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Main Authors:	Antonello Provenzale, Mariasilvia Giamberini, Carmela Marangi, Matthias Jurek, Magnus Andresen, Herman Hummel, Aletta Bonn, Emile Crouzat, Christiaan Hummel, Ilse Geijzendorffer, Anett Richter
Reviewers	Aletta Bonn, Herman Hummel

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Editor	Antonello Provenzale
EC Project Officer	Gaëlle Le Bouler

Abstract	This deliverable reports about the activities done to build the ECOPOTENTIAL Community of practice due in WP1 – Task 1.4 (lead: CNR) aimed to link to GEO and other existing networks and stakeholders communities.
Keywords	CoP, GEO, stakeholders, LTER, LifeWatch, GEO BON, GEO ECO

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TERMS AND ABBREVIATIONS

CoP	Community of Practice
GEO BON	GEO Biodiversity Observation Network
GEO ECO	GEO Ecosystem Community
EO	Earth Observation
EF	Ecosystem Functions and Structures
EVs	Essential Variables
EEVPA	Essential Environmental Variables for Protected Areas
ESVPA	Essential Socio-Economic Variables for Protected Areas
ES	Ecosystem Services
GEO	Group on Earth Observations
GEOSS	Global Earth Observation System of Systems
Ground-truthing	Process of validating remote sensing derived information using in-situ collected data
LifeWatchERIC	E-Science European Infrastructure for Biodiversity and Ecosystem Research
LTER	Long-Term Ecological Research Network
PA	Protected Area
VLab	Virtual Laboratory Platform

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1. Executive summary

The present document is a deliverable of the ECOPOTENTIAL project, which is funded by the European Union's Horizon 2020 Programme under Grant Agreement #641762.

In this framework, ECOPOTENTIAL is creating a new unified framework for ecosystem studies and management of protected areas (PAs), with impacts on knowledge-based conservation, management and restoration policies. ECOPOTENTIAL focuses on internationally recognized Protected Areas (PA) in Europe and beyond. The majority of these are either UNESCO World Natural Heritage Sites, Biosphere Reserves, national parks or Natura2000 sites, or a combination of these. LTER (Long Term Ecological Research) sites and Large Marine Ecosystems are also included.

A "Community of Practice (CoP)" is herein intended as a community formed by producers and users of knowledge and information on a specific theme, interacting on a regular basis and addressing common concrete problems. The role of information producers and users is interchangeable, in the sense that producers in some occasions become users and vice versa.

ECOPOTENTIAL fosters the best use of Earth Observation (EO) and monitoring data. New modelling approaches including information from EO data are being developed, ecosystem services in current and future conditions are being assessed and the requirements of future PAs are being defined. The ECOPOTENTIAL Virtual Laboratory Platform, fully integrated in GEOSS, will assure open and interoperable access to data and knowledge. Support to transparent and knowledge-based conservation and management policies, able to include information from EO data, will be given. Knowledge gained in the PAs is being used for planning and management of future PAs. The ECOPOTENTIAL project invests in capacity of several target audiences, including students, scientists and PA managers.

The current ECOPOTENTIAL CoP, built during the first three years of the project, is composed by scientists working in the project, by external advisors and scientists who have been associated to the project in the course of time, and by the main user group of the project, namely, technical and management staff of Protected Areas as well as conservation policy makers and conservationists. Activities involving citizens have also been undertaken. During the last year of the project, this CoP will be extended to include PAs staff outside the areas involved in the project. Long-term sustainability of the CoP will be guaranteed by the inclusion of this specific community into the Ecosystem Community of Practice of the GEO ECO Initiative of GEO GEOSS, which is being built starting from the experience gained in ECOPOTENTIAL.

This document presents the actions undertaken so far by the ECOPOTENTIAL project to build the project Community of Practice at several levels and involving different types of users.

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2. Introduction

2.1. Purpose of the document

This document presents the actions undertaken so far by the project to build the ECOPOTENTIAL community of practice at several levels and involving several kinds of users:

- Within the international research and monitoring communities (LTER, LifeWatch, EGU, GEO, GEO ECO, GEO BON, Belmont Forum and other data infrastructures and projects);
- With parks technical staff and managers and policy makers;
- With citizens.

3. Building the ECOPOTENTIAL Community of Practice: The ECOPOTENTIAL Storylines

In a process that started at the very beginning of the project, closely involving the technical and management staff of the Protected Areas involved in the project, the ECOPOTENTIAL partners co-developed a number of narratives (the storylines), which contextualize the overall workflow of ECOPOTENTIAL in specific ecological, management and policy settings. The storylines integrated the real-life issues which have broad relevance to many Protected Areas included in the ECOPOTENTIAL project. The close collaboration resulted in a specification of the needs for Earth Observation data and in-situ data for ecosystem modelling, ecosystem services, cross-scale topics, as well as the demands for future protections, policy and capacity building. The goals of each Storyline were defined based on co-design with the staff of Protected Areas, identifying, through personal meetings and written exchanges, the main applied issues that are of major concern in each Protected Area.

While storylines do not have to cover actions in all the Work Packages of the project, they are aimed to be broad, truly transdisciplinary and locally relevant so that the narratives speak to and engage stakeholders and decision-makers. Each storyline focused on at least one Protected Area and formed the basis for further operational work in the field, adding specifics, defining a work plan, assigning tasks, and allocating resources (person-months) among partners, as well as engaging Protected Areas staff in the co-development of the plans. They thereby formed the basis of the concrete and in-situ collaborations between ECOPOTENTIAL researchers and protected areas technical and managerial staff. The storylines thus represent the core of the ECOPOTENTIAL approach in providing the necessary knowledge for solving specific conservation issues and building knowledge-informed management actions. A number of ECOPOTENTIAL publications have been developed as research outputs of the several storylines and the Remote Sensing products developed in the project are now available and used for day-to-day monitoring and management in several of the project Protected Areas.

The ECOPOTENTIAL Storylines are listed and described in detail in the ECOPOTENTIAL Website at: http://ecopotential-project.eu/site-studies/storylines.html

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4. Comparing the Views of Park Managers and Scientists

4.1. The ECOPOTENTIAL surveys and visited PAs

Four major surveys have been carried out in 2015, 2017 and 2018, to assess the indicator variables that were judged by Protected Area (PA) managers, rangers and ECOPOTENTIAL scientists to be the most important for the status and development of the Ecosystem Functions and Structures (EF), Ecosystem Services (ES), and pressures (Threats) in their PAs.

