GEOESSENTIAL ERA-PLANET

Essential Variables workflows for resource efficiency and environmental management

Deliverable 9.4

Cooperation with other projects

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Creation date	February 1. 2019
Due date	February 28. 2019
Last revision date	March 9. 2019
Status	In Progress
Type	Report
Description	Description of the types of collaborations that GEOEssential has established
Right	Public
Language	English
Citation	Anthony Lehmann, Denisa Rodila, Grégory Giuliani, Cooperation with other projects. GEOEssential Deliverable 9.4
Grant agreement	ERA-PLANET No 689443

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Introduction

The aim of this deliverable is to present the ongoing collaborations of GEOEssential partners with national and international projects closely related to the project activities. We are also describing the internal collaboration that was created across the four strands of the ERA-PLANET project:

- SMURBS: Building urban resilience against environmental pressures - www.smurbs.eu
- iGOSP: Integrated Global Observing Systems for Persistent Pollutants - www.igosp.eu
- iCUPE: Integrative and Comprehensive Understanding on Polar Environments - www.atm.helsinki.fi/icupe
- GEOEssential: Essential Variables workflows for resource efficiency and environmental management - www.geoessential.eu

Relations of partners with existing projects

GEOEssential is closely related to a series of co-funding and/or ongoing national and international projects that are listed in table below (Table 1).

Table 1: List of identified projects from GEOEssential partners related to the GEOEssential objectives

Short name	Description	Main thematics links	Partners involved	Cofunding ERA-PLANET
IPBES Global Assessment	Intergovernmental science-policy Platform on Biodiversity and Ecosystem Services – Global Assessment Report.	Biodiversity, Ecosystem Services Indicators and Essential Variables	SGN, UNIGE	NO
IPBES Value Assessment	Intergovernmental science-policy Platform on Biodiversity and Ecosystem Services – Methodological Assessment on the Conceptualization of Values of Biodiversity and Nature's Benefits to People.	Biodiversity, Ecosystem Services Assessment Methods	SGN	NO
GFBio	The German Federation for Biological Data' (GFBio); data and information management to harmonize the national biological data landscape.	Biodiversity, Essential Variables	SGN	NO
NextGEOSS	Through developing GEOSS to become the next generation data hub, we will enable increased use of EO data supporting decision making.	Interoperability, GEO services	CREAF, CNR	NO

LTER-D	Long-term Ecosystems Research Network Germany	Ecosystem	SGN, UFZ, FZJ	NO
TERENO	TERENO is embarking on new paths with an interdisciplinary and long-term research programme involving six Helmholtz Association Centers. TERENO spans an Earth observation network across Germany that extends from the North German lowlands to the Bavarian Alps. This unique large-scale project aims to catalogue the long-term ecological, social and economic impact of global change at regional level. Scientists and researchers want to use their findings to show how humankind can best respond to these changes.	Biodiversity, Soils, Water, Ecosystems	UFZ, GFZ, FZJ	NO
MOSES	Modular Observation Solutions for Earth Systems – MOSES is a mobile, modular and networked measuring, observing and analyzing system for recording future changes of the earth system on different space and time scales.	Biodiversity, Soils, Water, Ecosystems, Essential Variables	UFZ, FZJ, GFZ	NO
eLTER H2020	Integrated European Long-Term Ecosystem & Socio-Ecological Research Infrastructure is a major project that will help advance the development of European Long-Term Ecosystem Research infrastructures. The overall aim of the eLTER H2020 project is to advance the European network of Long-Term Ecosystem Research sites and socio-ecological research platforms to provide highest quality services for multiple use of a distributed research infrastructure.	Biodiversity, Soils, Water, Ecosystems	UFZ, FZJ, SGN	NO
GEO BON	GEO BON has facilitated the development or enhancement of at least 25 national biodiversity observation systems, representing most of the Earth's major biomes, that are coordinated and can contribute to regional and global biodiversity assessments. The Project improve the acquisition, coordination and delivery of biodiversity observations and related services to users including decision makers and the scientific community.	Biodiversity, Remote Sensing, Indicators and Essential Variables	SGN, UFZ	NO
Ecopotential	Ecosystem services assessment in protected areas.	Ecosystem services, essential variables	CNR, UNIGE, MfN, CREAF	NO
SWATCH21	Eco-hydrologic services of Swiss rivers and catchments under climate and landuse scenarios.	Ecosystem services, Nexus	UNIGE	YES

