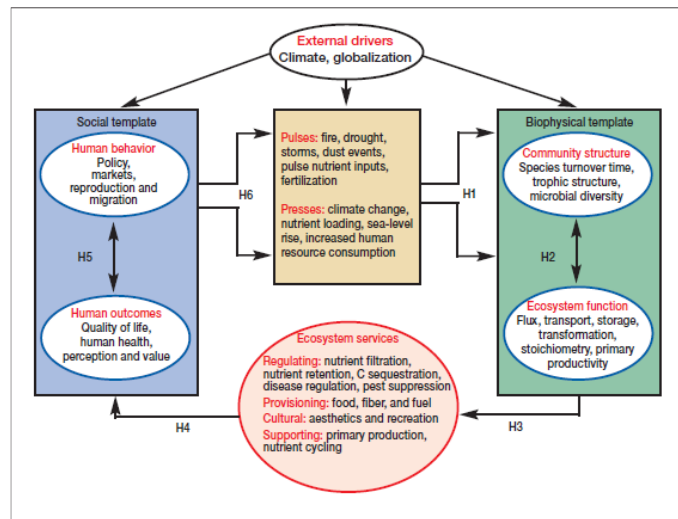


Figure 8: The Social-Ecological Press-Pulse-Dynamics Model (From Collins et al. 2011).

Research programs at LTSER platforms are influenced by diverse pressures including stakeholder interests and concerns (LTSER is supposed to be responsive to these concerns), funding limitations, the expertise of scientific staff, and the interests of

sponsoring institutions and agencies. In fact, platform scientists opined that these conflicting interests were often the most frustrating to address – particularly with regard to potential mismatch between institutional funding priorities and stakeholder concerns, and also between network-scale interests and bottom-up place-based needs (Holzer et al. 2018).

LTSER research targets: What are the criteria for good LTSER targets? They should be:

- Suitable for up-scaling (that is, research that can be replicated at broader spatial and longer temporal scales,
- Feasible, which implies fitting with staff and infrastructure capacity, disciplinary background and funding,
- Attractive for society (as determined in part by stakeholders),
- Enabling integration across platforms – intra- and internationally,
- Phrased appropriately such that meeting the targets requires input from natural, social scientists and stakeholders

Examples of LTSER research questions. The following are sample research topics that have been and are addressed in platforms across Europe (for a comprehensive summary, see Dick et al. 2018; Review article is summarized in Appendix A):

- “Identify effective solutions for agricultural development and the conservation of biodiversity in farmlands - Zone Atelier Plaine & Val de Sèvre, France (Bretagnolle et al. 2018).
- “Socio-ecological metabolism and land use in agriculture” – Eisenwurzen, Austria (Gingrich et al. 2013)
- “Local resident perspectives on ecosystem services” – Arava Valley, Israel (Sagie et al. 2013)
- “Socio-economic factors as drivers for biodiversity conservation” – Doñana, Spain (Díaz-Delgado 2010)
- “Assess how individuals perceive and utilize their local environment” – Cairngorms, UK (Orenstein, Katz-Gerro, and Dick 2017).
- “The extent to which social learning at multiple governance levels for sustainable landscapes occur” – Bergslagen, Sweden (Axelsson et al. 2013).

Unifying concepts and conceptual models across the LTSER network

Despite collaborative development of the LTSER concept (Haberl et al. 2006; Singh et al. 2013; Mirtl et al. 2018), it is still subject to broad interpretation by various types of researchers and stakeholders, as well as the platform teams themselves. Therefore, it is imperative to reiterate and persist in aspiring to the common conceptual frames, research foci and terminology throughout the network. Such concepts should include resilience, feedbacks, succession, thresholds, collapse, and disturbance. Ecosystem services and ecosystem integrity are widely regarded by the LTSER teams as excellent

common currency for cross-platform comparisons. Ecosystem services are appropriate in several ways. They represent objects of concern to stakeholders, and they are the conceptual link in models (below) between human and natural systems.

Models currently employed or promoted among LTSER researchers include: 1) Driver-Pressure-State-Impact-Response (DPSIR) model; 2) Integrative Science for Society and the Environment (ISSE model; Figure 8; (Collins et al. 2011)), and 3) Socio-economic biodiversity pressures and driver (Figure 9; (Haberl et al. 2009))

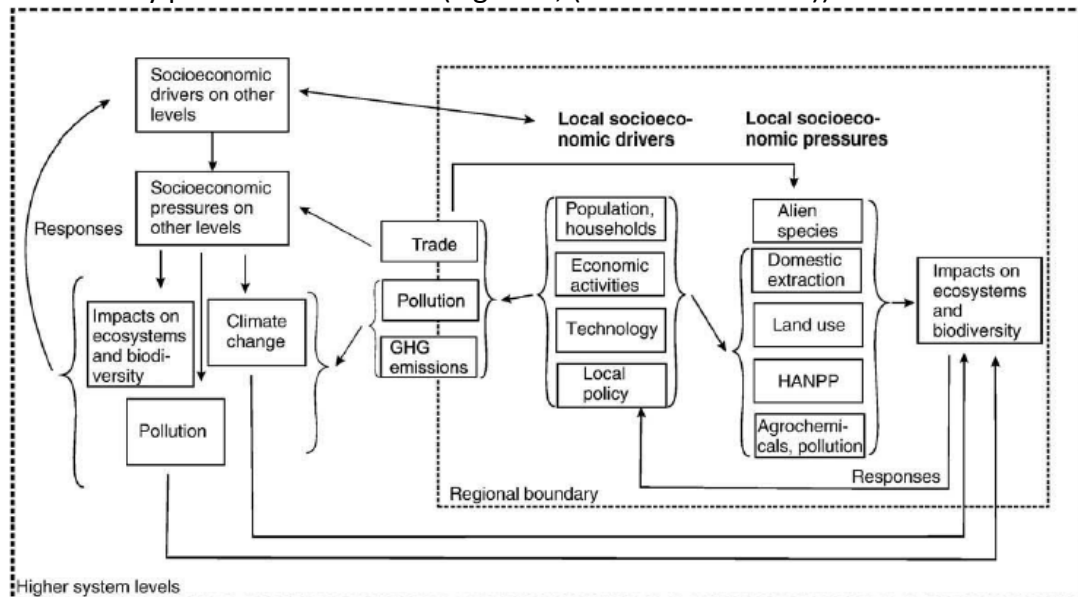


Figure 9: Socioeconomic biodiversity pressures and drivers (from Haberl et al. 2008)

Communication

It is crucial that frameworks be established for publicizing the work of different groups in the platform (e.g. annual plenary meeting, newsletter, WEB Site). For public relations, the LTSER network will keep an on-line folder for information regarding different target groups (regional stakeholders, funding bodies, public, universities, etc.), posters, presentations of research results in the region) and other information. In parallel, each LTSER platform is encouraged to establish its own website in its national language and providing more in-depth information relevant to the particular platform.

