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Abstract	European Parliament, biodiversity, conservation, Earth observation, global changes.
Keywords	This document describes the ECOPOTENTIAL – GEO workshop that took place at the GEO headquarter in Geneva, Switzerland, on October 24th 2019, co-organised by ECOPOTENTIAL and the GEO Secretariat.

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Table of Contents

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1. Executive summary

On 24 October 2019, ECOPOTENTIAL and GEO jointly organized a one-day conference at the GEO headquarters in Geneva, Switzerland, to discuss the legacy ECOPOTENTIAL can leave to GEO and GEOSS. The Secretariat Director of GEO was present, together with several members of the GEO Secretariat, most of the members of the ECOPOTENTIAL CCT, representatives of LifeWatch ERIC, eLTER RI, the GEO GNOME Initiative and the GEO ECO Community Activity, and representatives of the European Commission's Directorate-General for Research and Innovation.

Overall, it was established that the links between ECOPOTENTIAL, GEO/GEOSS and EuroGEOSS are very strong and the approach, methodology and results/products developed by ECOPOTENTIAL will find significant application in the GEO activities, notably in the GEO ECO Community Activity, and in the GEO Knowledge Hub.

Concretely, ECOPOTENTIAL will contribute to re-shape the GEO ECO Community Activity, linking also with eLTER RI and LifeWatch ERIC, with the aim of extending at global level the approach to protected areas developed in ECOPOTENTIAL, extending also the main products developed during the project, such as the Protected Area Map Browser, the EODESM, and the Virtual Laboratory Platform, as to include protected areas and their immediate surroundings from selected regions worldwide. The co-design of research questions with users, mainly technical and management staff from protected areas as developed in ECOPOTENTIAL, will be extended to GEO through the support to the GEO Ecosystem Community of Practice.

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2. Introduction

ECOPOTENTIAL is variously involved in the initiatives of the Group on Earth Observations, as described in the Description of Actions and in the deliverables 1.5 Community of Practice; 1.7: Report on the GEO Community of Practice; 1.6 Recommendations to GEO/GEOSS and 10.4 Contribution to the GEOSS Ecosystem Task and to the GEOSS Data Core.

The main commitments are related to the task of creating a Community of Practice also involving GEO, supporting the GEO ECO and GEO GNOME activities, and to the task of making EO products available through GEOSS.

In a broader sense, the overall contribution of ECOPOTENTIAL to GEO is to leave a legacy of knowledge, research threads and products that will support the aim of GEO of exploiting Earth observations for the benefit of human well-being, sustainable development and nature conservation.

As explained in D1.5 and D1.7, ECOPOTENTIAL partners took active part to GEO workshops and conferences in the past four years to convey its findings and concepts into GEO, and various partners are actively involved in the GEO initiatives and boards at several levels.

The overall contribution and legacy to GEO has been then presented and discussed with GEO in a final workshop at the GEO headquarters in Geneva, Switzerland, at the end of the project. The major outcomes are reported in this document. The speakers' presentations have been made available on the project website.

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3. Event summary

The joint GEO – ECOPOTENTIAL workshop has been hosted at the GEO headquarters in Geneva on 24th October 2019, and brought together ECOPOTENTIAL partners and the components of the GEO Secretariat. Mr Gilles Ollier, Head of Sector on Earth Observation at the European Commission's Directorate-General for Research and Innovation, and European Commission's contact point for GEO, also took part in the event.

The workshop aimed to present the major findings and outputs of ECOPOTENTIAL related to GEO as well as the GEO initiatives to which ECOPOTENTIAL partners can contribute, and discuss how to continue the conveying of the ECOPOTENTIAL legacy into the activities of GEO after the end of the project.

The programme of the day let ample part to the discussion. Topics presented where gathered into three main themes:

- Data archives and on-line services for users
- Overarching questions and policy recommendations on Earth observations at pan-European scale
- Liaisons between ECOPOTENTIAL, the European Research Infrastructures on natural ecosystems and GEO initiatives.