The first survey was focused on the views of ECOPOTENTIAL scientists, and the second on the opinion of PA staff. These two surveys, both held in 2015, indicated the existence of firm differences between the perceptions of PA managers and scientists (see section 3.2 Bonn et al 2016; Nolte et al 2017) (Hummel et al 2017). From the analysis of the survey's results it became clear that a stronger interaction between the different stakeholders (scientists versus PA management) was needed. To this end, a range of actions was set up, which, next to workshops in Pisa during May 2017 and February 2018, included the large-scale third survey that was held during summer and autumn 2017.

In the large-scale third survey, 25 PAs, of which 22 European, 1 Israeli, and 2 near/in Africa, were visited on the spot, i.e. at the PAs territories, by a dedicated team of ECOPOTENTIAL scientists. During those visits, the management and rangers were interviewed during one or two days following a questionnaire of 30 pages long, including questions on managerial, economic, environmental, sociological and cultural issues concerning the PA. More than 120 PA managers, rangers and scientists participated in the third series of surveys.

The fourth survey in 2018 was held among ECOPOTENTIAL scientists in order to review their change in perception since 2015, and to compare the results with those of the third survey.

The results of the third and fourth survey showed that, within 2 years' time of ECOPOTENTIAL actions, the views of PA managers and scientists became much more uniform and equilibrated.

The sequence of surveys, and the results therefrom, indicates that an ongoing discussion between scientists and PA managers can help to come to a jointly shared harmonised framework for the analysis and management of PA. This harmonisation depends largely on the intensity and degree of communication between partners. As such, several joint workshops were organized to co-develop ECOPOTENTIAL research and to simultaneously prepare the ground for a long-term CoP bringing together a diversity of knowledge producers and users.

4.2. Towards a shared view of Essential Variables for PAs

During the first two ECOPOTENTIAL surveys in 2015 (see 3.1) in total 396 variables were suggested by PA managers and scientists as being important in PA. Later on, in the fourth survey 768 indicator-metrics combinations were given to measure these variables.

At the start of the ECOPOTENTIAL project (2015) the high diversity in variables judged to be important went together with a large difference between scientists and PA managers in their perception of the degree and type of importance of the ES and Threats variables in PA (Hummel et al 2017). PA managers had among each other a consistent and comparable view on the importance and type of variables, whereas ECOPOTENTIAL scientists deviated strongly from each other and from the managers.

After harmonisation of the results of the first two surveys a total of 67 harmonised important variables remained. The perception of the importance level of these variables was tested again after a 2 years long communication process in the project (see 3.1). A final set of seventeen (17) very highly important variables over all PAs was found (11 essential environmental and 6 essential socio-economic variables for PA, the EEPVA and ESVPA respectively).

This final set of Essential Variables (EV) has now been perceived equally and jointly by the PA managers and scientists, and is applicable in any kind of area (i.e. transitional waters, semi-arid areas, and mountains). Thereby the ECOPOTENTIAL process to select EV jointly by practitioners and scientists is a showcase for the interactions that may occur in a Community of Practice.

The selected priority variables are for the EF a set of 5 EEVPA (Habitat suitability, Biodiversity, Population dynamics, Primary production, Land- and sea-scape). For the ES, there are 4 EEVPA (Habitat for feeding and breeding, Charismatic landscape, Biodiversity conservation, Charismatic species), and 3 ESVPA (Leisure activities, Education and research, Spiritual significance). For the threats, there are 3 ESVPA (Overexploitation, Disturbance, Tourism) and 2 EEVPA (Change in species, Climate change).

These variables do share a strong resemblance with Essential Biodiversity Variables as determined by the GEOBON initiative, though using different terminology. The variables recognised in ECOPOTENTIAL are determined in a bottom-up procedure with the PA practitioners, and thereby more basic of nature and connected to environmental functionalities and practical use in PA and the before mentioned storylines, denominating the daily occurring interactions between environment, society and the actually acting pressures.

For the 17 most important variables, a range of 50 possible indicators and their metrics were prioritised along a range of criteria, including that they give unambiguous outcomes, convey a single meaningful message, are informative at the detail level of the specific variable, and are generally applicable in time and space over all studied domains during any moment in the year.

Because of the bottom-up and jointly shared character of the variables and their general occurrence in the majority of the PAs in different domains, the EEVPA and ESVPA may form the preferable basis for further studies and comparisons on the current and future status and changes in the quality and requirements of PAs.

Because of a low appearance of ESVPA (the socio-economic variables) in many studies and reports, these variables should get more attention and have priority in the further studies and discussion to be entertained by a Community of Practice.

4.3. Joint PA workshops to co-develop PA research and to assess cultural ecosystem services through participatory mapping

In November 2016, the Participatory Mapping Workshop for an ‘Ecosystem service assessment of the Pelagos Sanctuary for Marine Mammals’ was organised by the European Institute of Marine Studies (IUEM, France) and the IOC-UNESCO, as collaboration of ECOPOTENTIAL with the LabexMER project. The two-day participatory mapping workshop gathered field experts and practitioners (e.g. local experts, whale-watching companies, researchers) of the Pelagos Sanctuary for Marine MammalsTM area from Italy, France and Monaco. The aim of the meeting was to: i) collect information on the social perception of whale-watching activities in the area; ii) build together maps of whale-watching zones and other human activities in the area; and iii) to discuss the dual role of humans in the ecosystem, as beneficiaries and as drivers of change. Through the use of participatory mapping methods and focus group discussions, the workshop participants identified the most critical areas for whale watching in the Sanctuary. The outputs of the meeting fed into ECOPOTENTIAL ecosystem service models, created a storymap (in collaboration with GRID-Arendal) to inform the general public about the work done in this area and to discuss and validate this by other area experts that were not able to attend the meeting.

In May 2017, the UFZ team, Daniel Orenstein from Technion University and Silvia Giamberini from the CNR ECOPOTENTIAL management team organised a participatory mapping workshop as part of the PA meeting in Pisa to develop joint mapping of cultural ecosystem services to co-develop both ecosystem service mapping fieldwork and the Citizen science app development. This included a fieldtrip and a questionnaire survey to assess landscape

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preferences and nature appreciation values and to discuss with PA managers suggested research methodologies and outputs.

In March and April 2018, the UFZ team organized three workshops in close collaboration with the local park managers and scientific ECOPOTENTIAL partners University of Zürich and to assess ecosystem services in mountain protected areas. Each workshop targeted one of the national parks studied by the UfZ team: the Swiss National Park, the Austrian Kalkalpen National Park, and the Portuguese Peneda-Geres National Park. For each park and its surroundings, participants with diverse backgrounds (park managers, tourism, conservation, forestry …) collectively identified hotspots for cultural ecosystem services and discussed their main drivers and trends. The workshops also served to prepare the upcoming field work of summer 2018, when the visitors' perceptions and uses of cultural ecosystem services in the three national parks will be collected and to co-design the envisaged output for the PAs.