Data Collection, Management and Sharing

LTER-Europe is an infrastructure of ecological and socio-ecological observation and research sites across Europe with heterogeneous funding sources and differing funding consistencies. Among its unique features, it is a network of sites and platforms spanning across the continent, covering all or most of the European Union's ecosystems and socio-economic zones (Mollenhauer et al. 2018; Metzger et al. 2010). As a network,

among its primary objectives is to achieve systematic and harmonized data collection throughout the network, data which will be policy relevant and publicly accessible for multiple user groups. Like for LTER, long-term and continuous data collection is a central pillar and unique feature of LTSER. The underlying conceptual framework of ILTER and LTER-Europe calls for systematic collection, storage, analysis and sharing of data to identify 1) long-term trends and changes in socio-ecological variables, and 2) to enable continental-wide comparative research on the social drivers of ecosystem change and the resultant changes in the provision of ecosystem services (Mirtl et al. 2018; Collins et al. 2011; Redman, Grove, and Kuby 2004).

This goal has proven to be one of the most elusive of the research network. As of 2018, and as systematically uncovered in eLTER H2020, there is currently very little systematic collection of socio-ecological data across the network, and few examples of individual platforms that are systematically collecting data. There are multiple explanations for this challenge, particularly due to funding issues (e.g. grants do not cover long-term data collection, underlying human and physical infrastructure is not adequately funded for activities beyond typical funding cycles; Holzer et al. 2018). As Holzer and colleagues pointed out (Holzer et al. 2018), while standardized and systematic data collection is a network expectation, this is generally viewed as an encumbrance, rather than a benefit of being a network member (for example, funders most often pay for data collection and sharing but seldom data harmonization). Another prevalent challenge is that no systematic data protocols have been established that provide guidelines for individual platforms – including what data to collect, how to prepare it, how to store it and how to provide access. Finally, funding is short-term, while LTER-Europe expects long-term observation and research from each of its LTSER platforms (Angelstam, Manton, et al. 2019; Holzer et al. 2018).

However, resolving these issues is now central to LTER-Europe priorities. With the acceptance of eLTER RI into the European Strategy Forum on Research Infrastructures (ESFRI) framework, network researchers are adamant in initiating systematic, harmonized data collection, storage and distribution and finding the correct funding mechanisms at multiple scales to assure long-term sustainability. Significant resources and administrative efforts are now (as of 2019) being sought to achieve this and pilot data collection is planned for five LTER-Europe platforms across Europe (Cairngorms in the United Kingdom, Doñana in Spain, the French Alps in France, Braila Island in Romania, and Eisenwurzen in Austria).

LTSER researchers have participated in several iterations of discussions and activities to determine which socio-ecological variables are most relevant for collection across European LTSER platforms, and this list will be implemented and analyzed for its efficacy in the next generation of eLTER RI scientific and administrative development. By including this list in this Best Practices handbook, we are also emphasizing that current and emerging LTSER platforms will be expected to initiate the systematic collection of this data, to be submitted to the central eLTER RI data nodes currently in development,

and with metadata submitted to the eLTER RI DEIMS central data node (Figure 10; Wohner et al. 2019).

General characteristics Site Name* Short Name DEIMS.ID** Size General Site Description Purpose of Site Images Parent Site Name Sub Site Name(s) EnvThes Keywords	Ecosystem and environmental characteristics Temperature Average From To Precipitation Average From To Biomes Biome Geo-Bon-Biome Ecosystem and land use Biogeographic region (only for Europe) EUNIS habitat Geology Hydrology Soil Vegetation	Protection status and resource management Protection program Protection program Cover Notes Management of resources Management of resources Cover Notes
Contact Details Site Manager * Site Owner Funding Agency Web Address		Infrastructure and operation Infrastructure Infrastructure value Infrastructure notes Accessible all year All parts of site accessible Access type Permanent power supply Infrastructure collection Operation Permanent operation Operation costs Operation notes Sampling interval Maintenance interval
Metadata Details Metadata Provider Metadata Update Date**	Site Classification Site Type (Spatial Design)	
Geographic Location Country* Center coordinates Site boundaries Shapefile Elevation Average From To	Network affiliation Networks/Projects Network specific ICP Forests Code Site classification ExpeER	Data Sharing Policy Data Request Format General Data Policy Data Policy Notes
Status and History Site status Year site established Year site closed History of site	Focus, design and scale Research topics Parameters Observation design Scale of observation Design of observation Experimentation design Scale of experimentation Design of experimentation	Data management Data storage location Data storage format Data services Data notes

Mandatory*
 Automatically generated**
Recommended (and used for calculating completeness of a record)

Figure 10: Metadata requirements for all LTER sites (From Wohner et al. 2019)

We recommend two types of data collection – data that can be collected at the network (continental) scale and data that must be collected at the local scale (though harmonized and stored at the network/continental scale; Figure 11).