Speakers of the day were:

Introduction:

G. Camara	Introduction to GEO and the scope of the meeting
G. Ollier	Welcome address from the EU and the role of EuroGEOSS
A. Provenzale	The ECOPOTENTIAL project – overview of scope and results

Data archives and on-line services for users

Mazzetti/Marangi	The ECOPOTENTIAL Virtual LAB and the modelling tools
I. Manakos	On-line services for the use of Remote Sensing data
C. Domingo Marimon	The ECOPOTENTIAL Map Browser
Giuliani/Domingo/Manakos	The ECOPOTENTIAL Data Cubes
R. Lucas	The EODESM – EO Data for Ecosystem Mapping system
J. Peterseil/D. Poursanidis	In-situ data and the DEIMS portal
Giamberini/Bustamante	Users' data and knowledge needs: Report from the Researchers-Users workshop in Doñana Biological Station

Overarching questions and policy recommendations on Earth observations at pan-European scale

A. Karnieli	European-scale ecosystem assessment from remote sensing
C. Beierkuhnlein	Threats of climate change to protected areas
J. Bitsch	Policy recommendations from ECOPOTENTIAL

Liaisons between ECOPOTENTIAL, the European Research Infrastructures on natural ecosystems and GEO initiatives

A. Basset/F. Sanchez	ECOPOTENTIAL and LifeWatch ERIC

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J. Peterseil	ECOPOTENTIAL and eLTER
G. El Serafy	GEO ECO
C. Adler/E. Palazzi	GEO GNOME
D. Cripe	GEO LDN

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4. Summary of the presentations and of the discussion

The general aim of the presentations was to present the main ECOPOTENTIAL results and discuss how GEO may benefit of the results and products of ECOPOTENTIAL.

Dr. **Gilberto Camara** opened the workshop with a short presentation about the need of sound and robust data and information that policy makers can trust, stating the fundamental role of science in Earth Observation. He also stated the importance in co-designing the collection of information in order to deliver socially robust results that society can trust. In delivering data – said Camara – institutions must be able to gain trust from society and policy makers and in achieving this, institutions also need to be transparent.

In Earth Observation science, moreover, publishing peer review papers is not transparent enough if data and interpretation methods are not available, as data interpretation would not be reproducible nor debatable. In this sense, Camara affirmed the importance of sharing both in-situ and remote sensing data on ecosystems, also taking into account the successful stories of existing repositories and infrastructures. .

There are a few important open issues in the policy of how to manage big data in Earth Observation. Satellites are producing enormous quantities of data that are not easy to store nor to analyse. Moreover, the necessary storage infrastructures need to have a huge capacity. This poses the need of taking policy decisions about data storage and sharing, which have to be inclusive with respect to countries with limited capability of setting up national data storage infrastructures.

Possible solutions for sharing information on Earth Observation are:

1) Publishing scientific results accompanied by publication of data, executable codes and models, in order to make reproducible results;
2) Relevant data made searchable by anyone on cloud infrastructures.

GEO is in the process of creating a GEO Knowledge Hub, which will include a digital archive providing access to research papers, methods, algorithms, EO datasets.

Mr. **Gilles Ollier**, Head of Sector on Earth Observation at the DG Research of the European Commission and EC-GEO contact point, presented how EuroGEO will support the European Commission policy on sustainable development. The mission of the EC is to make Europe the first carbon neutral continent, with a large need to invest in research and innovation and to reach a “green new deal”. The EU commission is doing a large investment in the EuroGEO showcases in order to facilitate the access to knowledge. Also, EuroGEO wants to change the “paradigm” of creation and storage of data from a “data centric” approach to a “user driven” approach as in the new funded project E-SHAPE, which supports EuroGEO.

After the two introductions by Camara and Ollier, the ECOPOTENTIAL project and the results/products have been presented as from the programme.

In the morning, the EO products have been presented, while in the afternoon the presentations were about a few key general studies of the project, including the science-policy connection, and the GEO initiatives of interest for ECOPOTENTIAL.

Presentations of the morning session “Data archives and on-line services for users”

Antonello Provenzale (CNR), the project’s coordinator, presented the general framework of the project and the “storyline based approach” of the research conducted together with the staff of Protected Areas. **Paolo Mazzetti** (CNR) presented the ECOPOTENTIAL Virtual Laboratory (Vlab) (https://vlab.geodab.org/) and how the Vlab can serve the modellers to make models available and run them from the cloud; **Ioannis Manakos** (CERTH) presented the models currently available on the Vlab and which GEO initiatives can benefit from them. **Cristina Domingo** (CREAF) presented the “Protected Areas from Space” portal (web browser) (http://maps.ecopotential-project.eu/)

and how it allows to extract EO products, providing not only EO images but also data. The "PA from Space" web browser will be a long-time service provided by CREAF and can be easily expanded to other protected areas.