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5. Joint meetings of PA Staff and researchers

From May 2nd to May 5th 2017, 70 participants from across Europe and beyond gathered in the Regional Natural Reserve "San Rossore – Migliarino – Massaciuccoli" in Pisa (IT) to take part in the workshop titled 'Application of Earth Observation tools in Protected Areas in Europe and beyond'.

Scientists, Protected Area Managers and technical staff from 23 different Protected Areas (Kruger, Wadden Sea, Rèunion Island, Mediterranean LME, Gran Paradiso, Samaria, Har HaNegev, Curonian Lagoon, Sierra Nevada, Camargue, La Palma, Abisko, Bavarian Forest, Danube delta, Swiss National Park, Negev, Doñana, Lake Ohrid, Alta Murgia, Montados, Kalkalpen, Hardangervidda, Isole Egadi) attended the Workshop.

This four-day event was organized by the Institute of Geoscience and Earth Resources of the Italian National Research Council (CNR) together with the UN Environment (UNEP) with the help of other ECOPOTENTIAL project partners.

The meeting, aimed to foster the creation of the ECOPOTENTIAL ecosystem Community of Practice, was specially focussed on understanding the practical needs in the use of Earth Observation (EO) tools, such as satellite imagery and ecosystem models, under development by ECOPOTENTIAL, to facilitate the management of Protected Areas.

Sessions focused on four topic areas of tools and research developed in the framework of the project:

- Application of in situ monitoring data, including soil and water samples;
- Use and interpretation of Remote Sensing products, such as photographs and infrared images from satellites;
- Modelling of ecosystems, ecosystem functions and services;
- Citizen science activities in Protected Areas.

For each topic area, Work Package leaders organized a session designed to both inform the Protected Area staff about the tools and research developed in ECOPOTENTIAL and to gather information about how this work can meet needs of the protected areas. A central goal was to ensure that Protected Areas can be managed from an ecosystem services perspective, using tools such as satellite images of landscapes to accurately identify threats, like deforestation, biodiversity loss and climate change, to effectively protect ecosystems. The aim was to take into account the feedback provided by representatives from Protected Areas in the research work undertaken by ECOPOTENTIAL.

Antonello Provenzale (CNR), ECOPOTENTIAL's Coordinator, and Matthias Jurek (UN Environment) introduced the ECOPOTENTIAL Project and meeting aims in the opening session. Following the welcome notes, a series of presentations then addressed to Protected Area perspectives and expectations (Ramona Viterbi, Gran Paradiso National Park), the variation in perspectives of Protected Area managers (Herman Hummel, NIOZ) and the need for Earth Observation tools for Protected Area management (Fiona Danks WCMC). The first day continued with the presentations of case studies of good practice of the use of EO tools for the management of Protected Areas: Bavarian Forest (Marco Heurich, NPBW), Curonian Lagoon (Lina Dikšaitė and Zilvinas Grigaitis, CNSPA) and Isole Egadi (Sergio Cappucci, AMP Egadi). Tina Schoolmeester (GRIDA) presented "The use of story maps and the upcoming photo exhibition". Izak Smit (SAN Parks) concluded the first day event with the talk on the Kruger National Park and the role of science.

The second day was organized in 2 sessions. The morning session focused on the identification of the needs for the use of Remote Sensing and in situ data in Protected Areas chaired by Cristina Domingo (CREAF) and Dimitris Poursanidis (FORTH). The afternoon session aimed at finding a match perspective of PA managers and scientists for the management of Protected Areas chaired by Herman Hummel (NIOZ). Antonello Provenzale (CNR) and Ilse Geijzendorffer (TdV) concluded the second day with the presentation "Towards an Ecosystem Community of Practice, including overall training needs and the science-policy interface".

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The third day was organized in 2 sessions. The morning session dealt with the EO-based modelling tools in Protected Areas chaired by Antonello Provenzale (CNR). The afternoon session concerned the possibilities and issues for participatory ES Mapping & Citizen Science in Protected Areas facilitated by Aletta Bonn (UfZ), Martin Mantel (UfZ) and Daniel Orenstein (Technion).

At the end of the three days, on 5th May, the CNR team, in collaboration with the Italian NGO "LIPU" (an Italian NGO devoted to birds' protection) organized a fieldtrip inside a wetland within the Park: the "Massaciuccoli Lake", also aimed at conducting a citizen science exercise about the perception of anthropic vs natural landscape led by the scientist Daniel Orenstein. During the visit, the participants visited the archaeological remains of two important Roman remains from the Imperial period, the protected area managed by technicians and volunteers of the LIPU bird sanctuary (Oasi LIPU), known as "Riserva del Chiarone". During the walking, the participants had the possibility to watch many rare species of flora and numerous birds living in the lake, representing the ideal place for breeding, wintering or stopping during migration.

During the event, the participating technical staff stressed the needs for a training workshop to learn essential skills for practical application of Earth Observation tools developed by ECOPOTENTIAL.

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6. Training Course on the use of EO and Modelling tools

Following the request of the PAs technical staff, the training course *"ECOPOTENTIAL Training Course on Remote Sensing and Modelling Applied to Natural Ecosystems"* has been organized by the ECOPOTENTIAL Coordinator, the Institute of Geosciences and Earth Resources (CNR-IGG), and took place on February 19-23, 2018, in Pisa (IT). The course focused on the use of Remote Sensing Data and In-situ information, as well as on the use of ECOPOTENTIAL-related data portals and of ecological models. About 50 people attended, with 16 attendees representing 8 Protected Areas, and about 30 partners. There were 18 Teachers, all belonging to ECOPOTENTIAL partner Institutions.

All the training was aimed to illustrate the use of all the practical tools developed within ECOPOTENTIAL, ready to be adopted in the monitoring activities within the protected areas for retrieving information and for calculating variables and indicators.

The lectures were based on case studies at several levels of difficulty and addressing practical problems in the several ecosystem types, e.g. teaching how to calculate the most important proxy variables that can be extracted from remote sensing data or showing practical cases on the use of models. Other tools, as the DEIMS repository, the website "Protected Areas from Space" and the EODESM system for extracting land cover maps have been showed and discussed. The ECOP Virtual Laboratory, the ECOPOTENTIAL Virtual Research Environment, has also been introduced. An anonymous final survey on the evaluation of the course has given very positive answers. As a follow up, researchers from Gran Paradiso national park asked for a training "on site" about the use of EODESM to evaluate the possibility of using it in the routine surveys of the Park. The training will take place in September 2018.