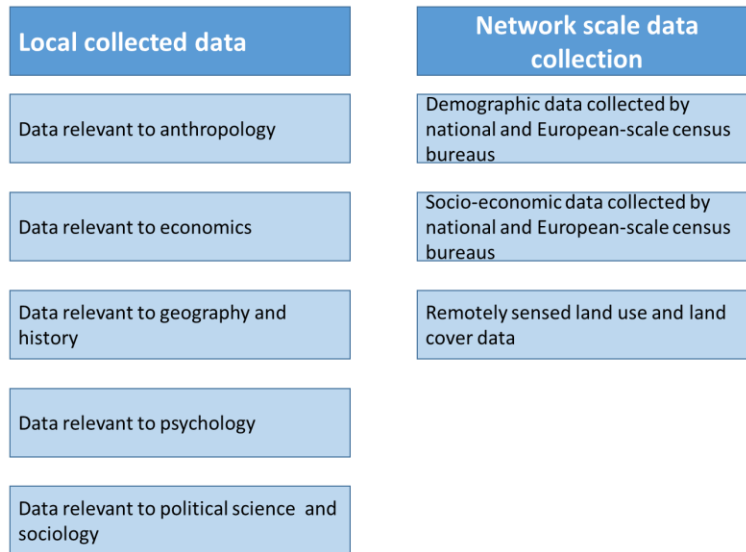


Figure 11: Types of data relevant to LTSER platforms

Local scale data collection (for all platforms)

Several iterations of consideration were made during the eLTER H2020 project defining socio-ecological data needs and capacities. Sources include internal LTER-Europe discussions, the 2018 LTSER workshop in Kibbutz Ketura, Israel (see appendix 2 and 3), and published literature (Redman, Grove, and Kuby 2004; Holzer et al. 2018; Angelstam et al. 2018; Haberl et al. 2006; Dick et al. 2018; Angelstam, Manton, et al. 2019).

Data	Possible sources	Notes
Historical land use, spatially explicit, collected per decade (agriculture, mining, protected areas, urban and peri-urban development, forest)	Remote sensing	Recommendation to collect this data through a central node (e.g. expert topic center and have the data prepared and distributed to recognized and contributing LTSER platforms. See below.
Population and economic density	Census data	See, for example, Angelstam et al (Angelstam et al. 2018) regarding economic density
Demographic and economic variables (age distribution, mean income, employment, educational achievement)	Census data	
Governance structures and character	Narrative	
Sense of Place / Nature connectedness and relatedness (to track long-	Surveys	See, for example: (Schultz 2000; Nisbet, Zelenski, and Murphy 2009) for nature relatedness indices

term trends in nature perceptions and preferences)		
Stakeholder engagement process indicators and profile of engaged stakeholders	Protocol and systematic documentation	LTSER staff keeps permanent records of stakeholder projects, network interactions, meetings
Detailed platform characteristics (platform boundaries, see table above)	Protocol and systematic documentation	DEIMS meta-data
Property ownership/laws/institutions	Qualitative, historical narrative	Considered to be a crucial driver in resource use and land use change.
Ecosystem Services Profile	Research	Requires the development of a user-friends, efficient and effaceable protocol (Dick et al. 2014).
Main environmental parameters (precipitation, temperature)		
Ecological data (productivity, biodiversity; data systematically collected in associated LTER sites)		

Other areas for exploration for systematic data collection across platforms include potential for big data collection (photo surveys, visitations, spatially specific cell phone usage).

Network scale data collection (centrally collected and distributed)

We suggest that much socio-ecological data in the form of remotely sensed land use and land cover data and national and European-scale census bureau data, can and should be collected at the network level and provided to the individual platforms as a network service. Remotely sensed data can allow for high-resolution, time-series data access that could be used as a foundation for socio-ecological research (Grove et al. 2013; Zimmerer 2013). Sijtsma and Angelstam demonstrated the potential of a single research node collecting such data for LTSER platforms (see work package deliverable 10.2). A single, well-managed and well-manned spatial data center could systematically collect, refine and store such data, and prepare it for easy access, use and analysis by network members. This provides added value to network engagement, particularly for platforms lacking the technological and human infrastructure for such work.

A second type of data that can be collected by a single data node and be provided to platforms is socio-economic and demographic data collected by national and European-scale census bureaus (e.g. OECD, Eurostat, the European Social Survey and European Economic Area databases).

In order to benefit from such data sources, platform researchers would need to provide precise boundaries for the platforms as GIS geo-referenced polygons (see section on establishing platform boundaries). As noted in the section on boundaries, platform staffs should consider the spatial designation of data sources (census boundaries, political boundaries, ecological boundaries) during the delineation process. Selecting boundaries that don't coincide with those of data availability fundamentally challenge the relevance of those data sources for given socio-ecological research questions. Compatibility and other assumptions must be made at the platform scale.

Evaluation – What constitutes success? How can we align expectations and achievable objectives?

LTER-Europe, via eLTER H2020, has developed a systematic evaluation process particularly designed for LTSEr platforms (Holzer, Carmon, and Orenstein 2018), but which also has applications to transdisciplinary projects in general. The process focuses on understanding whether, according to the assessment of platform stakeholders and concrete outputs and outcomes, the platform is fulfilling its underlying role of producing policy-relevant socio-ecological research, and whether that research is positively impacting policy. The stages of evaluation are found in Figure 12. The authors note that evaluations, differing from process-oriented assessments, are product-oriented, prescriptive and judgmental. We recommend that platforms, as reflexive and responsive projects, constantly engage in self-assessment, and that a periodic evaluation such as that proposed here would facilitative this process and keep it focused and productive.

Activity	Purposes	Deliverables
1) In-depth interviews	Define the evaluation context; understand research goals and priorities; understand the “degree of transdisciplinarity” of research; assess perceived strengths, weaknesses, successes, areas for improvement, and failures (from diverse stakeholder perspectives); collect narrative examples. The focus is both on the process and impacts of research as well as the processes and impacts in the socio-ecological unit being researched. See, e.g. “social impacts” and “ecological impacts” in Table 2.	Audio recordings of interviews, notes, reflections
2) Qualitative Analysis	Distill key themes; determine gaps in the evaluation and prioritize questions to be addressed in subsequent stages	Transcribed and coded interviews, analysis of findings
3) Survey tool creation and distribution	Understand scientific productivity, including leadership positions, invited talks, number of students mentored, cross-sector collaborations, and/or other data, as well as perceived impacts of research, and consequences on social and environmental realities	Completed surveys
4) Quantitative Analysis	Analyze quantitative data collected from surveys and/or additional existing data sets; create graphical representations of data to use in focus groups	Analyses of quantitative survey and/or existing data sets; a report, including graphical representations
5) Focus group	Prompt researchers and stakeholders to reflect upon the preliminary results of the evaluation	Recordings and notes
6) Final synthesis and report	Synthesize qualitative and quantitative findings and feedback from focus groups; create a concise, useful product to communicate these results to the target audience	Final reports and presentations

Figure 12: Six stages of LTSEr platform evaluation (Holzer, Carmon, and Orenstein 2018).

