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# Knowledge generation using satellite Earth Observations & the GEOSS platform to support Sustainable Development Goals (SDG): a use case on Land Degradation

UNGGIM-Europe Webinar – May 14, 2025

Gregory Giuliani (UNIGE) in collaboration with ESA, CNR, EVERSIS, JRC & GEO



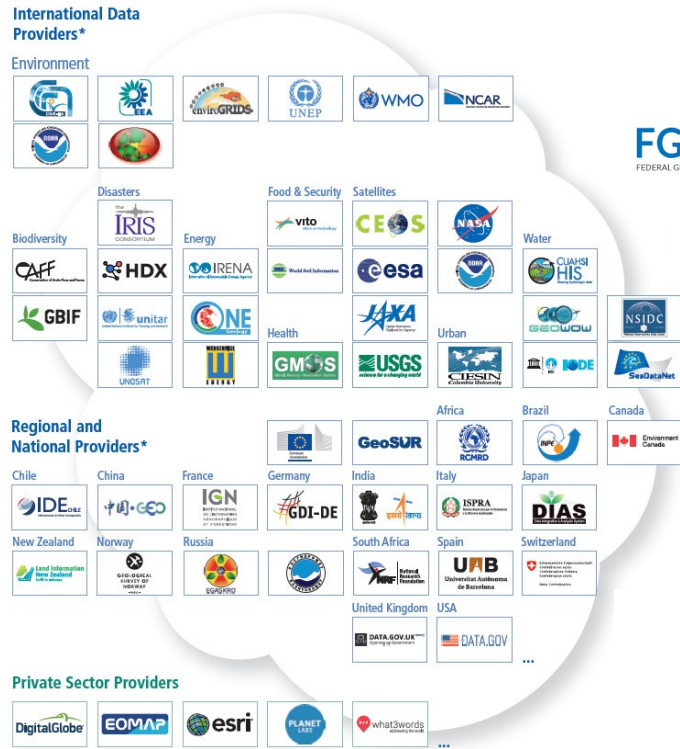
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# The GEOSS Platform: a bridge from data to Knowledge



Data, technologies, resources, Services providers



\* a selection of more than 150 providers



Status Checker



Yellow Pages



End-users (e.g. Decision Makers)



Intermediate users (e.g. Developers scientists)

