GEOESSENTIAL ERA-PLANET

Essential Variables workflows for resource efficiency and environmental management

Deliverable 7.1

Report on the selection of the EVs for inclusion in the GEOEssential Indicators toolbox and Dashboard

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Introduction

In Workpackages 4, 5, and 6, several thematic workflows are expected to be developed, and find their ways into the GEOEssential dashboard. The GEOEssential dashboard is an open web-based platform that will show the transformation of data sources into policy indicators, using the thematic workflows. However due to the nature of the GEOEssential Dashboard, the audience of the platform, and harmonization of inputs, the incoming workflows should meet certain requirements. This deliverable summarizes which characteristics make a workflow, a nominee for the current version of the GEOEssential Dashboard. During the project, selected workflows will be cataloged here in this report.

Data publication & Dashboard creation

Before creating a Dashboard, data and metadata should be published in the GEOEssential GeoServer (for publishing data as OGC webservices such as WMS, WFS, WCS) and GEOEssential GeoNetwork (for metadata publication). These are the two basic components for further creating a dashboard (figure 1).

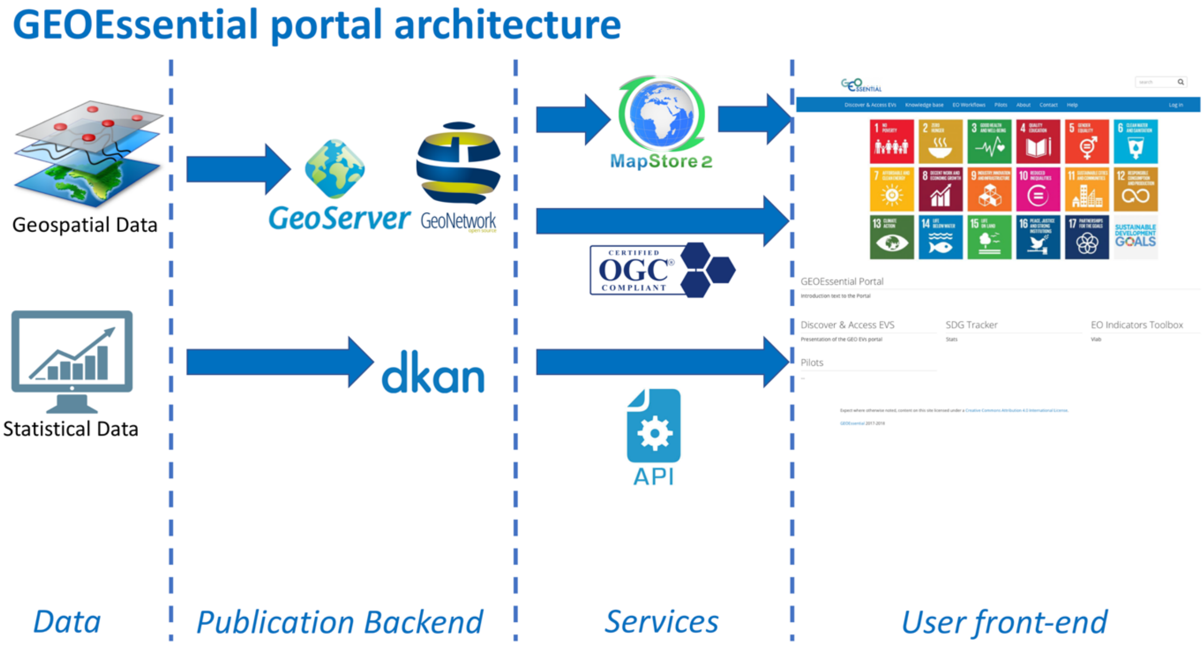


Figure 1 The integrations of workflows geospatial and statistical outputs into the GEOEssential dashboard

The endpoints are:

- GeoServer: http://geoessential.unepgrid.ch/geoserver
- GeoNetwork: https://geoessential.unepgrid.ch/geonetwork

Once data (such as output of a GEOEssential VLab model) and their description (e.g., metadata) are published then they are automatically available into the GEOEssential MapStore, that is the component to be used for thematic maps and dashboards. This component is available at: https://geoessential.unepgrid.ch/mapstore/

Users have the choice to either create a dynamic map with some widgets (e.g., text, graphs) or a complete dashboard with maps, graphs, text, images, tables that can be dynamically synchronized (see the example on SDG15.3.1). This is the recommended option to be used.

A full documentation on how to use MapStore is available at:
https://mapstore2.readthedocs.io/en/user_docs/

Credentials will be created for WP4,5,6 so that each thematic WP can create their dashboards. A detailed description on how to create a dashboard can be found at:
https://mapstore2.readthedocs.io/en/user_docs/exploring-dashboards/

Workflow Selection Criteria

Thematic workflows need to present certain characteristics to be selected for the GEOEssential Dashboard.

1. Workflows should **address a certain Essential Variable (EVs)**. The selection of EVs should be carried out in line with classes/groups already agreed by the scientific community. For example: workflows that are referring to Essential Biodiversity Variables (EBVs) should be adaptable to the classes defined by GEOBON[1].

2. Workflows should **address at least a relevant policy**. The selected workflows need to be linked to at least one of the targeted policies in the GEOEssential project (e.g. SDGs).

3. In particular, workflows **should focus on agreed indicators** to monitor the implementation of the policy goals in step 2. (e.g. Indicator 6.3.2 of SDGs: Proportion of bodies of water with good ambient water quality).

4. It is expected that thematic work packages deliver **turnkey** workflows which **covers all steps from A to Z**. Workflows should harvest inputs from publicly accessible data servers, and deliver the final output. Previously produced products, e.g. thematic model inputs, can be assimilated into the workflow as long as they are wrapped in the docker package or accessible on an online repository. In addition, these products should have a public copyright license (e.g., creative commons) so that any user can access to them.