Consult, discuss, initiate, research, present, repeat: A final note from the authors

Transdisciplinary socio-ecological research, as envisioned by LTER-Europe, is an ongoing process in which a diversity of researchers works collaboratively and continuously with civil society actors to monitor, study and address sustainability challenges at the local, regional, continental and global scales. Collaboration continues in iterations, constantly monitoring outcomes, assessing current conditions and designing subsequent phases of socio-ecological research.

Such a challenging, but ultimately rewarding, task requires consistency, dedication and determination, particularly for overcoming the institutional and bureaucratic impediments to long-term monitoring research, such as short-term budgeting cycles, fluid job markets and short-sited institutional commitments. Successful sustainability project precedents, including successful LTSEER platform activities, require dedicated and visionary scientists, institutional support, long-term funding commitments and strong trust and working relations with LTSEER stakeholders. Despite these challenges, the potential for conducting high-impact sustainability research, and contributing to the resolution of threats to socio-ecological sustainable, are great rewards. We wish you great success, look forward to expanding the network of LTER-Europe socio-ecological platforms, and will be happy to provide support, camaraderie and advice on setting up and operating an LTSEER platform.

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Appendix 1: Studies published in the peer-reviewed academic literature within the framework of eLTER H2020 Work Package 3.

The LTSER audit within the Advanced eLTER WP3 yielded 3 academic publications directly relevant to JRA 3.3 (a fourth manuscript is currently under review). Below we include the abstract of each, followed by a short description of how the study related to the demands of eLTER H2020 deliverables.

Article 1

Dick, J., Orenstein, D. E., Holzer, J. M., Wohner, C., Achard, A. L., Andrews, C., ... Van Ryckegem, G. (2018). What is socio-ecological research delivering? A literature survey across 25 international LTSE platforms. Science of the Total Environment.

Abstract

With an overarching goal of addressing global and regional sustainability challenges, Long Term Socio-Ecological Research Platforms (LTSE) aim to conduct place-based research, to collect and synthesize both environmental and socio-economic data, and to involve a broader stakeholder pool to set the research agenda. To date there have been few studies examining the output from LTSE platforms. In this study we enquire if the socioecological research from 25 self-selected LTSE platforms of the International Long-Term Ecological Research (ILTER) network has produced research products which fulfil the aims and ambitions of the paradigm shift from ecological to socio-ecological research envisaged at the turn of the century. In total we assessed 4983 publicly available publications, of which 1112 were deemed relevant to the socio-ecological objectives of the platform. A series of 22 questions were scored for each publication, assessing relevance of responses in terms of the disciplinary focus of research, consideration of human health and well-being, degree of stakeholder engagement, and other relevant variables. The results reflected the diverse origins of the individual platforms and revealed a wide range in foci, temporal periods and quantity of output from participating platforms, supporting the premise that there is a growing trend in socio-ecological research at long-term monitoring platforms. Our review highlights the challenges of realizing the top-down goal to harmonize international network activities and objectives and the need for bottom-up, self-definition for research platforms. This provides support for increasing the consistency of LTSE research while preserving the diversity of regional experiences.

Implications for LTER-Europe

This research was conducted, in part, to address the eLTER H2020 objective of conducting a “*meta-analysis of results from a network of LTSE Platforms [to determine if they] can deliver data and information relevant to problem-solving*”. As the title reflects, we asked what LTER-Europe socio-ecological platforms are delivering. Additionally, we asked to what degree does the research culture reflect the tenets of socio-ecological research (e.g. Are stakeholders involved? Is research conducted by an

inter-disciplinary team? Are the research questions policy oriented?). The salient lessons for LTER-Europe, explained in the article's discussion include:

- The rate and extent to which the local platform fully adopts an integrative socio-ecological approach (as opposed to a traditional, natural sciences disciplinary approach) is dependent on the characteristics, limitations and desires of the local research team. This creates a broad spectrum of socio-ecological capacities and performance between individual platforms. Some of these characteristics include (1) local and national funding institutions and collaborating management agencies, which can expedite the process of transitioning to a socio-ecological research approach; (2) The age of the platform, although this can be ambiguous because older platforms have had time to transform, while some younger platforms are initiative from the start with a socio-ecological approach, and; (3) the underlying *raison d'état* for platform establishment.
- There was a broad divide between platforms regarding the proportion of their publications that considered socio-ecological aspects of their platforms, reflecting broader heterogeneity in the adoption of a socio-ecological approach.
- There was great difficulty in establishing a protocol used for the literature review in this article, reflecting a broader difficulty in initiating a harmonized protocol for systematic data collection (an objective of the eLTER RI). Challenges were both due to intrinsic cultural and disciplinary difference between the participating researchers, but also due to funding constraints for some of the participants, whose participation was limited by funding and therefore by the protocol complexity.
- Considering that a primary objective of the eLTER RI is to collect systematic, harmonized data sets from LTSER platforms, this study revealed that such objectives must consider whether the requested data is relevant to the various platforms and their stakeholder-driven agendas, whether the platform staff has the financial and professional capacities to collect the data, and whether there are sufficient incentives to encourage data collection.
- The authors recommended that platform leaders make effort to diversify the disciplinary composition of their research staffs and integrate stakeholders for determining the platform research program. Top-down funding earmarked towards stakeholder integration could address the funding challenges posed by implementing these recommendations.

Article 2

Holzer, J. M., Adamescu, M. C., Bonet-García, F. J., Díaz-Delgado, R., Dick, J., Grove, J. M., ... Orenstein, D. E. (2018). Negotiating local versus global needs in the International Long Term Ecological Research Network's socio-ecological research agenda. Environmental Research Letters.