MapX	An open geospatial platform to manage, analyze and visualize data on natural resources and the environment.	Chemicals management, disaster risk reduction, biodiversity planning, extractives, environmental security	UNIGE	YES
EnMAP	German Hyperspectral Satellite Mission for environmental parameter estimation/mapping/quantification.	Agriculture, Biodiversity, Soils, Water, Ecosystems, Essential Variables	GFZ	NO
GLAM.DE	Providing agricultural land-surface products at regional scale for JECAM site DEMMIN (Germany).	Food-Water-Energy-Nexus	GFZ	YES
NATEC-KRH	EO based spatial and temporal analysis of biodiversity indicators.	Biodiversity, Ecosystem services, essential variables	GFZ	YES
LandSense	Citizen science observatory for land cover and land use.	Land cover, land use	IIASA	NO
DISHEAT	Development of procedures and technology validation for the creation of locally available biomass value chains in W. Macedonia in order to cover the fuel needs of the local district heating systems.	Biomass estimations, Land use Land cover	AUTH	NO
MAIL	Identifying marginal lands in Europe and strengthening their contribution potentialities in a CO2 sequestration strategy.	Marginal Lands, Land use, Land cover	AUTH	NO
ENVIROLENS	Copernicus for environmental law support, environmental monitoring and enforcement.	Environmental, EVs,	AUTH	NO
GEOGLAM	Coordination satellite monitoring observation systems in different regions of the world in order to enhance crop production projections and weather forecasting data (http://geoglam.org/).	Agriculture, crop monitoring	SRI	NO
Setting national voluntary Land Degradation Neutrality	Project Goal for Ukraine as for volunteer participant in this UN Project is setting national LDN targets for territory of Ukraine as well as cross-comparison of global and national indicators (namely Land Use change and Land Productivity Dynamics)	Land degradation, land productivity trends, land cover change	SRI	NO

(LDN) targets using the UNCCD indicator framework	(https://www.researchgate.net/project/Setting-national-voluntary-Land-Degradation-Neutrality-LDN-targets-using-the-UNCCD-indicator-framework).	monitoring		
Intellect	Developing new technologies of environment monitoring and risk analysis of natural disasters and anthropogenic emergencies based on large amounts of satellite data, intelligent geoinformation technologies, cloud computing. The result of implementation of the project will be creating a specialized computing environment (satellite monitoring center based on intelligent cloud computing), which provides easy access to large amounts of satellite data and their intelligent analysis using deep learning. (https://www.researchgate.net/project/Intelligent-technologies-for-satellite-monitoring-of-environment-based-on-deep-learning-and-cloud-computing-InTeLLeCT).	Land cover, land use	SRI	NO

Relations with other ERA-PLANET Strands

The GEOEssential Knowledge Platform is an instance of a more general ERA-PLANET Knowledge Platform (KP), conceived as an enhancement of the ECOPOTENTIAL Virtual Laboratory (VLab), with a specific focus on knowledge management and generation, and a broader scope to multi-disciplinarily to address policy goals from International treaties and initiatives (GEOEssential deliverable 1.1).

As demonstrated in Figure 1, GEOEssential (Lehmann et al. 2019a) can share with the other strands of ERA-PLANET several components such as the construction of workflows in the VLab (WP4-6), the Knowledge Base on EVs (WP1), and the use of its dashboard to expose SDG related indicators (WP7).