[1] https://geobon.org/ebvs/what-are-ebvs/

5. Ideally, **Copernicus product(s)** should be part of the sources used in the workflow.

6. The spatial resolution of workflows' outputs should meet the requirements of the targeted policy.

7. Workflows should be scalable. It should be possible to apply workflows developed at local scale to regional and global scales. At the current version of the dashboard, workflows are expected to demonstrate an example at the level of country or coarser.

8. The final products derived from workflows **should allow temporal comparisons**, i.e., at least two-time steps should be provided. Ideally, the data produced could be used for time series analysis and development of future projections (i.e., scenarios). At the current version of the dashboard, workflows are expected to demonstrate an example on annual or longer time scales.

Targeted Policies and policy instruments

The GEOEssential project (Lehmann et al. 2019) is built on an end-user driven approach to first identify environmental policy indicators, then their associated EVs, and finally the appropriate data sources. From international to local scales, environmental policies and indicators are more and more percolating from the global to the local agendas. Furthermore, integrative agendas such as the SDGs are built from thematic efforts and should reuse the work made in defining indicators in each domain (e.g. biodiversity, climate, water, energy, agriculture and extractives), as showed in Figure 2.

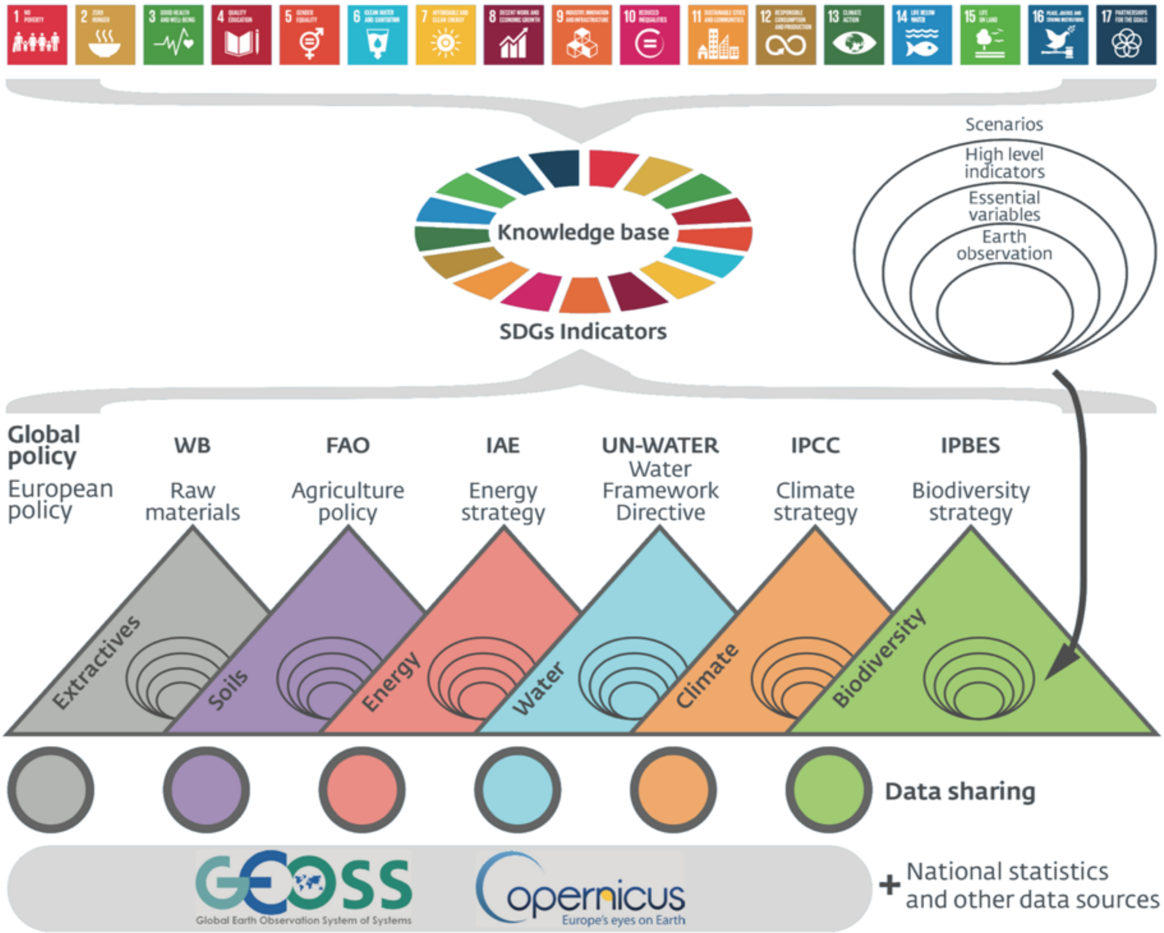


Figure 2. GEOEssential general framework linking data sources to policy indicators through Essential Variables with the help of a knowledge base.

At the global scale

UN Sustainable Development Goals (SDGs)

The SDGs are setting the scene for a more sustainable agenda for the world by 2030 with 17 goals and 169 targets. Having been built from a large consultative effort, they represent what the world of development estimates being the most important challenges to reach sustainability. A set of 232 indicators has been defined by the Inter-Agency and Expert Group on SDG Indicators [2] (IAEG-SDGs). These indicators are mostly thought to be derived from national statistics, but Earth observation could help in some instance where national statistics are lacking or when adequate statistics do not exist[3]. Earth observation can also contribute to validate national statistics and provide assessments through time and space at finer resolutions. Earth observation could further help to define new indicators for environmental related targets where things could be more easily, rapidly and systematically monitored from space than from national statistics.