Abstract

Over the past decade, long-term socio-ecological research (LTSER) has been established to better integrate social science research and societal concerns into the goals and objectives of the International Long-Term Ecological Research (ILTER) network, an established global network of long-term ecological monitoring sites. The Horizon 2020 eILTER project, currently underway, includes as one of its key objectives to evaluate the performance of LTSER platforms. This article reflects part of this evaluation: six LTSER platforms were assessed through site visits of the lead author, coupled with reflections and insights of the platform managers, who are also co-authors. We provide background for the mission and goals of LTSER, then assess the six international LTSER platforms—Baltimore Ecosystem Study LTER, USA; Braila Island LTSER, Romania; Cairngorms LTSER, UK; Doñana LTSER, Spain; Omora Ethnobotanical Park Cape Horn LTER, Chile; and Sierra Nevada LTSER, Spain. While based on a strong theoretical foundation in socio-ecological research, there has been a steep learning curve for scientists applying the concept in practice at LTSER platforms. We show positive impacts that have been achieved, including contributions to policy, land-use planning, and natural resource management. We explain key aspects of LTSER platforms that have proven challenging, including management, interdisciplinary integration, and stakeholder collaboration. We characterize the tensions between top-down desires for network harmonization, bottom-up demands such as local policy relevance, and platform-level constraints such as time and budget. Finally, we discuss challenges, such as local context dominating the character of LTSER platforms, and the fact that scientists are often disincentivized from engaging in transdisciplinary science. Overall, we conclude that while the international network offers important advantages to its members, a more productive balance between local and global goals could be achieved, and members may need to temper their expectations of what the network can and cannot offer at the local level. ILTER: producing societally

Implications for LTER-Europe

This research addresses the eILTER H2020 objective “*screen site metadata for a small number of the most advanced LTSER Platforms provided through VA*”, although using trans-national access (TNA) rather than VA. It was part of a four-year research project, which included the development of a novel methodology for evaluating socio-ecological projects and the application of the methodology on four LTSER platforms in Europe. In this article, three of the four platforms under study were combined with three additional platforms in Spain, the US and Chile, in order to give international relevance to the study. Several of the lessons learned in this study confirm the findings of the previous study, and the depth of analysis from fewer platforms complements the breath of analysis in the previous study, which focused on 25 platforms. The lessons for LTER-Europe from this study highlight top-down/bottom-up points of conflict and the

importance of local conditions and context for defining the character of the platform, the degree of integration of social and natural sciences, the degree of stakeholder engagement.

Article 3

Angelstam, P., Manton, M., Elbakidze, M., Sijtsma, F., Adamescu, M. C., Avni, N., ... Yamelnyets, T. (2018). LTSER platforms as a place-based transdisciplinary research infrastructure: learning landscape approach through evaluation. *Landscape Ecology*. <https://doi.org/10.1007/s10980-018-0737-6>

Abstract

Context: Place-based transdisciplinary research involves multiple academic disciplines and non-academic actors. Long-Term Socio-Ecological Research (LTSER) platform is one concept with ~ 80 initiatives globally.

Objectives: As an exercise in learning through evaluation we audited (1) the siting, construction and maintenance of individual LTSER platforms, and (2) them as a distributed infrastructure for place-based transdisciplinary research with focus on the European continent.

Methods: First, we defined a normative model for ideal performance at both platform and network levels. Second, four surveys were sent out to the 67 self-reported LTSER platforms officially listed at the end of 2016. Third, with a focus on the network level, we analyzed the spatial distribution of both long-term ecological monitoring sites within LTSER platforms, and LTSER platforms across the European continent. Fourth, narrative biographies of 18 platforms in different stages of development were analyzed.

Results: While the siting of LTSER platforms represented biogeographical regions well, variations in land use history and democratic governance were not well represented. Platform construction was based on 2.1 ecological monitoring sites, with 72% ecosystem and 28% social system research. Maintenance of a platform required three to five staff members, focused mostly on ecosystem research, was based mainly on national funding, and had 1–2 years of future funding secured. Networking with other landscape approach concepts was common.

Conclusions: Individually, and as a network, LTSER platforms have good potential for transdisciplinary knowledge production and learning about sustainability challenges. To improve the range of variation of Pan-European social–ecological systems we encourage interfacing with other landscape approach concepts.

Implications for LTER-Europe

This paper further addresses objectives 1,2 and 4 in WP10, mapping European LTSER platforms and assessing their representativeness across socio-ecological landscapes (i.e. including ecological, political, and land-use gradients) and querying self-reporting platforms regarding characteristics of their platforms' establishment and performance. The salient conclusions that should be integrated into LTSER best practices address both individual platform and network-scale considerations.

Individual platform considerations

- Social and interdisciplinary research is expanding within platforms, but continues to lag behind more disciplinary ecological research. The authors make conceptual and practical recommendations to remedy this situation. The authors suggest strengthening the role of humanities and social sciences within platform research and expanding the role of stakeholder participation more radically and comprehensively than advocated in early LTSER conceptual papers (e.g. Haberl et al. 2006).
- Each platform is established based on its own set of unique local needs and objectives, combined with top-down network-scale influence. Similarly to the conclusions of Holzer et al. (2018), this suggest that platforms must find a balance between locally-driven objectives, expectations and capacities, and network-scale expectations for ecosystem observation, transdisciplinarity, and harmonization of research structure and data provision.

Network-scale considerations

- While ecosystem coverage is fairly complete, political and land-use gradients are less fully represented in the current network. The authors call for “reference areas representing ecological integrity and resilience,” and “wider gradients of governance and political cultures.” In particular, post-Communist eastern European countries need greater representation, as do areas with less intensively developed landscapes (e.g. intact forests).
- Funding emerges as both a preeminent challenge, but also the potential solution, to gaps in LTSER platform performance and socio-ecological integration. The three funding-related problems are (1) historic focus on disciplinary, ecological research funding, (2) short periodicity of grant cycling (usually 1-4 years), which discourages long-term research, observation and administrative continuity, and (3) unlike traditional natural science research, such as climate change research, which often requires large equipment budgets, transdisciplinary research requires large budgets for human resources, e.g. facilitation and administration of stakeholder integration processes and qualitative research, for which there is less funding available than for capital expenditures. Longer funding terms, coupled with emphases on transdisciplinary research can provide top-down incentives for fulfilling platform objectives.
- Acceptance in 2018 to the ESFRI Framework provides a great opportunity to harmonize performance and data collection between research platforms and incentivize their collaboration using administrative support and funding potential.
- Many LTSER platforms are also identified with other transdisciplinary and landscape-scale international designations (e.g. Ramsar sites, Biosphere reserves, Heritage sites, etc.). Such dual and multiple designations can be synergistic with regard to platform funding, stakeholder integration or research.