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7. Citizen Science

7.1. Workshop on Citizen Science in Protected Areas

On 21 November 2017, the ECOPOTENTIAL workshop titled '*How can Citizen Science enhance environmental monitoring in protected areas in Europe?*' in Roma, Italy, was organised by UFZ/iDiv and co-hosted by a range of partners: the Italian Academy of Sciences, EUROPARC Federation, JRC European Commission, the European Citizen Science Association (ECSA) and LifeWatch. In the workshop, around 25 participants from over 10 European countries, both protected area staff and managers and researchers, worked jointly to discuss good practice of citizen science and how to develop guidelines. Building on results from the workshop, a guide is currently being developed on how to establish citizen science projects in protected areas in Europe. The workshop was held prior to the national Italian Citizen Science conference that took place at the CNR headquarters in Rome on November 22 and 23, offering opportunities for further discussions and involvement with protected area managers and ECOPOTENTIAL partners.

7.2. Development of the MapNat2 smartphone app

The smartphone application MapNat2 (Mapping Nature's services – version 2) has been developed in the context of the ECOPOTENTIAL project and it is currently ready as Beta Version (see also D12.9). It contributes to the development and operationalization of participatory mapping methods based on new technologies. It has been designed as a tool for citizens and scientists to map nature's services, focusing on the actual use of ES and including the location where they are used. This app can be used as a citizen science tool, through which citizens can map and share their use of ES on site, and as a research tool, with scientists observing the actual locations and modalities of ES use. It has been developed by the Helmholtz Centre for Environmental Research-UFZ (Germany) in collaboration with the Norwegian Institute for Nature Research-NINA (Norway) and the Leibniz Universität Hannover-LUH (Germany).

In the context of the ECOPOTENTIAL project, the use of MapNat2 app will be promoted in three protected areas (Swiss National Park, Austrian Kalkalpen National Park and Portuguese Peneda-Geres National park) during the summer 2018 to assess visitors' use of cultural ecosystem services. This will provide a prototyping of the app so that the app can also be used in other protected areas interested to assess the actual use of (cultural) ecosystem services. Besides, the MapNat2 will be used in teaching e.g. at Leibniz Universität Hannover or the Friedrich-Schiller University Jena, especially during excursions and study projects. It will be open access and available to all interested users.

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8. Connections with LTER and LifeWatch

The ECOPOTENTIAL Community of Practice does not live in isolation, but it is connected and interlinked with the other major European and international initiatives in the field of ecosystems, biodiversity and Earth Observation. In particular, the ECOPOTENTIAL CoP is strictly linked with LTER (both eLTER and ILTER), the LifeWatch ERIC, and GEO GEOSS. The GEO Ecosystem Community of Practice, which is being built based on the activities of the ECOPOTENTIAL project, will include relevant contributions from LTER and LifeWatch.

8.1. LTER Europe and ILTER

Long-Term Ecosystem Research (LTER) is an essential component of global efforts to better understand ecosystems and their changes across ecological and socio-ecological gradients. Through research and monitoring, LTER seeks to improve our knowledge of the structure and functions of ecosystems and their long-term response to environmental, societal and economic drivers. LTER contributes to the knowledge base informing policy and to the development of management options in response to the Grand Challenges under Global Change.

LTER-Europe (www.lter-europe.net) is the European network for Long-Term Ecosystem Research (LTER) comprising of the different national LTER networks. The network is the result of a 15-year process of integration of ecosystem research infrastructures across Europe, which resulted in formal LTER networks in 21 countries (see Figure 2) with well-established national and European governance structures and embedded in the global LTER network (ILTER). It was founded in 2003 as the outcome of the Network of Excellence project ALTER-Net. Since its launch in 2003, LTER-Europe has sought to better integrate traditional natural sciences and holistic ecosystem research approaches that include human activities and wellbeing. LTER-Europe has been heavily involved in developing the concept of Long-Term Socio-Ecological Research (LTSER). As a result, LTER-Europe now comprises not only a continental network of LTER sites but also larger LTSER platforms, where long-term transdisciplinary research is encouraged.

LTER-Europe builds on an in-situ infrastructure of about 488 formally acknowledged ecosystem research sites (65% terrestrial, 26% aquatic and 9% transitional waters LTER Sites) and 50 LTSER Platforms for socio ecological research at the regional scale. All sites and national networks comply with a refined site classification reaching from highly instrumented master sites (19%), to regular LTER sites (44%), extensive (24%) and emerging sites (4%). The infrastructures are operated by around 100 institutions. LTER Europe is a regional group of the global ILTER network.

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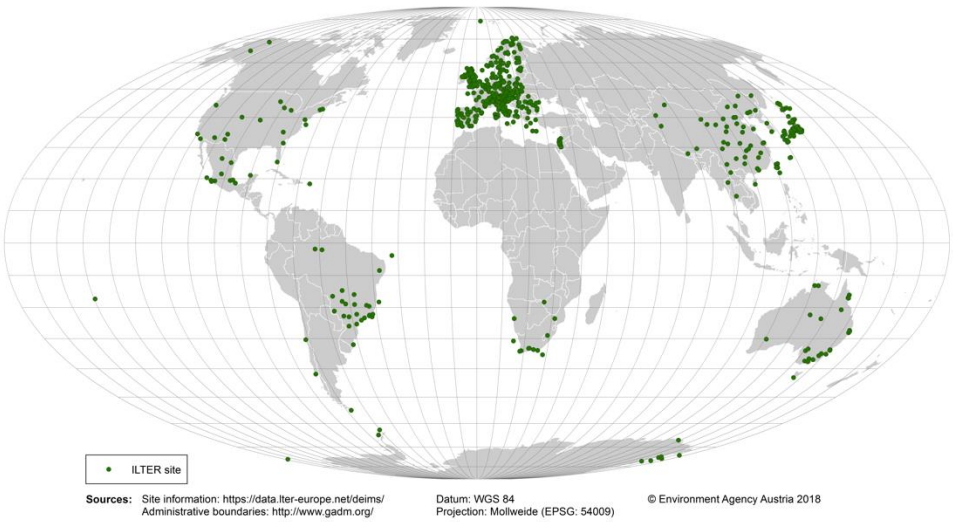

Figure 1 Overview of the LTER sites and LTSER platforms in the ILTER network (Source DEIMS-SDR Status 01/2018)

ILTER (https://www.ilter.network/) forms an important component of Earth observation, complementing Remote Sensing (RS) and offering valuable opportunities for ground-truthing and RS service development and refinement. The high spatial and temporal resolution of ecosystem monitoring carried out at ILTER Sites enables the detection of both sudden and slow but significant changes in ecosystem functioning responding to the presence, absence and mix of pressures/drivers. The ILTER whole system approach contributes to our understanding of the influences and interactions of multiple and complex ecosystem variables including socio-economic factors (PSR, DPSIR framework). ILTER encourages complementary experiments at ILTER sites (e.g. long-term treatments and management approaches compatible with the long-term observational purpose) or research questions related to ILTER sites in order to speed up knowledge production.