[2] https://unstats.un.org/sdgs/indicators/indicators-list
[3] http://www.data4sdgs.org/resources/earth-observation-data-support-sdgs

Convention on Biological Diversity (CBD) and the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES)

The CBD, which became effective in 1993, aims at the conservation of biological diversity, the sustainable use of the components of biological diversity, and the fair and equitable sharing of benefits obtained from the utilization of genetic resources.[4]. Decision XIII/28 of the Conference of the Parties to the CBD[5] defined the indicators for the Strategic Plan for Biodiversity 2011-2020 and the Aichi Biodiversity Targets, which were agreed in Nagoya in 2010. In particular, the action plan to halt biodiversity loss is based on five strategic goals and 20 target indicators.[6]

Established in 2012, IPBES further developed a global and regional framework for biodiversity and ecosystem services assessments, and further proposed a set of core and highlighted indicators to be used in its first assessment reports. In order to avoid duplication of efforts and dilution of messages, these policy instruments would gain in aligning their effort with the most closely related SDG goals, targets and indicators (i.e. SDG 14 and 15). This is indeed the case when we compare the list of IPBES indicators that are mostly derived from the CBD for monitoring the global biodiversity and ecosystem services governance. For further information see the IPBES Methodological Assessment on Scenarios and Models (IPBES 2016), the IPBES thematic assessment on land degradation (IPBES 2018), and series of IPBES regional Assessments.

United Nations Framework Convention on Climate Change (UNFCCC), and the Intergovernmental Panel on Climate Change (IPCC)

The UNFCCC is an international treaty (currently with 197 Parties) aiming at combating climate change. Since the Paris Agreement in 2015, the main goal of the UNFCCC is focused on strengthening the global response to climate change and its related impacts. Specific objectives aim at limiting the temperature increase to 1.5 degrees Celsius this century from the pre-industrial level[7].

The IPCC has defined several indicators for the AR5 report to follow climate change, and impact and adaptation possibilities (IPCC, 2014). These indicators are usually integrated in a vulnerability framework where climate change represents the exposure that is combined with sensitivity to define the potential impacts, and these indicators must themselves be combined with the adaptive capacity to assess vulnerability. These indicators are essentially linked to SDG 13 but with connections to most other SDGs when looking at the impacts of climate changes.

[4] https://www.cbd.int/intro/default.shtml
[5] https://www.cbd.int/sp/indicators/
[6] https://www.cbd.int/sp/targets/default.shtml
[7] https://unfccc.int/process/the-convention/history-of-the-convention

UN-WATER

UN-WATER is now coordinating the Integrated Monitoring Initiative for SDG 6 and related indicators[8]. With its yearly UN World Water Development reports, links with SDGs are becoming more explicit with 79 references in the 2018 report on Nature Based Solutions, compared to 50 references in the 2017 report focusing on Wastewater, 15 references in the 2016 report on Water and Jobs, and only 6 in the 2015 report on Water for a Sustainable World. UN-WATER is regularly using the Driver-Pressure-State-Impact-Response (DPSIR) and Vulnerability indicator frameworks in various reports.

International Energy Agency (IEA)

SDG 7 includes targets to ensure access to affordable, reliable, sustainable and modern energy. The IEA provides annual country-by-country data[9] on access to electricity and clean cooking (SDG 7.1). IEA energy balances are also the main data source for tracking official progress towards SDG targets on renewables (SDG 7.2) and energy efficiency (SDG 7.3).

UN Food and Agriculture Organisation (FAO)

The FAO is responsible for developing 21 SDG indicators for Goals 2, 5, 6, 12, 14 and 15, and is contributing to the assessment of 4 other indicators[10]. According to FAO, the SDGs offer a new vision where food and agriculture are the key to sustainable development. FAO has the experience and expertise to support policy development, partnership building, and projects and programs based on the three pillars of sustainability. Both the SDGs and FAO's strategic framework are addressing the causes of poverty and hunger for a more just society.[11]

Extractive Industries Transparency Initiative (EITI)

For the EITI, the management of natural resources is crucial for providing decent employment, business development, increased fiscal revenues, and infrastructure linkages. Unfortunately, extractives industries are contributing to the problems addressed by the SDGs such as environmental degradation, displacement of populations, conflict, corruption and the violation of human rights. Countries contributing to the EITI are mitigating these impacts by improving the management of these impacts. Implementation of EITI[12] is particularly closely related to several SDGs (1, 10, 16 and 17) and their related targets.

Equator principles

These principles, which are adopted by financial institutions, foster the identification, assessment, and management of environmental and social impacts derived from carrying out industry and infrastructures projects. Impacts should be minimized, mitigated and /or

[8] http://www.sdg6monitoring.org/indicators
[9] https://www.iea.org/sdg
[10] http://www.fao.org/sustainable-development-goals/indicators/en/
[11] http://www.fao.org/sustainable-development-goals/overview/en/
[12] https://eiti.org/document/how-eiti-contributes-towards-meeting-sustainable-development-goals

compensated. The Equator principles promote efficient environmental management and responsible social development[13].

At the European scale

Sustainable Development Strategy

The overall objective of the EU Sustainable Development Strategy launched in 2001 was to develop actions to improve by 2010 the quality of life of European residents by better managing the available resources for ensuring prosperity, environmental protection and social cohesion[14]. The strategy sets general objectives and concrete actions on climate change and clean energy, sustainable transport, sustainable consumption and production or conservation and management of natural resources. Eurostat has assessed the progresses by developing indicators compatible with the SDGs (Eurostat 2017).

Biodiversity Strategy

Concerning Biodiversity, the European Strategy is aiming at slowing and possibly halting losses of biodiversity and ecosystem services by 2020 in connection with the international commitments of the EU with the CBD. This strategy launched in 2011 presents 6 targets and 20 actions with a mid-term review showing with an interactive dashboard[15] that the EU is achieving some progresses but needs much more efforts to reach its targets.

Climate and Energy framework

The Climate and Energy framework 2030[16] defines three main targets by 2030: more than 40% cuts in greenhouse gas emissions (from 1990 levels); more than 27% share for renewable energy; more than 27% improvement in energy efficiency. This strategy is aiming at moving to a competitive low carbon economy by 2050.

Water Framework Directive

With the European water policy[17], it is recognized that clean and available water is necessary for human, animal and plant life, but is also needed for a fruitful economy. Water contributes also to climate regulation through the water cycle. The protection of water resources is therefore a priority of European environmental protection as the issues are transboundary and necessitate concerted actions. Several maps and indicators are available to follow the state of the resource as part of the Water Information System for Europe (WISE)[18].