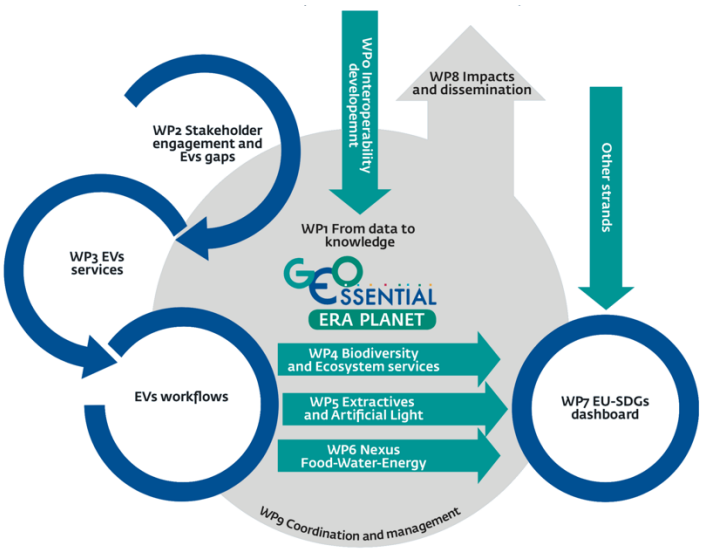

Figure 1. GEOEssential project structure and work packages.

Workflows in the Virtual Laboratory

At the EuroGEOSS meeting in September 2018, the ERA-PLANET coordinators decided to expand the use of the Virtual Laboratory (VLab) to all strands of the project (iGOSP, iCUPE, SMURBS, GEOEssential).

We decided therefore to organize the second VLab workshop (www.workshop.vlab.geodab.eu) by inviting participants from the 4 strands to participate. The workshop took place in Florence from February 26. to 28. 2019. About 30 participants took part in this workshop and worked on the following workflows (Table 2). See Annex 1 for more details.

Table 2: List of identified projects from GEOEssential partners related to the GEOEssential objectives

Title	Strand	Contact person	Related policy
SDG 11.6.2 calculator	SMURBS	Observatory of Athens (Orestis)	SDG 11.6.2
Built up areas mapping from Sentinel 2	SMURBS + GEOESSENTIAL	AUTH (Vasiliki, Maria, Natalia)	SDG 11.3.1
Water stress workflow	GEOESSENTIAL	Jülich (Bagher)	SDG 6.4.2
Essential Water Variables from SWAT	GEOESSENTIAL	UNIGE (Lehmann)	EWVs
Zonation for landscape prioritization	GEOESSENTIAL	UNIGE (Lehmann)	protected areas
Fractional snow cover	iCUPE	CNR (Salzano)	snow cover
Primary Productivity resilience	GEOESSENTIAL	CNR (Vicario)	resilience
Phylo H (phylogenetic entropy)	GEOESSENTIAL	CNR (Vicario)	biodiversity
SARWIND (retrieval of wind on sea surface)	GEOESSENTIAL	CNR (Adamo)	wind
Cross correlation analysis	SMURBS	CNR (Adamo)	land cover changes

Knowledge base on EVs

GEOEssential is building the following elements that could be used by other ERA-PLANET strands and other external projects:

- **List of EVs**: GEOEssential is compiling a list of EVs across the GEO Societal Benefit Areas (GEOEssential deliverable 2.2, see also: https://docs.google.com/spreadsheets/d/1JO-BjTC_FBckPJohpPjFhMBLwoIj2nP3cCU675LWAhc/edit?usp=sharing)