Article 4 (currently in review)

Holzer, Jennifer M., Adamescu, M. C., Cazazcu, C., Diaz-Delgado, R., Dick, J., Méndez, P. F., Santamaria, L., Orenstein, D. E. (2019). Results from a Case Study Evaluation of Transdisciplinary Science in the European Long-term Socio-Ecological Research (LTSER) Network. Haifa, IS.

Abstract

Researchers in multiple, related fields, such as global environmental change, sustainability science, and social ecology, have shown ongoing enthusiasm for transdisciplinary social-ecological research to promote sustainability. However, few studies have evaluated its effectiveness, assessed its achievements, and identified challenges to its implementation. We conducted a multi-site, qualitative, participatory evaluation of several social-ecological projects across Europe using an evaluation methodology specifically tailored to evaluate transdisciplinary projects. We conducted 66 stakeholder interviews at four designated Long-Term Socio-ecological Research (LTSER) platforms – Danube Delta LTSER and Braila Island LTSER (Romania); Cairngorms LTSER (Scotland); and Doñana LTSER (Spain). Using qualitative analysis, we synthesized data from interviews and then returned to the sites to present findings to stakeholders and facilitate focus group discussions with them to record their responses. From these findings, we conclude that while particular scientists at each platform have taken on entrepreneurial roles to operationalize transdisciplinary science, a business-as-usual attitude tends to dominate their institutions, limiting progress in meaningful transdisciplinary objectives, including: integrating social sciences research, giving non-researcher stakeholders a more meaningful role in advancing relevant research, and improving knowledge exchange among different stakeholder groups, among other issues. While we found that all the components of transdisciplinary social-ecological research exist at the sites, there is no overarching strategy to link long-term planning and funding, knowledge integration, and priority-setting with stakeholders to ensure the relevance of research for policy and practice. We conclude with reflections about implementing our evaluation methodology, and a call for periodic, participatory evaluation into the future.

Implications for LTER-Europe

This work is the culmination of a three-year evaluation of four European LTSER platforms that was designed specifically to address the objectives of WP 10.3, #2-4. Insights, obtained through two rounds of in-depth interviews with platform researchers and administrators, largely reflect the prevailing themes revealed in the previous three studies. We suggest that the multiple inquiries using different research approaches (literature reviews, questionnaires, interviews, focus-group discussions) and querying different informants within the LTER-Europe network contributes to our high confidence in the conclusions and the robustness of the research. Beyond the brief conclusions provided in the abstract, relevant insights for LTER-Europe include:

- The amount of social research, and the degree of interdisciplinary integration, at LTER-Europe platforms varies according to the local context (e.g. disciplinary

- focus of lead investigators, particular funding mechanisms for social research, demands and expectations of institutional sponsors).
- The degree of stakeholder integration is similarly low and sporadic, with no procedures or guidelines determining the character of stakeholder integration. Further, rarely were tools in place for systematic knowledge transfer to stakeholders, although some ad hoc tools had been effectively employed. These diminish potential impact of LTSER research on local and regional environmental policies and planning.
 - No formal monitoring of socio-economic variables exists in the platforms, although metadata has been submitted by all study platforms to DEIMS.
 - The participation in LTER-Europe has proven useful for leveraging international collaborations and funding requests.

Appendix 2: Long-Term Socio-Ecological Expert Workshop (Ketura, Israel; March 2018) – Lessons and implications for eLTER H2020

Workshop Overview

In March, 2018, The eLTER H2020 WP10.3 Team organized, in collaboration with WP6, a training workshop for LTSER platform staff and researchers entitled “The LTSER Platform: Initiating and Integrating Social and Ecological Systems Research”. The goal of the workshop was to stimulate a two-way learning process, where participants could both contribute from their collective experience regarding how to best conduct socio-ecological research, and to learn from one another and from network organizers regarding how best to coordinate and collaborate at the network scale. In particular, objectives were presented to participants as follows:

- **TRAINING:** Providing and sharing theoretical and applied tools for siting, constructing and maintaining an LTSER platform.
- **LTSER NETWORK DEVELOPMENT and ADVANCEMENT:** Provide a setting for current and future platform managers to share insights and experiences, strengthening the LTER-Europe network and its members’ capacity to communicate and collaborate.
- **CAPACITY BUILDING:** Exchange personal experiences of running an LTSER platform and means for addressing challenges.
- **CATALYZING LOCAL ENGAGEMENT:** Conduct a real-time stakeholder engagement process in the Southern Arava Valley, including stakeholder mapping, preliminary engagement, and collaborative agenda setting.
- **SHARING AND DOCUMENTING EXPERIENCES:** Using discussions from the above as a means to document and compare LTSER experiences across Europe.

Several sessions of the workshop were dedicated to bridging between bottom-up context of individual LTSER platforms and top-down network-scale expectations for behaving as a network (e.g. data harmonization, continental-scale research across socio-ecological gradients, etc.) (See Appendix C for full workshop schedule). The outcome of these discussions, with an emphasis on the input of participants regarding how best to bridge these gaps are included here as part of the workshop protocol relevant to eLTER H2020, in general, and WP 10.3, in particular. The workshop was attended by 20 participants¹ and 5 staff (4 WP 10.3 researchers and a guest expert, Professor Muki Haklay from University College London, who ran several sessions on stakeholder engagement via citizen science).



¹ The participants and staff represented 15 countries, including Finland, Germany, Israel, Italy, Jordan, Latvia, Lithuania, Palestine, Poland, Portugal, Romania, Slovakia, Spain, Sweden and the United Kingdom.

Workshop Protocol relevant to WP 10.3

The workshop provided an opportunity, with representatives of 10 existing platforms and several emerging platforms (or LTER researchers expressing interest in developing the socio-ecological research framework), to further validate findings of the in depth analyses noted in the previous section and complement this information with additional experiential knowledge regarding the WP objective of conducting a “meta-analysis of results from a network of LTSE Platforms [to determine if they] can deliver data and information relevant to problem-solving.” It was further an opportunity to explore top-down/bottom-up relationships, including (1) the question of what types of data the network can reasonably expect the member platforms to provide in a harmonized and systematic way for collaborative, continental-scale socio-ecological analyses and (2) exploring what advantages to individual platforms stand to gain from being part of the LTER-Europe network.