Common Agriculture Policy

The Common Agriculture Policy (CAP) is fixing the objectives for Europe of a multi-

[13] https://equator-principles.com/about/
[14] http://ec.europa.eu/environment/sustainable-development/strategy/index_en.htm
[15] https://biodiversity.europa.eu/mtr/biodiversity-strategy-plan
[16] https://ec.europa.eu/clima/policies/strategies/2030_en
[17] http://ec.europa.eu/environment/water/index_en.htm
[18] https://water.europa.eu/

functional agriculture of about 11 million farms and 22 million people active in this domain. With its agricultural resources, the European continent can and must play a key role in ensuring food security. Farmers have a dual challenge to produce food while preserving nature and its biodiversity. Sustainable agriculture is essential for our food production and for our quality of life - today, tomorrow and for future generations. Agriculture is being monitored with different sets of indicators (EC 2015).

Strategic Implementation Plan (SIP) of the European Innovation Partnership on Raw Materials

This action plan focuses on "ensuring the sustainable supply of raw materials to the European economy whilst increasing benefits for society as a whole". EU governments contributed to define a strategy together with industry, academia, and NGOs. The objectives of the plan are based on improving resource efficiency, reducing dependency on importing raw materials, and diminishing negative environmental, social and health impacts[19].

European indicator system

Finally, the European Environment Agency indicators[20] are defined to support environmental policy making, from designing policy frameworks to setting targets, and from policy monitoring and evaluation to communicating to policy-makers and the public. They are defined as Descriptive, Performance, Efficiency, Policy effectiveness and Total welfare indicators.

The "Digest of EEA indicators 2014" provides a comprehensive guide to EEA indicators (EEA 2014) and its Indicator Management System contains 120 indicators and also defines a *Core Set of Indicators*, which provides a manageable and stable basis for indicator-based assessments of progress against environmental policy priorities. The Streamlining of environmental indicators' project is coordinated by Eurostat to avoid duplicates, to publish indicators online, and to define an indicator streamlining process.

[19] https://ec.europa.eu/growth/tools-databases/eip-raw-materials/en/content/strategic-implementation-plan-sip-0#Targets

[20] https://www.eea.europa.eu/data-and-maps/indicators/about

Examples / Case studies

Work package 4: Biodiversity and Ecosystems

Workflow 4.1:	Land degradation
Spatial Extent	Switzerland, Europe
Dashboard link	https://geoessential.unepgrid.ch/mapstore/#/dashboard/4
Temporal Extent	1970-2020
EVs used	Land cover
Inputs	Landsat and Copernicus scenes
Outputs	Land degradation
Targeted Policy	SDG 13.1: By 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world
Targeted indicators	15.3.1: Proportion of land that is degraded over total land area
Main Process	Trends. Earth model : http://trends.earth
Level of development	50%
GitHub code	To be included when available
Outputs endpoint	To be included when available
Partner(s)	UNIGE
Contact person	Grégory Giuliani (UNIGE)

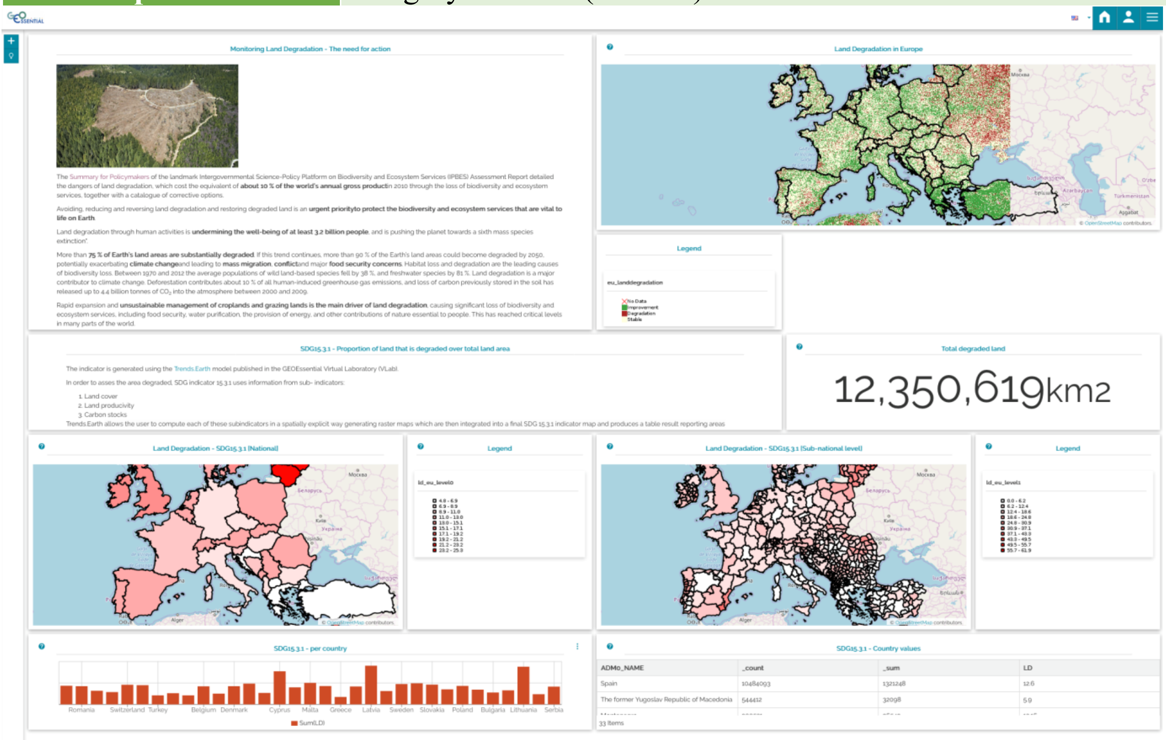


Figure 3 Workflow 4.1: GEOEssential dashboard with data from land degradation in Europe