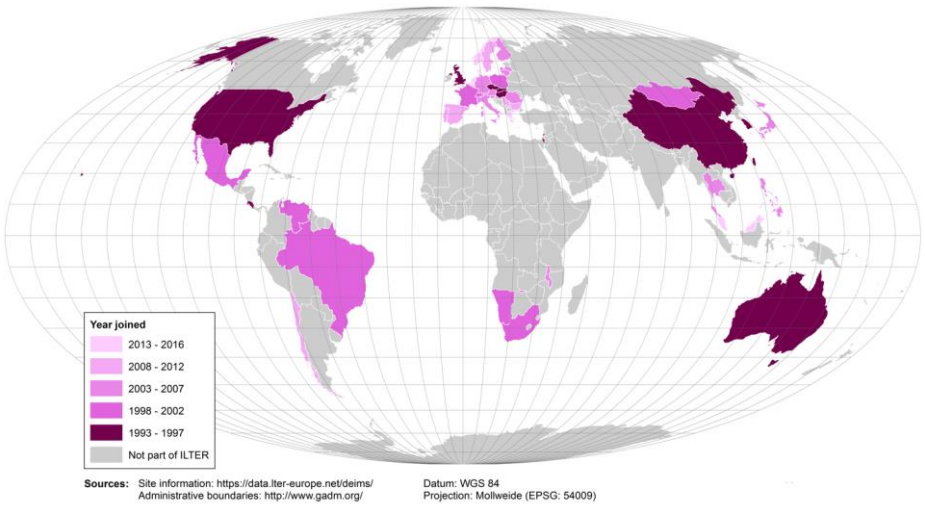

Figure 2 Member networks of ILTER

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At the network level, ILTER supports globally comparative and synthetic analyses over time and space in search of general ecological principles prevailing across biomes, environmental zones, ecosystem types and scales. It thereby enables the expansion of scientific opportunities and knowledge, and delivering reliable information for evidence-based policy.

For the network, but also beyond it, a set of about 50 metadata attributes (installations at the sites, covered research topics, data policy etc.) is defined in order to establish a registry of long term monitoring sites. In the DEIMS-SDR[1] site, documentation of LTER allows for the fast and objective selection of sub-sets of sites, which are suited for involvement in specific projects. The tool is shared within the research community and is used beyond the network to document relevant observation and experimentation facilities and the resulting data.

Sharing the site network

ECOPOTENTIAL is building on a network of well recognized globally important protected areas. Apart from protecting their natural heritage, most of these areas harbour major research infrastructures for studying ecosystem process and how they are affected by global change. Many of the protected areas, at least on a European scale, are therefore part of the LTER network providing indispensable long-term data and knowledge about major ecosystem types in Europe. 10 of the protected areas in Europe are officially part of the European LTER network.

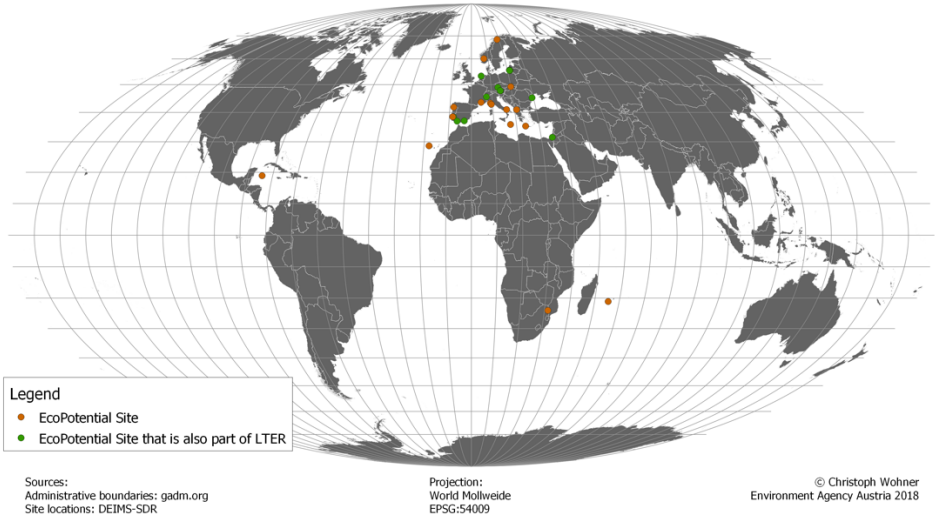

Figure 3 Map of protected areas in ECOPOTENTIAL (in Green the ECOPOTENTIAL protected areas which are also LTER sites)

[1] See https://data.lter-europe.net/deims/

Protected areas which are hosting LTER sites taking part to ECOPOTENTIAL research are:

LTER & ECOPOTENTIAL site:	Country
Bavaria National Park	Germany
Curonian Lagoon Biosphere Reserve	Lithuania
Danube Delta biosphere reserve	Romania
Doñana National Park	Spain
Gran Paradiso National Park	Italy
Har ha Negev	Israel
Kalkalpen National Park	Austria
Sierra Nevada	Spain
Wadden Sea	The Netherlands

The Abisko National Park (Sweden, https://data.lter-europe.net/deims/site/f0b67e0d-d3f0-483b-adf0-99ca7bcdcc26) as well as the Montado in Alentejo Natura2000 (Portugal, https://data.lter-europe.net/deims/site/10e6a0e2-a593-43d0-b915-31ec6e2d840e) site are not LTER sites themselves but are located nearby to a formal LTER site.

Part of the research activities conducted in the LTER-ECOPOTENTIAL sites are actively contributing to the ECOPOTENTIAL research programme, as in Gran Paradiso National Park, Italy, where the research on status and long-term changes of alpine grasslands is object of a specific ECOPOTENTIAL storyline.