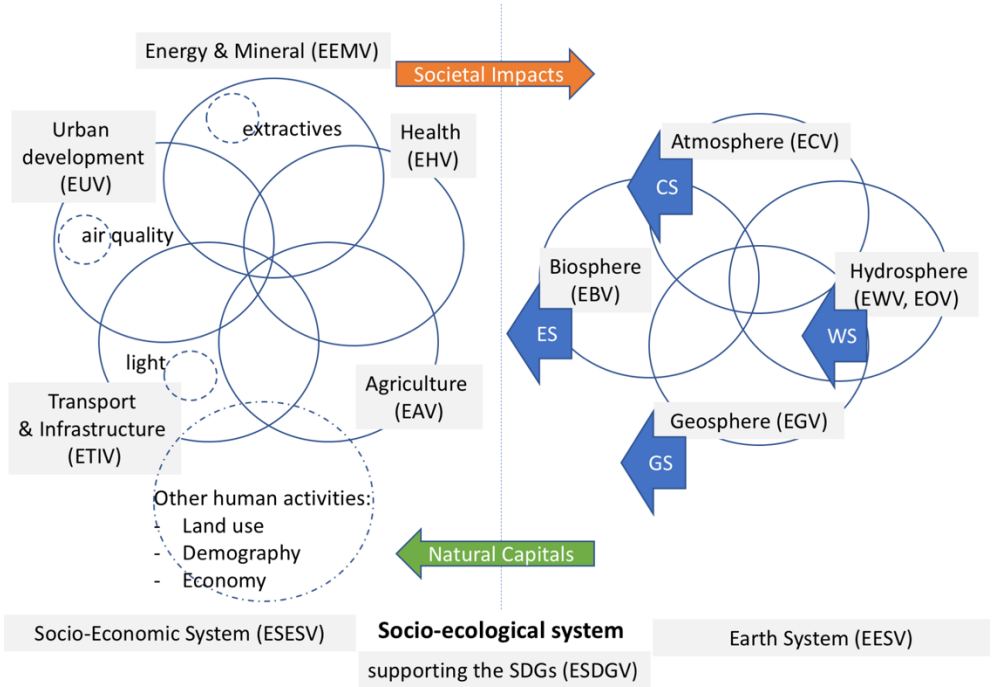

Figure 2. A proposition for generalising and integration of the concept of EVs across the Societal Benefit Areas of GEO and across the border between Socio-Economic and Earth systems EVs. Set of proposed EVs groups in grey boxes, Natural resource and corresponding data services in blue arrows, Natural capitals necessary for environmental sustainability (green arrow), and socio-economic impacts jeopardising Earth system integrity (in orange). (Lehmann et al. 2019b)

- **Database**: From the EV list described above, a data base is being created in PosgreSQL, linking Data sources to EVs, to Indicators and Policies. This data base will contribute to the Knowledge Base using RDF technologies.
- **Ontology**: The GEOEssential Knowledge Base will include an ontological conceptual model which will aide in the transition from Data to Knowledge. On a more abstract level, the ontology schema defines the major concepts of the specific domain (e.g. Essential Variables, Policy Goals, Indicators, Targets) and the relationships between them. The conceptual taxonomy, organizing classes at different hierarchical levels, will be obtained by including concepts and terms defined in the common terminology. The Knowledge Base will be based on OWL/RDF technologies. (GEOEssential Deliverable 1.4).

GEOEssential dashboard

The GEOEssential Dashboard will be the visual front-end of the project, exposing the major outputs/results of the different thematic workflows on biodiversity, ecosystems, extractives, night light, and the food-water-energy nexus, while using the GEOSS platform capacities (Figure 1).

Through a set of dedicated modules, it will allow users to:

(1) discover and access various Essential Variables;
(2) visualize a selection of policy indicators using Earth Observations data; and
(3) explore different pilots' studies related to SDG monitoring using EO data.

The GEOEssential Dashboard will use as much as possible the GEOSS platform tools such as the GEOSS API, GEOSS View, GEOSS Mirror and GEOSS Widget.