Workflow 4.2:	Changes in forest and agriculture extent
Spatial Extent	Global
Dashboard link	To be included when available
Temporal Extent	1992-2015
EVs used	EBV ecosystem structure
Inputs	Land cover product (ESA CCI)
Outputs	Mean values of forest and agriculture extent for an area defined by the user. Data available from 1992 to 2015.
Targeted Policy	UN SDG
Targeted indicators	The analyses carried out could contribute to informing about the indicator 15: Life on land: 15.1.1: "Forest area as a proportion of total land area"
Main Process	Fractional land cover rasters of forest and agriculture are estimated using the ESA CCI LC product (Figure 4). The legend of the ESA CCI LC product was aggregated according to the IPCC land cover legend (Land cover CCI product user guide v 2.0, p. 30, available at: https://maps.elie.ucl.ac.be/CCI/viewer/download/ESACCI-LC-Ph2-PUGv2_2.0.pdf). The fractional land cover rasters are the inputs of a workflow that extracts mean values of forest and agriculture extent for an area provided by the user (i.e. polygon). Mean values can be extracted for a time frame of 24 years (1992–2015), which allow us to compare the evolution of the ecosystem structure and how changes in those land cover classes extent relate to each other (Figure 5). The spatial resolution of the ESA CCI LC product is 0.0027 (300 m at the Ecuador). Fractional land cover products are provided at a spatial resolution of 0.2777 (or 0.02777) preserving the information of the original datasets.
Level of development	100%
GitHub code	To be included when available
Outputs endpoint	To be included when available
Partner(s)	SGN
Contact person	Marta Gómez-Giménez (SGN)

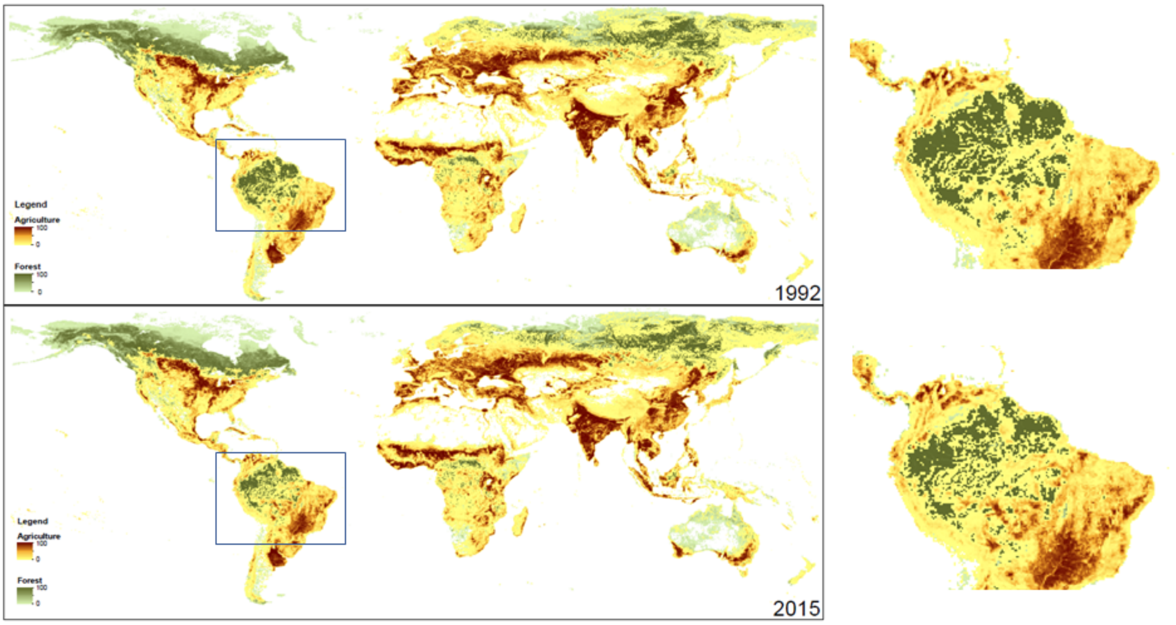


Figure 4 Workflow 4.2: Percentage of agriculture and forest land cover classes extent in Brazil between 1992 and 2015.