Sharing of tools and services between LTER and ECOPOTENTIAL

ECOPOTENTIAL extended and contributed to the development and usage of tools provided by LTER Europe and ILTER. With the DEIMS Site and Dataset Registry (SDR), a core component of the LTER data infrastructure was used to document the ECOPOTENTIAL protected area's observation and experimentation facilities. DEIMS-SDR does not only allow documenting the research sites but also the dataset generated (see Figure 4)

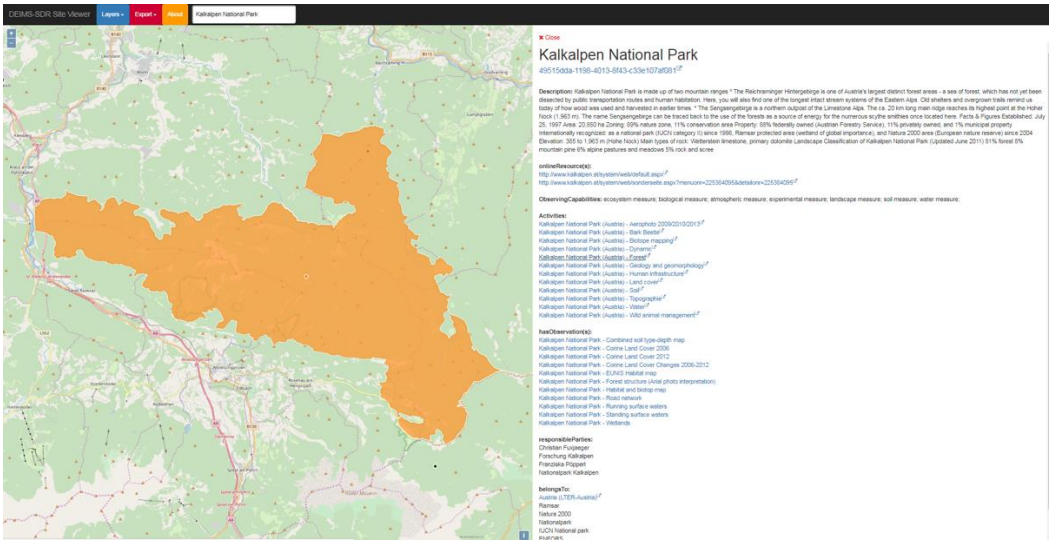

Figure 4. Interactive Map Viewer visualising data on an LTER site and ECOPOTENTIAL Protected Area from DEIMS-SDR (https://data.lter-europe.net/deims/site/49515dda-1198-4013-8f43-c33e107af081)

Protected areas taking part at ECOPOTENTIAL research and not yet formally part of the LTER network joined the DEIMS repository and added their relevant information. An "ECOPOTENTIAL code" has been created in order to

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classify the sites, under the format ***ECOPOT_XX_###,*** where XX is the country code (e.g. ECOPOT_GR_001) (see figure 5)

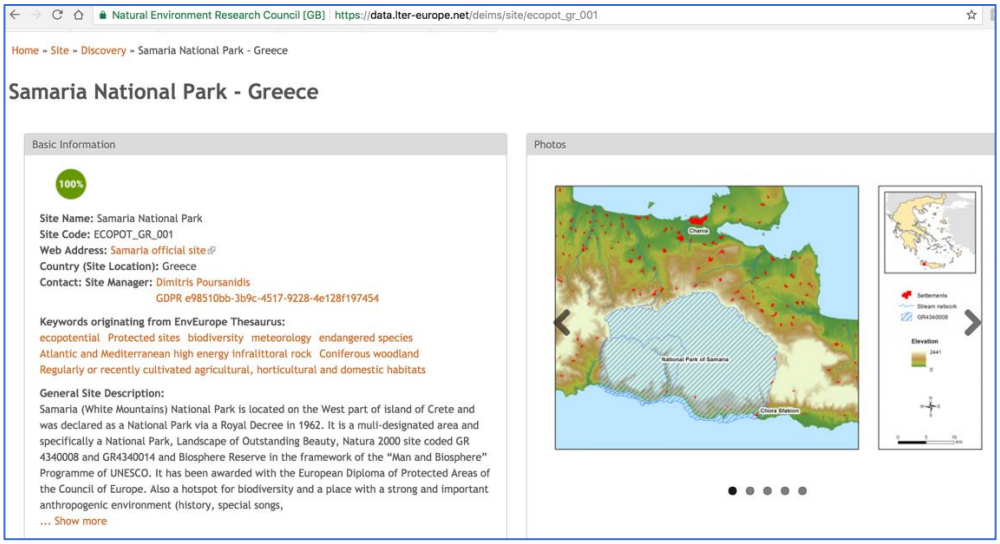

Figure 5: visualization of the Samaria National Park – Greece on DEIMS portal

ECOPOTENTIAL adopted EML and ISO19115/19139 as basic metadata standards. The project is also contributing to the development of common shared vocabulary for environmental observations -EnvThes -. The contributions focus especially including the expertise on the interface between remote sensing and environmental science. The work on EnvThes is an important task to create a common semantic basis for the documentation and sharing of the data across different domains.

Sharing of knowledge and contribution to meetings

ECOPOTENTIAL contributed to a number of LTER meetings on the national, European and global scale focusing on the presentation of results and on interlinking protected area research and monitoring with the concepts of LTER. In particular ECOPOTENTIAL members participated in the following conferences, presenting ECOPOTENTIAL results and approaches:

ILTER First Open Science Meeting (Skukuza, South Africa, October 2016)

- 2 posters from CNR (Baneschi, Giamberini, Imperio, Provenzale et Al), 1 poster from CSIR (Abel Ramoelo);
- 2 oral presentations by CNR (Provenzale – ECOPOTENTIAL coordinator) about ECOPOTENTIAL and GEO ECO;
- participation of 8 ECOPOTENTIAL Researchers which are also LTER members, presenting their work on LTER sites and/or who have coordination roles within the LTER network.

ILTER Network Meeting and Zone Ateliers & Critical Zone Observatory Network (LTER France) (Nantes, France, October 2017): Oral and poster presentations presenting ECOPOTENTIAL research:

- Giamberini S., Baneschi I., Provenzale A., Tasevska O.: The fate of the iconic Salmo letnica in Lake Ohrid under multiple threats (Oral presentation);
- Imperio S., Provenzale A., Vivaldo G., Marimon C.D., Palazzi E., Marangi C., Karnieli A., Giamberini S.: Changes in Protected Areas: the ECOPOTENTIAL view (Oral presentation);
- Orenstein D.: Nature, landscapes and biodiversity: what do the 99% (non-ecologists) think? (Oral Presentation);

- Ilaria Baneschi, Stefano Ferraris, Silvia Giamberini, Simona Imperio, Pietro Mosca, Antonello Provenzale, Brunella Raco1, Ramona Viterbi. The Earth Critical Zone and Ecosystem Observatory at Nivolet, Gran Paradiso National Park, Italy

Interdisciplinary workshop "Towards a Unified framework for life supporting systems in the Anthropocene"; October 2017, Tzuba, Israel, sponsored by the Israel Academy of Sciences and Humanities. Invitees were targeted from among the ECOPOTENTIAL, NEON and LTER communities. The workshop brought together senior scientists from both ILTER and ECOPOTENTIAL l to develop a synthesis of conceptual and research frameworks including "Critical Zones", "Ecological Integrity", and Socio-Ecology. Participants included Antonello Provenzale, Carmela Marangi, Silvia Giamberini, Arnon Karnieli, Ehud Meron (ECOPOTENTIAL), Michael Mirtl (LTER and ECOPOTENTIAL), Moshe Shachak, Nikolaos Nikolaidis (LTER), , Daniel Orenstein (LTER and ECOPOTENTIAL), and others.