Gregory Giuliani (University of Geneva and GRID- Geneva) presented the use of the Swiss data cube in ECOPOTENTIAL (in Gran Paradiso National Park, one paper published) and the Data-cubes produced within ECOPOTENTIAL (Pelagos, Spain, Greece). ECOPOTENTIAL supported the creation of the data-cubes and data-cubes supported the research in ECOPOTENTIAL. The Greek data – cube will also contribute to the E-SHAPE project.

Richard Lucas (University of Aberystwyth) presented the EODESM service "Earth Observation Data for EcoSystems Management) and its potentiality to analyse land cover changes from any date to any date all over the world wherever data are available. EODESM can give a great contribution to GEO ECO as it is possible to apply it to any protected area worldwide. **Johannes Peterseil** (Environment Agency of Austria) presented the DEIMS-SDR repository and how in ECOPOTENTIAL the WP devoted to In Situ data (WP5) faced the problem of the quality of the metadata documenting the in-situ datasets. **Silvia Giamberini** reported on the results of the ECOPOTENTIAL storylines in terms of effective use of the scientific results by the protected areas staff, also reporting the discussion from the last users workshop that took place in Doñana National Park at the beginning of October: the long-term and side by side collaboration between Protected Areas and researchers is the key of success of the knowledge transfer from ECOPOTENTIAL to the Protected Areas. Regarding products and tools (e.g. software), the protected areas usually have no expert personnel and they ask for easy-to-use products, unique and reliable sources of information, training and support from local institutions to deliver them the EO products that they need.
In the afternoon, two presentations regarding overarching research questions in ECOPOTENTIAL and one presentation regarding the summary of policy recommendations on how to enforce the use of Earth observation for nature conservation have been given.

Arnon Karnieli (Ben Gurion University) presented a study to upscale ground/point climatic measurements in PAs to pan- European scale by extracting climatic growth-limiting factors from Earth observation systems (e.g., MODIS, Meteosat, Sentinel). The main finding is that the accepted assumption on the negative relation between LST (Land Surface Temperature) and NDVI (Normalized Difference Vegetation Index), with respect to droughts, should be used with caution since it is not universal and should be examined for specific location and time of the year.

Carl Beierkuhnlein (Bayreuth University) presented a global mapping of biomes, together with a critical analysis of the different definitions of biome. A specific taxonomy has been analysed in depth and applied to obtain the final output on global scale.

Jessica Bitsch (UNEP) then discussed the activities done in ECOPOTENTIAL to reach policy makers and the Recommendations to the EU Parliament, to the GEO Community and to EuroGEO arising from the project's experience and already contained in other project's deliverable (D1.6 "*Recommendations for the activities of GEO/GEOSS and GEO-GNOME*"; D11.2 "*Synthesis study on integration of EO data/tools in decision-making*"; D11.3 "*Policy recommendations mainstreamed into the GEO/GEOSS*", D12.12 "*Science-policy briefing at the European Parliament*".

As for links with other initiatives and research infrastructures, **Alberto Basset** (University of Salento) presented the LifeWatch ERIC, aimed to provide a technological infrastructure for biodiversity data. The LifeWatch infrastructure is available to exploit the models developed in ECOPOTENTIAL in the Virtual Research Environment (VRE) and to foster their application (e.g. the model on the optimal control of *Ailanthus altissima)* in other ecosystems and other Protected Areas. LifeWatch is very interested in invasive species modelling as a way to understand threats to biodiversity and will organise, together with CNR, a summer school on invasive species modelling in summer 2020. The VRE will continue to make available data and models for at least 20 years and can guarantee the sustainability of deployment of ECOPOTENTIAL results.

Johannes Peterseil presented the eLTER ESFRI Research infrastructure and the opportunity that it offers to collect, harmonise and make available data from the European LTER sites, which are long-term *In Situ* datasets collected in the European sites of the LTER network. eLTER also offers the chance to link the users' communities in European and international contexts, and contributes to EuroGEO and GEO. ECOPOTENTIAL and eLTER have been connected

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and will be connected in EuroGEO, both contributing to the E-SHAPE project. The core of 200 selected LTER sites that will enter into the eLTER infrastructure will work to standardise and harmonise data acquisition and will provide access to data, to sites and to tools and services.