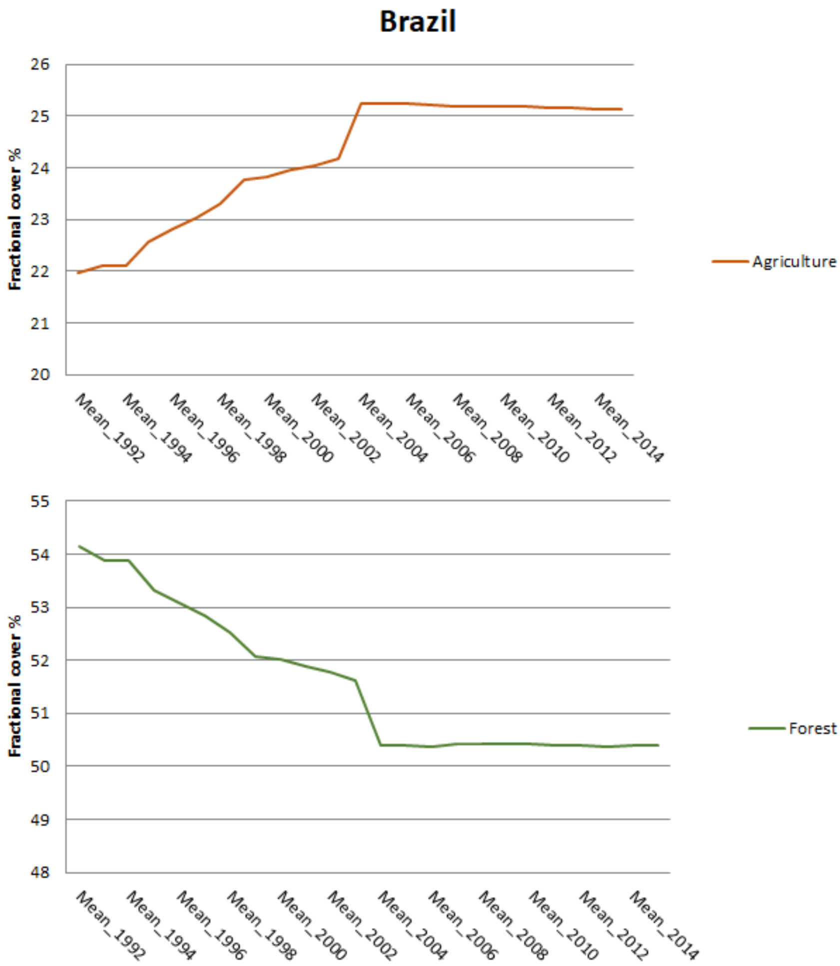
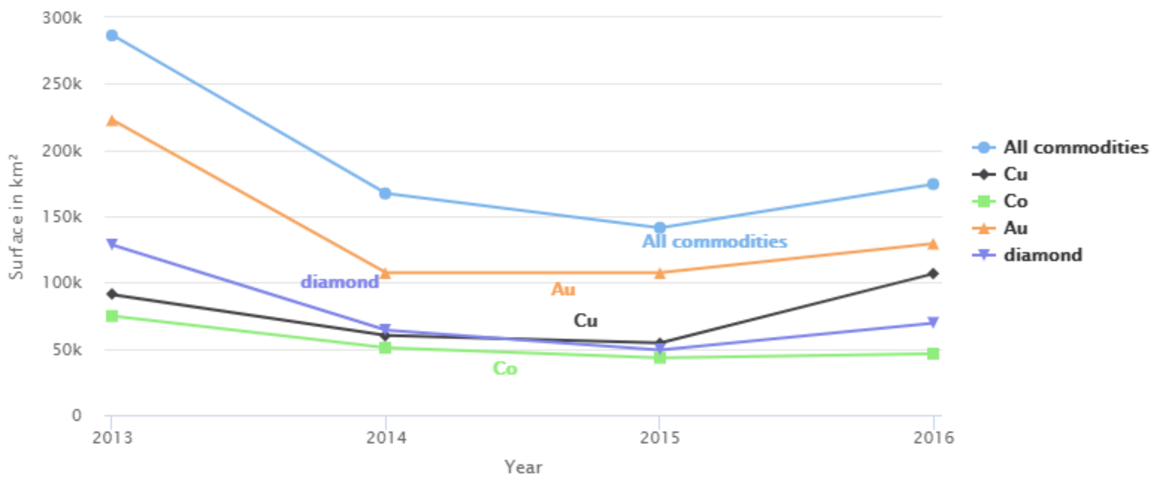


Figure 5 Workflow 4.2: Evolution of agriculture and forest mean fractional cover values in Brazil between 1992 and 2015.

Work package 5: Extractive industry & light monitoring

Workflow 5.1:	Land degradation
Spatial Extent	DR Congo, Africa
Dashboard link	https://geoessential.unepgrid.ch/mapstore/#/dashboard/9
Temporal Extent	2013 - 2016
EVs used	Land cover
Inputs	Landsat scenes and mining cadaster
Outputs	Surface of forest covered by mines
Targeted Policy	15.3 By 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world
Targeted indicators	15.3.1 Proportion of land that is degraded over total land area
Main Process	Overlap between satellite images representing forest cover and mining concessions Calculation of the surface of overlap Monitoring of this surface over time
Level of development	75%
GitHub code	https://github.com/ambroso0/MinesWorkflowfinal
Outputs endpoint	https://geoessential.unepgrid.ch/geoserver/web/ and https://geoessential.unepgrid.ch/geonetwork
Partner(s)	UNIGE
Contact person	Pierre Lacroix (UNIGE)

Surface of forest covered by mining concessions
(total and for each main commodity), 2013-2016



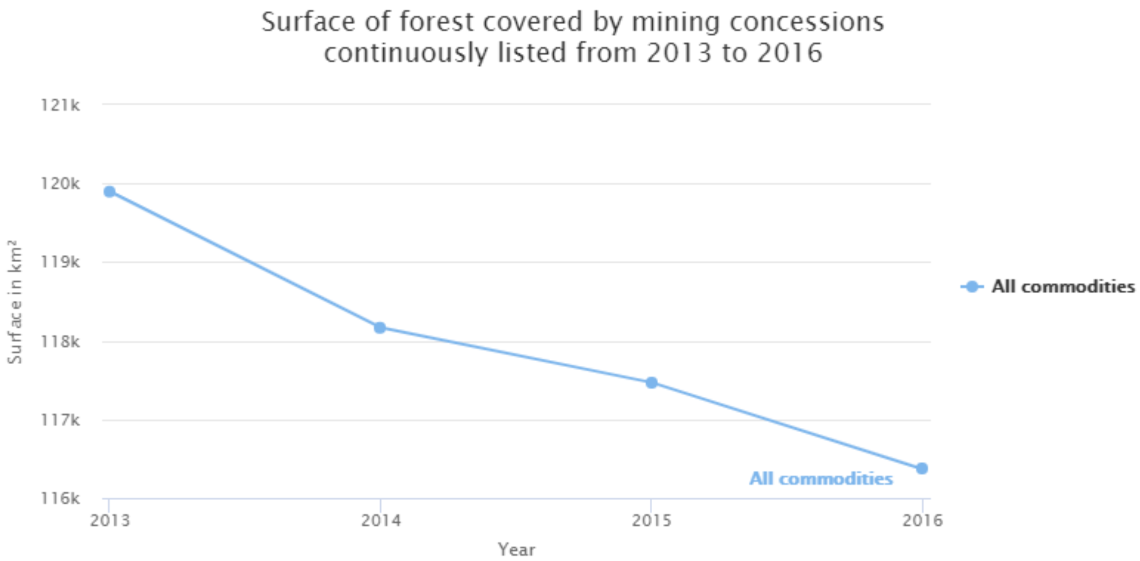


Figure 6 Workflow 5.1: Surface of forest covered by mining concessions between 2013 and 2016, for each main commodity (copper, cobalt, gold, diamond) and for all commodities. In the second graph, the surface of forest was calculated only in the mining concessions that were exploited continuously during the years 2013-2016, reflecting a non-stop industrial activity