LTER Europe Conference and Advance eLTER Final Meeting (Malaga, Spain, November 2017)

- Provenzale: Oral presentation on "Climate change and European Protected Areas" and participation at the eLTER final meeting;

LTER Italy annual assembly (Nov 2017): participation at the meeting and discussion as ECOPOTENTIAL coordination (Giamberini, Provenzale).

Shared work between ECOPOTENTIAL and LTER has also been presented by:

- Francisco Garcia Bonet (University of Grenada, working on LTER and ECOPOTENTIAL site Sierra Nevada National Park) at the European GEO Workshop – EGW 2017 in Helsinki, June 2017, on a thematic workshop organised by the ECOPOTENTIAL coordinator on "Global change impacts in mountain regions";
- Miri Tsalyuk, Idan Porat, Daniel Orenstein (Technion - ITT) at the 45th Annual Meeting of the Israel Union of Ecology and Environmental Sciences, 10-11/7/2017 Herzlia, Israel.

ECOPOTENTIAL was mentioned during the "super-core" eLTER meeting in Eilat in March 2018, also regarding possible relationship with ECZO and the forthcoming Gran Paradiso summer school at Gran Paradiso in July 2018 (ECOPOTENTIAL is one of the organisers), where eLTER might "co-endorse" the event.

The collaboration of ECOPOTENTIAL and LTER also resulted in research papers on peer-reviewed journals, such as:

Nestola E. et al.	Are optical indices good proxies of seasonal changes in carbon fluxes and stress-related physiological status in a beech forest?	Science of the Total Environment	CNR	15/01/2018	10.1016/j.scitotenv.2017.08.167
Rogora M. et al.	Assessment of climate change effects on mountain ecosystems through a cross-site analysis in the Alps and Apennines	Science of the Total Environment	CNR, EURAC	27/12/2017	https://doi.org/10.1016/j.scitotenv.2017.12.155

Dirnböck T., et al.	Historic nitrogen deposition determines future climate change effects on nitrogen retention in temperate forests.	Climatic Change	EEA	21/07/2017	**doi:10.1007/s10584-017-2024-y**

8.2. LifeWatch ERIC

LifeWatch is the European Infrastructure supplying e-Science research facilities for scientists seeking to increase knowledge and deepen the understanding of biodiversity organisation and ecosystem functions and services, with the goal of supporting civil society in addressing the key planetary challenges. Combining a wide range of ICT tools and resources with deep knowledge of the domain, as an e-Science infrastructure LifeWatch-ERIC provides unprecedented opportunities to perform faster, cutting-edge collaborative activities for biodiversity and ecosystem research.

LifeWatch-ERIC has been designed to tackle many of the constraints affecting researchers' daily activities and their pressing need for increasingly diverse data and larger and more advanced models, open data and open science cloud, making it possible to explore the new frontiers of the ecological domain. Aware of its socio-economic dimension, LifeWatch-ERIC was set up with a clear mission to support civil society in addressing the challenges ahead. The infrastructure is more than a resource for researchers, being directly connected to a number of issues at the heart of society's wellbeing today, such as biodiversity conservation, ecosystem management, food & energy supply, the blue & green economies, the waste cycle, tourism & cultural heritage.

LifeWatch shares with the ECOPOTENTIAL project the objective of making data and models on ecosystem services and functions available for all and the concept that open data is provided to increase knowledge exchange and growth. The University of Salento, Lecce, Italy is the headquarter of the LifeWatch "Service centre" and is also partner of ECOPOTENTIAL. Their role in the project is to bring the LifeWatch experience on biodiversity and ecosystem data within the project, taking part to the building of the conceptual scientific framework (WP2), to the identification of relevant datasets (WP5) and to capacity building (WP12). In the framework of WP12, LifeWatch and ECOPOTENTIAL have developed a "serious game" on ecology for schools, called ECOPOTENTIAL 4 SCHOOLS (http://193.204.79.105/ecopotential/) which has also been presented by other ECOPOTENTIAL partners at dissemination events as like as the European Researcher's night. The coordinator of ECOPOTENTIAL has been invited to give a keynote speech at the conference on the European Ecological Federation 2015 "Ecology at the interface" in Rome (21-25 September 2015) and is currently coordinating a big national proposal for the empowering of the Italian contribution to the LifeWatchERIC infrastructure. Three ECOPOTENTIAL abstracts have been submitted to the forthcoming Italian National LifeWatch conference (Rome, 25-26 June 2018).

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9. Connections with GEO

The Group on Earth Observations (GEO), established in 2005, is a voluntary partnership of governments and organizations that evisions "a future wherein decisions and actions for the benefit of humankind are informed by coordinated, comprehensive and sustained Earth observations and information". GEO has the goal of creating the Global Earth Observation System of Systems (GEOSS), that will link Earth observation resources world-wide across multiple Societal Benefit Areas (SBA) and make those resources available for better informed decision-making.

In the period 2005-2015, one of the Societal Benefit Areas was devoted to the global monitoring of ecosystems, while another was focused on biodiversity observations. From 2016 onward, these two SBAs will be joined in a new SBA called Biodiversity and Ecosystem Sustainability. Other SBAs are Disaster Resilience, Energy and Mineral Resources Management, Food Security and Sustainable Agriculture, Infrastructure and Transportation Management, Public Health Surveillance, Sustainable Urban Development, and Water Resources Management. Parallel to the general SBA structure, from 2016 the activities of GEO will be organized around a set of GEO Community Activities, GEO Flagships and GEO Initiatives (see www.earthobservations.org).