Strengthening of a Network

A recurring theme of the workshop was the unique and context-specific nature of an LTSE platform, shaped by local environmental challenges, funding constraints and strictures and disciplinary expertise of local researchers. A contrary – or harmonizing – theme was the impact of joint funding measures and international meetings (such as the current workshop), which serve to focus disparate research teams on a common set of environmental challenges (e.g. biodiversity conservation, land use/land cover change, ecosystem services or climate change, response and adaptation), and help to crystallize an epistemic community of researchers that use common conceptual frameworks to identify, characterize and study local and regional environmental challenges.

Following a discussion of the various advantages for being part of a Continental-scale network (Mirtl et al. 2018, 2013) and the associated administrative, financial and disciplinary challenges in securing that network, the workshop participants discussed the minimal requirements (primarily regarding data provision) that could be expected of individual platforms to be members of the network. The brainstorming session yielded the following considerations for data requirements of member LTSE platforms:

- Geographic delineation of platform boundaries
- Historical land use (remotely-sensed, time-series data)
- Basic meteorological data (precipitation, temperature)
- Ecological data (primary productivity, biodiversity distribution)
- Human demographic data (population density, age distribution, economic activity, stakeholder mapping)
- Human opinions monitoring (e.g. sense-of-place, environmental perceptions, expert opinion regarding main environmental challenges)
- Power structures (governance structures, property ownership rules, economic equity and distribution, educational infrastructure)

- Ecosystem services profile
- Reference landscapes, target indicators
- Big data (number of visitors, number of commuters, photographic analysis)

Participants also expressed the need to create a cadre of LTSEER managers who can lead the various research and participatory processes. These have to be provided adequate funding to assure long-term continuity of stakeholder integration processes (see below), consistent data provision, and a constant socio-ecological research stream. Despite contextual differences between platforms, such a cadre of socio-ecological scientists, functioning as an epistemic community with authoritative knowledge and experience regarding transdisciplinary project research and management can create an incentive for participation.

Tools for transdisciplinary socio-ecological research

The workshop program and the interests of the attendees led to a strong focus on **stakeholder engagement** as a preeminent characteristic of an LTSEER platform and a precondition to a well-functioning and productive platform. Stakeholder integration was emphasized for its contribution to setting the research agenda of the platform (i.e. platforms exist to provide research support for questions that matter to local people), for its potential to provide alternative data streams (e.g. citizen science), for its utility in creating a sense of community, and for generating public support for platform research and activities. Further, participants expressed the belief that scientific products are more relevant and interesting when questions are generated by stakeholders.

While most participants spoke of the necessity to elevate the role of stakeholders in the research process, some also expressed apprehension at the potential of “losing control” of the process and becoming an observer, rather than a leader. This concern was addressed by the suggestion that LTSEER scientists should be leading a participatory and transparent process and identifying and engaging multiple stakeholders. Along with research and policy outcomes, the stakeholder integration *process* is a *product*. That is, participants supported the process of stakeholder integration as a value, regardless of the outcome (see, for example, Reed, 2008, who identifies normative, as well as positive justifications for engaging stakeholders). But as stakeholders themselves, scientists also have the responsibility to contribute their expertise, synthesize research questions such that they both interest local stakeholders, but also address scientific agendas, and distill and refine questions such that they can be addressed via research. Further, stakeholder integration processes may differ between national and regional contexts – for instance, one participant noted, American (US) stakeholder integration focuses on consensus building, while British stakeholder integration focuses on proper process implementation.

Note that the workshop included sessions in which Arava Valley (the location of the workshop) stakeholders were queried regarding (1) the most positive aspects of living in the region, (2) threats to quality of life, (3) ideal conditions for future living and (4)

scientific knowledge gaps. In this way, the workshop exemplified the first round of a stakeholder integration process.

The workshop concluded with a graphical mapping of the participants' action plan for continuing their socio-ecological work (see illustration). Many of the outcome, including those noted here, are integrated into the revised LTSER Best Practice Guidelines.



Appendix 3: Schedule for LTSER Expert Workshop

Training workshop:

“The LTSER platform: Integrative socio-ecological knowledge production and learning”

4-8 March, 2018

Objectives:

- **TRAINING:** Providing and sharing theoretical and applied tools for siting, constructing and maintaining an LTSER platform.
- **LTSER NETWORK DEVELOPMENT and ADVANCEMENT:** Provide a setting for current and future platform managers to share insights and experiences, strengthening the LTER-Europe network and its members’ capacity to communicate and collaborate.
- **CAPACITY BUILDING:** Exchange personal experiences of running an LTSER platform and means for addressing challenges.
- **CATALYZING LOCAL ENGAGEMENT:** Conduct a real-time stakeholder engagement process in the Southern Arava Valley, including stakeholder mapping, preliminary engagement, and collaborative agenda setting.
- **SHARING AND DOCUMENTING EXPERIENCES:** Using discussions from the above as a means to document and compare LTSER experiences across Europe.

Schedule

Day 1 – 4 March

- 11:00 Arrival, room assignments, coffee
 - Welcome and technical details (**Elli Groner**)
 - Welcome round table: Explanation of objectives, introductions and expectations (**Daniel Orenstein**)
 - “Who am I and what is my role in my platform?” (**Jen Holzer**)
 - Learning aims: (1) Introduction of each participant (both participants and facilitators) (2) Locate the individual within their research/stakeholder context and within the broader context of the LTER network.
- 12:30 Lunch
- 13:30 *“My socio-ecological system.”* (**Kinga Krauze/Jan Dick**)
 - Learning aims: To expand the participants’ understanding of the socioecological context of their LTSER platform to include ecological characteristics, social/societal characteristics and the interactions between the two.
- 15:00 Welcome to the Arava Valley – A great place (with socio-ecological challenges). Meeting with **Dr. Hanan Ginat**, the Head of the Eilat Regional Council.