Work package 6: Food-Water-Energy Nexus

Workflow 6.1:	Change in Extent of Water
Spatial Extent	Global
Dashboard link	To be included when available
Temporal Extent	1984 - 2015
EVs used	Land Cover (ECV)
Inputs	Landsat https://global-surface-water.appspot.com/
Outputs	a number representing the total area in km2 of water extent lost, gained and unchanged between the years 1984 and 2015.
Targeted Policy	SDG 6.6. By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes
Targeted indicators	Indicator 6.6.1.: Change in the extent of water-related ecosystems over time
Main Process	GIS-based
Level of development	Beta
GitHub code	https://github.com/irmccallum/GeoEssential
Outputs endpoint	To be included when available
Partner(s)	UNIGE
Contact person	Ian McCallum (IIASA)

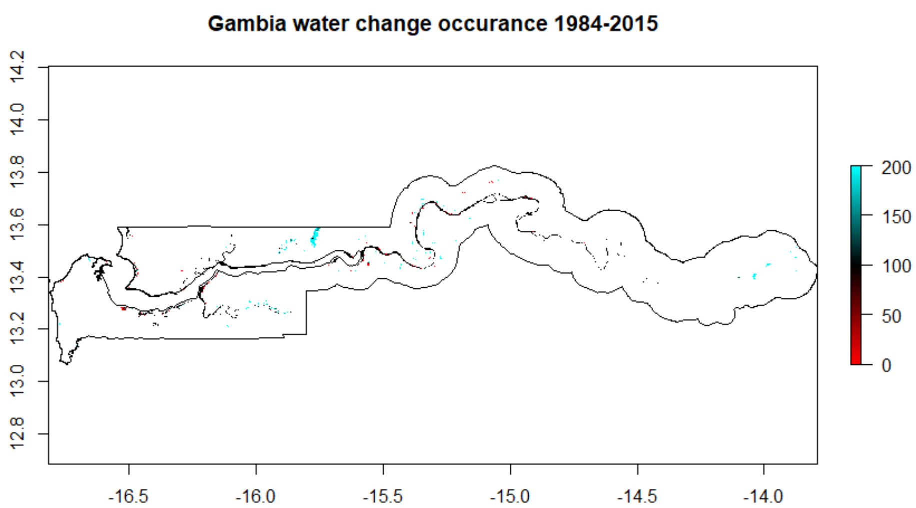


Figure 7 Water change occurrence 1984 - 2015

Workflow 6.2:	European Soil and Water Assessement Tool
Spatial Extent	Europe
Dashboard link	https://geoessential.unepgrid.ch/mapstore/#/dashboard/2
Temporal Extent	1973 - 2006
EVs used	Essential Water Variables
Inputs	European SWAT model outputs (Abbaspour et al. 2015)
Outputs	Water quality and quantity indicators
Targeted Policy	European Water Framework Directive
Targeted indicators	To be included when available
Main Process	GIS-based
Level of development	80%
GitHub code	To be included when available
Outputs endpoint	To be included when available
Partner(s)	UNIGE
Contact person	Anthony Lehmann (UNIGE)