Carolina Adler presented the GEO GNOME initiative (Global Network for Observations and Information in Mountain Environments) and the activities done in GEO. GEO GNOME has recently organised a workshop on Climate Essential Variables for mountains and will lead a joint session with GEO ECO at the next GEO week in Canberra. GEO ECO is interested in learning more about what kind of research has been conducted in ECOPOTENTIAL mountain sites in order to have the ECOPOTENTIAL point of view on the research interests and needs in European Protected Areas in mountain ecosystems.

During and after the presentations, ample time has been devoted to the discussion. Many key issues have been faced whose solution is of paramount importance for the sustainability of projects as ECOPOTENTIAL but goes far beyond the scope of the meeting.

In particular, the discussion focussed on:

- Sustainability of research projects and of their products after the end;
- The control of data ownership once they are deposited on clouds;
- The intellectual property of open data and if there is a right of co-authorship of data producers;
- The issue of resolution of RS open data, often not sufficient to deliver the required data for monitoring or modelling at fine scale;
- The “value chain” of Earth observation data and the policy that GEO will pursue in order to deliver final EO products;
- The investment plan of EuroGEO and the contribution of the Copernicus Services to GEO;

Regarding the resolution of RS open data, a possible solution suggested by Palma Blonda (CNR) could be to agree with commercial providers of high-resolution satellite data the release of HR data for a few selected “supersites” that may serve as research sites where to experiment data processing algorithms.

Regarding the “value chain” of EO data, Ollier explained that the vision of the EU / Copernicus services was to do a major investment in the satellites and sensors (ESA Sentinel programme), release the data and support research projects as ECOPOTENTIAL or E-SHAPE to do the “last mile” and develop / disseminate the EO products.

On the other side, Camara addressed the need of having ready products for non-expert users and the necessity of using already existing commercial services for this.

Regarding datasets, the copyright attribution can be made assigning a DOI do dataset (in particular to In Situ dataset) and choosing the appropriate Creative Common licence.

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5. Conclusions

The whole meeting and the final discussion allowed to reach important conclusions.

First, the legacy of ECOPOTENTIAL will support a full restructuring of the GEO ECO activities, focusing on extending to (selected) protected areas worldwide the approach and the methodology developed in ECOPOTENTIAL. Along these lines, GEO ECO will include

1. The data archives and the EO products developed in ECOPOTENTIAL (such as Data Cubes), together with the methods used to develop them, for extension to other protected areas worldwide.

2. The services developed in ECOPOTENTIAL, such as the Protected Area Map Browser and EODESM, with the aim of extending the study cases to a larger set of protected areas and their immediate surroundings worldwide. Partial financial support from other projects/RIs such as e-shape and eLTER RI is expected to achieve these goals.

3. The ECOPOTENTIAL Virtual Laboratory will be extended to include new case studies, always with the full integration of in-situ data, Remote Sensing products, data analysis tools and modelling tools. This extension will be coordinated with LifeWatch ERIC, which will also contribute to GEO ECO. Partial funding will come from European and national LifeWatch activities.

4. Most importantly, the expertise and knowledge gained in ECOPOTENTIAL on the co-design of research questions and activities with specific users will be extended at other protected areas. The main users continue to be identified as the technical and management staff of protected areas, and local, regional and global policy makers or regulatory entities. Clearly, other users are welcome and efforts in this sense will be made. In any case, the whole procedure of co-design will be made available and adopted in a set of specifically selected protected areas at global level.

Similarly, ECOPOTENTIAL legacy will enter the GEO Knowledge Hub, with the following three main aspects:

1. Provision of methodologies to identify biomes and the relevance of protected areas based on multi-source data and multi-parameter estimations, as already developed for European protected areas and the Natura2000 sites. Identification of the main current and future threats to protected areas owing to global climate and environmental change, using EO data and climate/environmental projections and adopting a vulnerability approach.

2. Definition of effective methodologies for the co-design of research questions with well-identified user communities – here, protected area staff and/or local and regional policy makers and regulatory entities – to guide the motivation and direction of research, achieving a user-driven knowledge creation. This methodology was developed in the framework of the ECOPOTENTIAL Storylines, developed for most of the protected areas involved in the project. This approach, with a description of successes and difficulties, is available for application and use in other situations.

3. Provision and extension of products integrating the information from in-situ data, Remote Sensing products, data analysis tools and numerical models, to be inserted in an open Virtual Research Environment available to users of various technical level. ECOPOTENTIAL will contribute the Protected Area Map Browser, EODESM, and the Virtual Laboratory Platform.