- 15:45 *Radical stakeholder engagement* (**Muki Haklay**)
- Learning aims: (1) To learn about new methodologies for conducting stakeholder-based integrative research; (2) to provide an understanding of a process of engagement.
- 18:00 Dinner
- 20:00 Evening presentation – Citizen science and crowdsourcing: State of the Art (**Muki Haklay**)
- **Day 2 – 5 March**
 - 8:00 Breakfast
 - 9:00 *Models for regional sustainability* (**Per Angelstam**)
 - Learning aims: (1) To provide an overview of the key components of place-based collaborative sustainability initiatives (which, as it turns out, are quite similar across approaches). (2) For each participant to appraise their own LTSER platforms regarding the presence/absence of these components (a list will be provided or compiled during the introduction), and where they can be strengthened. (3) To discuss “bridges and barriers” to implementing socio-ecological projects for knowledge production and learning.
 - 10:30 *Building and sustaining an LTSER Platform (and coffee)*
 - The LTSER Best Practices Handbook – a brief overview (**Mark Frenzel and Daniel Orenstein**)
 - Learning aims: Presenting the major components of the LTSER and the recommended steps towards establishing and maintaining a platform.
 - Harmonization at the European Scale (**Michael Mirtl**)
 - Learning aims: Presenting an update on the role of socioecological platforms within the eLTER ESFRI framework and discussion of data needs and objectives at the network scale.
 - 13:00 Lunch
 - 14:30 Stakeholder engagement – iNaturalist (**Muki Haklay**)
 - Learning aims: (1) gain familiarity with the spectrum of citizen science types and methodologies (2) to understand advantages and disadvantages/strengths and weaknesses of citizen science (3) to provide hands-on experience in conducting participatory citizen science
 - Acacia walk (**Elli Groner**) to apply iNaturalist
 - 18:00 Dinner – Keren Kolot BBQ
- **Day 3 – 6 March (day’s schedule subject to change)**
 - 7:00 Breakfast
 - 8:30 (Science Center Hall)
 - Today’s goals (**Daniel Orenstein**)
 - The history of the Wadi Arava LTSER platforms and their connection (**Elli Groner**)
 - 10:15 Tour of the southern Arava Valley – Ecology and Development

- 17:00 Development-Ecology conflicts in the Arava (panel discussion)
- 18:30 Dinner
- 20:00 Wine and synthesis (**Kinga Krauze and Jan Dick**)

Day 4 – 7 March

- 8:00 Breakfast
- 9:00 *Building an action plan for the Arava Valley LTSER* (activity with graphic facilitation; **Mark Frenzel and Aya Auerbach**)
- 11:30 *My action plan: participant strategizing for the next phase of their LTSER platform* (**Mihai Adamescu, Ricardo Diaz-Delgado and Aya Auerbach**)
 - Learning aims: The session will be used to brainstorm and present each platforms action plan for the next two years.
- 13:00 Lunch
- 14:00 *The state of LTSER from the local to the global*
 - Update from eLTER Work Package 10 (**Jan Dick (WP1), Per Angelstam (WP2), and Jen Holzer (WP3)**)
- 15:00 Sharing and documenting experiences (basis for collaborative manuscript) (**Per Angelstam**)
 - Learning goal: Participants will answer short, direct questions as a basis for short narratives about the relevance of socio-ecology to their research, and something they learned about another platform in the workshop.
- 16:00 Leave for Eilat
- 17:00 Walk on the beach and dinner in Eilat

Day 5 – 8 March

- 8:00 Breakfast
- 9:00 Bridging top-down versus Bottom up and top down: What you can give to the network and what the network can give to you (**Jan Dick**)
 - Learning aims: Brainstorming tools for facilitating networking and cross-platform harmonization (e.g. a social DEIMS).
- 10:00 Coffee and Round table concluding discussion: Recommendations for updating the LTSER best practices guidelines and conclusions (**Michael Mirtl, Mihai Adamescu, Kinga Krauze, Mark Frenzel**)
- 11:30 Departure

Appendix 4: Sample Memorandum of Understanding

ENVIRONMENTAL CHANGE NETWORK CAIRNGORMS NATIONAL PARK LONG-TERM SOCIO-ECOLOGICAL RESEARCH PLATFORM MEMORANDUM OF UNDERSTANDING

The undersigned organisation agrees to participate in establishing and supporting the Cairngorms National Park Long-Term Socio-Ecological Research (LTSER) Platform within the framework of the UK Environmental Change Network

Purpose

The purpose is to create a platform for an innovative approach to research in and using the Cairngorms National Park to promote excellence in interdisciplinary research and connections between research, policy and practice. Established within the UK Environmental Change Network (ECN), the research platform will connect researchers, stakeholders and management bodies addressing the interactions of natural, cultural and economic systems in the region.

The research will support the collective delivery of the four aims of the National Park by multiple stakeholders and contribute to wider research and policy agendas.

Signed:

Name:

On behalf of:

ANNEX I

Participation means that partners work together to deliver:

- Integration and focusing of research activities and facilities in the region with reference to identified research priorities;
- Collaboration between different specialist fields (interdisciplinarity);
- Close links between science and regional development, regional decision-makers, regional educational establishments etc. (transdisciplinarity);
- Understanding of the needs and potential contributions of stakeholders (participation);
- Research on long-term socio-ecosystems processes and trends;
- Use of synergies by linking monitoring and research;
- connections between the many diverse LTSER-relevant organisations and infrastructures in the region in multi-site analyses and experiments;
- strategies to secure, share and make available for use data, information and meta-information on the region.

Participants will seek to deliver the following benefits through the LTSER platform:

- Better evidence base to inform management of the area by multiple stakeholders, supporting delivery of the Cairngorms National Park Partnership Plan;
- Better collaboration between research institutions and with stakeholders;
- More efficient pooling of effort and resources;
- Effective way to use the Cairngorms National Park to contribute to Scottish, UK and international research and policy agendas;
- Easier opportunities to connect research disciplines and to build on the research of others;
- Opportunities to connect and contribute to educational programmes and training;
- Creation of a more tangible research community to communicate and share information about the region;
- Increased use and efficient management of data and monitoring;
- Improved access to environmental and socio-economic information about the region.

Participants will put in place efficient structures to support effective working including:

- Management/steering group
- Protocols on content and data management
- Communications and networking facilities

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