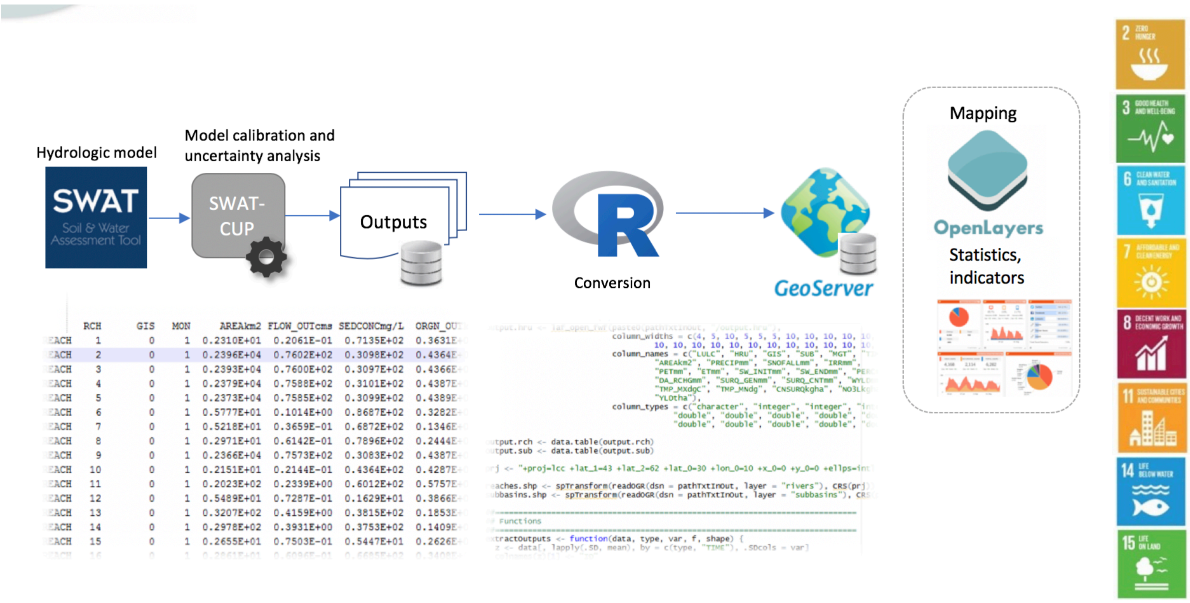
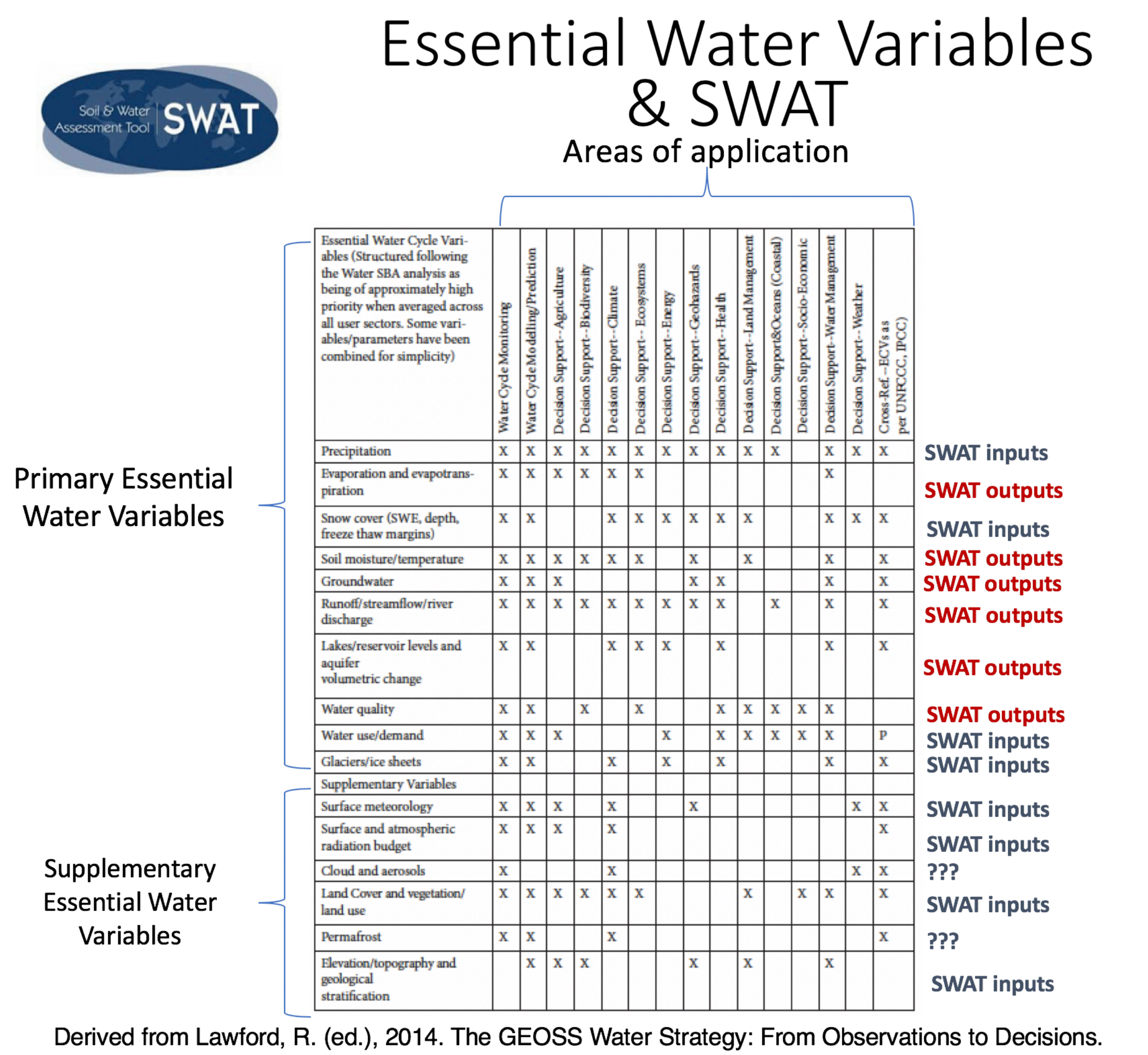


Figure 8 SWAT outputs to EU indicators workflow



Essential Water Cycle Variables (Structured following the Water SBA analysis as being of approximately high priority when averaged across all user sectors. Some variables/parameters have been combined for simplicity)	Water Cycle Monitoring	Water Cycle Modelling/Prediction	Decision Support--Agriculture	Decision Support--Biodiversity	Decision Support--Climate	Decision Support-- Ecosystems	Decision Support--Energy	Decision Support--Geohazards	Decision Support--Health	Decision Support--Land Management	Decision Support&Oceans (Coastal)	Decision Support--Socio-Economic	Decision Support--Water Management	Decision Support--Weather	Cross-Ref.--ECVs as per UNFCCC, IPCC)	
Precipitation	X	X	X	X	X	X	X	X	X	X	X		X	X	X	SWAT inputs
Evaporation and evapotranspiration	X	X	X	X	X	X							X			SWAT outputs
Snow cover (SWE, depth, freeze thaw margins)	X	X			X	X	X	X	X	X			X	X	X	SWAT inputs
Soil moisture/temperature	X	X	X	X	X	X		X		X			X		X	SWAT outputs
Groundwater	X	X	X					X	X				X		X	SWAT outputs
Runoff/streamflow/river discharge	X	X	X	X	X	X	X	X	X		X		X		X	SWAT outputs
Lakes/reservoir levels and aquifer volumetric change	X	X			X	X	X		X				X		X	SWAT outputs
Water quality	X	X		X		X			X	X	X	X	X			SWAT outputs
Water use/demand	X	X	X				X		X	X	X	X	X		P	SWAT inputs
Glaciers/ice sheets	X	X			X		X		X				X		X	SWAT inputs
Supplementary Variables																
Surface meteorology	X	X	X		X			X						X	X	SWAT inputs
Surface and atmospheric radiation budget	X	X	X		X										X	SWAT inputs
Cloud and aerosols	X				X									X	X	???
Land Cover and vegetation/ land use	X	X	X	X	X	X				X		X	X		X	SWAT inputs
Permafrost	X	X			X										X	???
Elevation/topography and geological stratification		X	X	X				X		X			X			SWAT inputs

Figure 9 SWAT inputs and outputs relationships with EWVs

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