To support European activities in the Global Ecosystem Monitoring Task of GEO/GEOSS, in 2014 the European Union launched the H2020 call SC5-16-2014 "Making Earth Observation and Monitoring Data usable for ecosystem modelling and services". The ECOPOTENTIAL project was funded in early 2015 under this call. One of the goals of ECOPOTENTIAL is to develop a strong European support and leadership within the GEO Ecosystem tasks and support/implement the general vision endorsed by GEO/GEOSS. The Coordinator of ECOPOTENTIAL Antonello Provenzale is the current coordinator of the GEO Global Ecosystem Initiative (GEO ECO), the leader of WP2 Henrique Pereira is the current coordinator of GEO-BON, a key scientist of ECOPOTENTIAL, Elisa Palazzi, is the co-chair of the GEO-GNOME initiatives on mountains and an entire work-package, WP10, is devoted to build the ECOPOTENTIAL virtual laboratory platform fully interoperable with the GEO Data portals and archives; the leader of WP10, Stefano Nativi, is the responsible for the maintenance of the GEO Data portals and archives. Together, and with the support of the other partners of the Consortium, already deeply involved in GEO-related activities and projects, the group participating in ECOPOTENTIAL is providing a coherent European contribution to GEO/GEOSS, through participation in the GEO Global Ecosystem Initiative (GEO ECO), the GEO Global Network for Observations and Information in Mountain Environments (GEO GNOME) and in the GEO Flagship on the Biodiversity Observation Network (GEO BON).

In this framework, the ECOPOTENTIAL coordinator and partners have taken part and organised the following events:

- Participation to the 9th and 10th GEO European Projects Workshops with presentation as ECOPOTENTIAL delegation;
- Participation at the XIII GEO Plenary in St Petersburg, November 2016;
- Participation of a delegation and organisation of a booth with posters and videos as part of the EUROGEOSS Stand at the GEO IVX plenary meeting in Washington DC, Oct 2017;
- Organisation of a GEO ECO workshop on "Global change impacts in mountain regions" at European GEO Workshop – EGW 2017 in Helsinki, June 2017, where ECOPOTENTIAL – related presentations have been given;
- Organisation of a side event in GEO IVX plenary meeting in Washington DC, Oct 2017;
- Organisation of the workshop "SPACED: Using Earth Observation to Protect Natural Landscapes" in Bruxelles January 2018.

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9.1. GEO ECO

One of the currently active GEO Global Initiatives is GEO ECO: The Global Ecosystem Initiative, which combines new activities related to the H2020 ECOPOTENTIAL and SWOS projects with continuing global ecosystem mapping activities carried forward from the former GEO Ecosystems Task. GEO ECO is the continuation of the activities of the GEO Global Ecosystem Monitoring Task, and it includes interactions with GEO-BON, LifeWatch, ILTER, the Belmont Forum and other relevant programs/projects.

The scope, timeframe, significance, and resourcing of the European projects and other global ecosystem mapping projects carried out by USGS are consistent with the nature of the concept and process for developing new GEO Initiatives in the second phase (2016-2025) of its existence, and have been accepted as such. Significant H2020 funding for the two European projects, and significant in-kind support available for the global ecosystem mapping efforts from Esri, are promising indicators of the commitment and likelihood of success for these activities in GECO.

Based on these existing perspectives and results, the GEO ECO Initiative intends to build upon available results and extend them to a global scale, identifying Protected Areas of international relevance where the same methodology used in ECOPOTENTIAL can be applied. Parallel to this, GEO ECO intends to foster other research initiatives on monitoring and modelling ecosystem changes, with a special focus on Protected Areas in and outside Europe. While not explicitly supporting new measurement programs, ECOPOTENTIAL will contribute to GEO ECO also by helping identifying knowledge and information gaps and eventually propose new measurement activities and modelling approaches, especially by adopting the so-called “vulnerability approach” in future projections of ecosystem conditions.

9.2. GEO BON

EO based data is increasingly embraced by GEO BON and in three working groups: Ecosystem Structure[2], Ecosystem Function[3] and Ecosystem Services[4]. Across these three groups, the scientific innovation obtained through the ECOPOTENTIAL project is included in the strategic development plan of data, indicators and tools, focusing on using EO data for monitoring of changes in biodiversity and ecosystem services. ECOPOTENTIAL has been participating in important interactive working meetings to reach out to an important part of the international research community.

Additionally, GEO BON has an initiative to facilitate uptake of tools by observatories worldwide, called the “Bon-in-a-box”. It is currently in its first stage of development and consists of a website with a catalogue of available tools[5]. Over time this initiative will become more interactive and versatile allowing for a community of users and developers to use, share and update both data and tools. This initiative seems to offer great potential for the inclusion of ECOPOTENTIAL developed tools, training material and data to ensure long-term accessibility to a community of practice. GEO BON currently already finances capacity building workshops on monitoring tools globally, publishes monitoring manuals and fosters a network through working meetings that could contribute to the long-term viability of the CoP that is being set up by ECOPOTENTIAL.

[2] https://geobon.org/ebvs/working-groups/ecosystem-structure/

[3] https://geobon.org/ebvs/working-groups/ecosystem-function/

[4] https://geobon.org/ebvs/ecosystem-services/

[5] https://geobon.org/networks/bon-development/

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10. Perspectives

Increasing data quantities require data processing capacities, data storage and data management expertise, and skills that are already not feasible for many protected area managers, and this trend is going to continue towards the future with more satellites and algorithms being developed and with the need of making all kind of data available to the wider community following the FAIR principles (Findable, Accessible, Interoperable, and Reusable), also harmonising metadata semantics. Setting up a Community of Practice is therefore important for, on the one hand, ensuring the relevance of developed data and tools, and, on the other hand, facilitating uptake of the data in real management decision for biodiversity conservation. A lively CoP additionally facilitates end users exchange with scientists and data and tool developers, to maintain a dynamic and viable context for innovative progress to take place.

One of the main characteristics of ECOPOTENTIAL is the integration of the expertise and needs of different communities: different scientific disciplines, observers and modellers, the technical and management staff of protected areas, conservation managers and policy-makers. In the first three years of the project, a Community of Practice joining scientists, modellers, remote sensing experts and technical/management staff of Protected Areas was formed. This led to the co-design of storylines, research activities addressing the practical needs of individual protected areas, and to regular exchanges across the different communities by emails, personal meetings and training events. This allowed starting a harmonization process of the views and needs of scientists (coming from different disciplines) and of the technical and management staff from protected areas, and will include the involvement of citizens in citizen science activities. Such harmonization is fostering widespread use of the Earth Observation products developed during the project through meetings and training courses. Integration with other communities such as LTER and LifeWatch was supported.

In the coming year, the ECOPOTENTIAL CoP will be extended to extra-European areas and finally merged into the GEO Ecosystem CoP. A specific access point (web site) for the GEO ecosystem CoP will be created. The ECOPOTENTIAL CoP established during these first three years will form the seed of this enlarged community us information producers and users.

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