GEOEssential Dashboard will demonstrate the data value chain from EVs to indicators (e.g., SDG) (GEO 2017). The Dashboard will be a generic (i.e., applicable to other indicators), replicable (i.e., expandable to other contexts), and scalable (i.e., national to regional to global) open web-based platform automating the transformation of Earth Observation data into indicators (as graphs or/and maps) through EVs. This will show that EO, when matched with appropriate tools and services, can contribute filling the gap between science and policy for decisions, management and reporting.

Objectives

- Build the GEOEssential EVs Hub with a dashboard from EVs to SDGs making use of the developed workflows; and

Main steps

- Determination of candidate EVs and workflows to be implemented;
- Recuperation of the outputs of the thematic workflows in GeoNetwork (metadata) and Geoserver (data); and
- Implementation of the web-based visual interface (the GEOEssential Dashboard with MapStore).
- Refinement and improvement following different users' feedbacks.

Expected outputs

- A portal component to discover and access Essential Variables;
- An indicator toolbox that makes use of EVs and the Knowledge base to generate different indicators;
- Thematic workflows on biodiversity, extractives, night lights, food-water-energy nexus to demonstrate the data value chain from EVs to indicators;
- Pilots studies using different technologies like Data Cubes to generate indicators; and
- A dedicated platform to integrate all the previously mentioned component.

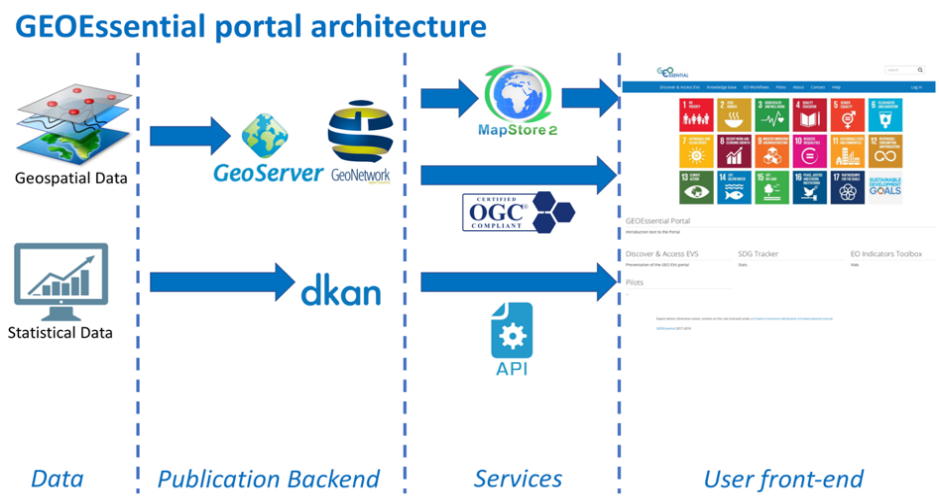

Figure 3. The integrations of workflows geospatial and statistical outputs into the GEOEssential dashboard (GEOEssential Deliverable 9.3)

GEO Initiative on EVs – GEO-EVs

In February 2019, GEOEssential has submitted a proposal for a new GEO initiative on EVs. If adopted by the GEO work plan, this initiative will strive to bring together experts from different SBAs and leading organization in charge of developing EVs in their respective fields to learn from each other experience and bring some convergence in the process of building EVs and in their potential use.

Context

Essential Variables (EVs) are used in Earth observation to identify variables that correspond to high impact on the Earth system and should be a priority for monitoring. EVs assume that there is a limited number of variables that are essential to characterize the state in a system without losing significant information on its past and future trends. The identification of these variables should help supporting adequate observing systems in the context of restricted budgets. EVs are also thought to improve the definition and maintenance of workflows from raw data to final end users' products. Indeed, EVs are being used by different communities to define the smallest number of variables describing a system allowing defining indicators for policy purposes.

The review of the set of EVs, conducted by ConnectinGEO (www.connectingeo.net (ConnectinGEO, 2016a, b, c)) in several GEO communities, revealed that there exist different maturity levels and a considerable overlap between the EVs identified by the different communities considered. The community working on the Global Climate Observing System (GCOS) was the first to develop a full set of EVs, i.e. the Essential Climate Variables (ECV) (Bojinski et al., 2014; Hollmann et al., 2013; Szczypta et al., 2014). Presently, significant efforts are being made to define and monitor EVs in the areas of biodiversity and ecosystems (Pereira et al., 2013; Scholes et al., 2012), water (Lawford, 2014), oceans (Constable et al., 2016; Hayes et al., 2015) and more recently on SDGs themselves (Reyers et al., 2017). Some of the later efforts are still incomplete. In addition, there is a need to generalize and complete the definition of EVs the rest of Earth thematic areas to have a full description of the status and trends of the Earth System.

Policy mandate for this initiative

Recently, a side event (*Can we have a GEO Initiative on a common approach to Essential Variables?)* was organized by members of the H2020 ERA-PLANET GEOEssential project during the GEO week in Kyoto (29th October 2018) with the participation of GEOBON, GEOGLAM, GEOGLOWS, and the GEO secretariat, among others. On that event we stated the need of a common initiative for a better meta-coordination and understanding among communities and SBAs, sharing knowledge and processes and give integrated responses to interconnected challenges such as SDGs. This event was followed by a request of the Swiss delegation to include such an initiative in the GEO work plan during the GEO Plenary. This request was supported by the Greek, German, Italian and Spanish delegations.

Actual and/or planned outputs of the Initiative

These are the expected outputs of this initiative:

- Monitoring the evolution of the EV definition in different domains. Detect gaps and overlaps.
- Recommendations to consolidate the EV in the themes that has not completed a consolidated list of EVs.
- Generate a roadmap to generalize and complete the definition of EVs to other EO communities to have a full description of the status and trends of the Earth System. This roadmap is based on the knowledge of the process on defining EV's.
- Ensure that all the relevant SDG indicators are covered by the existence of future EV's framework and other policy frameworks and GEO engagement priorities.
- Collecting the Definitions of the spatial and temporal resolutions of EVs for different scopes.
- Serve as a forum to exchange experiences, best practices, and knowledge about EVs.

Actual and/or intended users of the outputs

The immediate users of this process are the scientists that are experts in the topic that will benefit from a framework that can be presented to the policy makers to request for the needed funding to ensure resources to measure the evolution of the selected variables.
Another user of this process is the UN SDG indicator framework and other policy frameworks. Thanks to the definition of EV's and a clear way to obtain them the UN ensures that it is possible to monitor the progress to the SDG.

Expected outcomes, impacts and beneficiaries

- "Outcomes" refer to changes in decisions by users based, in part, on the outputs of the Initiative. These decisions may relate to policy, operational, household or other contexts.
    - Meta-coordination in the elaboration of EVs among SBAs. Reduce the overlapping already between existing between and future EVs
    - A common frame on spatial and temporal resolutions of EVs for different scopes.
    - Shared knowledge and processes for EVs definition.
    - Complete the approximation to SDGs indicators' retrieval based on the use of EVs as a proxy.
- "Impacts" refer to the ultimate intended benefits expected to be realized as a consequence of the outcomes. These could include reduction of mortality, reduced financial costs, improvements in biodiversity conservation, etc.
    - The ultimate impact of this initiative concerns the efficiency of reporting on all SBAs for improved decision making. This is closely related to reporting on the SDGs as well. Also reduce the cost of the reporting process.
    - A better coordination on EVs across SBAs can help the implementation of Nexus approach, also across the SDGs.
    - Support the SDG work programme.
    - Support GEO Engagement Priorities.
- "Beneficiaries" refer to the human populations expected to benefit from the impacts of the Initiative. These are often not the same as the intended users.
    - The scientific community (that have better argumentation in from of the funding agencies).

- The UN SDG framework and the national governments responsible for the monitoring of SDGs.
- The humanity as a whole, if the policy makers decide the right informed decisions to make the planet suitable.

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