**UPSTREAM**



**MIDSTREAM**

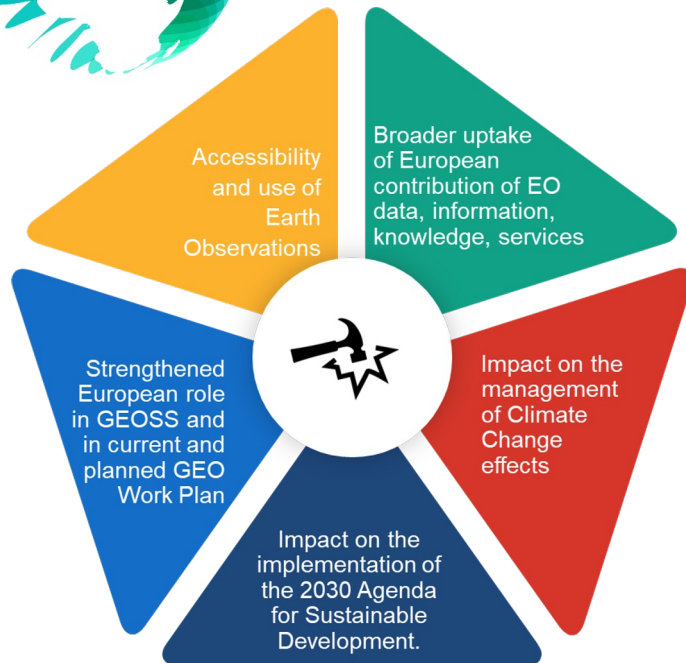


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**DOWNSTREAM**



# Expected Impacts

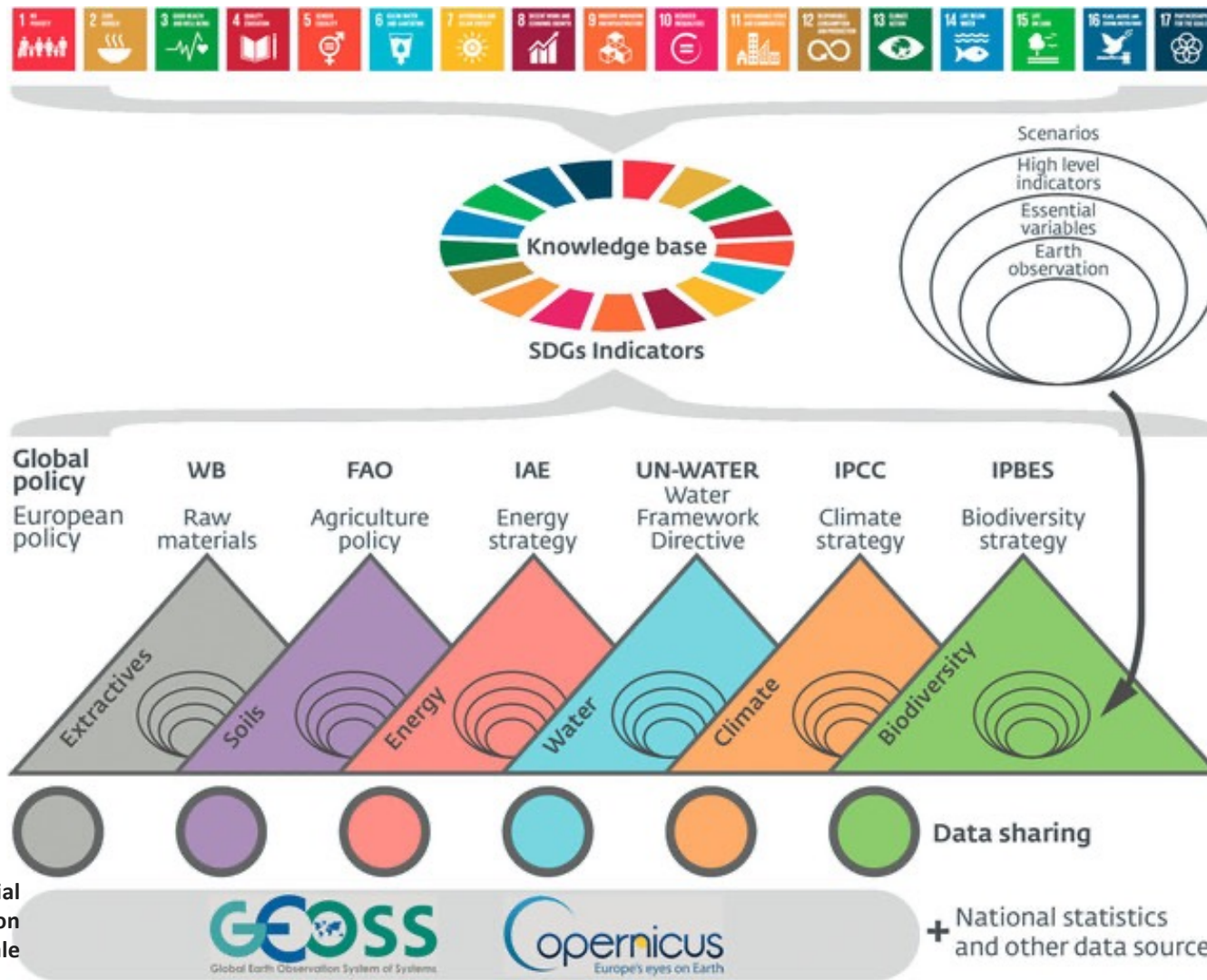


GPP will further evolve the GEOSS infrastructure with users' required functionalities to ***access and generate tailor-made information & actionable knowledge.***

GPP will enable ***services to non-specialists*** in the domain of ***adaptation to extreme climatic events*** and to ***changes in climatic conditions.***

It will implement different scenarios benefiting from GEOSS Platform developments. It will as well consider ***linking with the GKH to set up the foundations of more interoperability among knowledge platforms.***

# GEOEssential – Generalize the EV concept across GEO SBAs



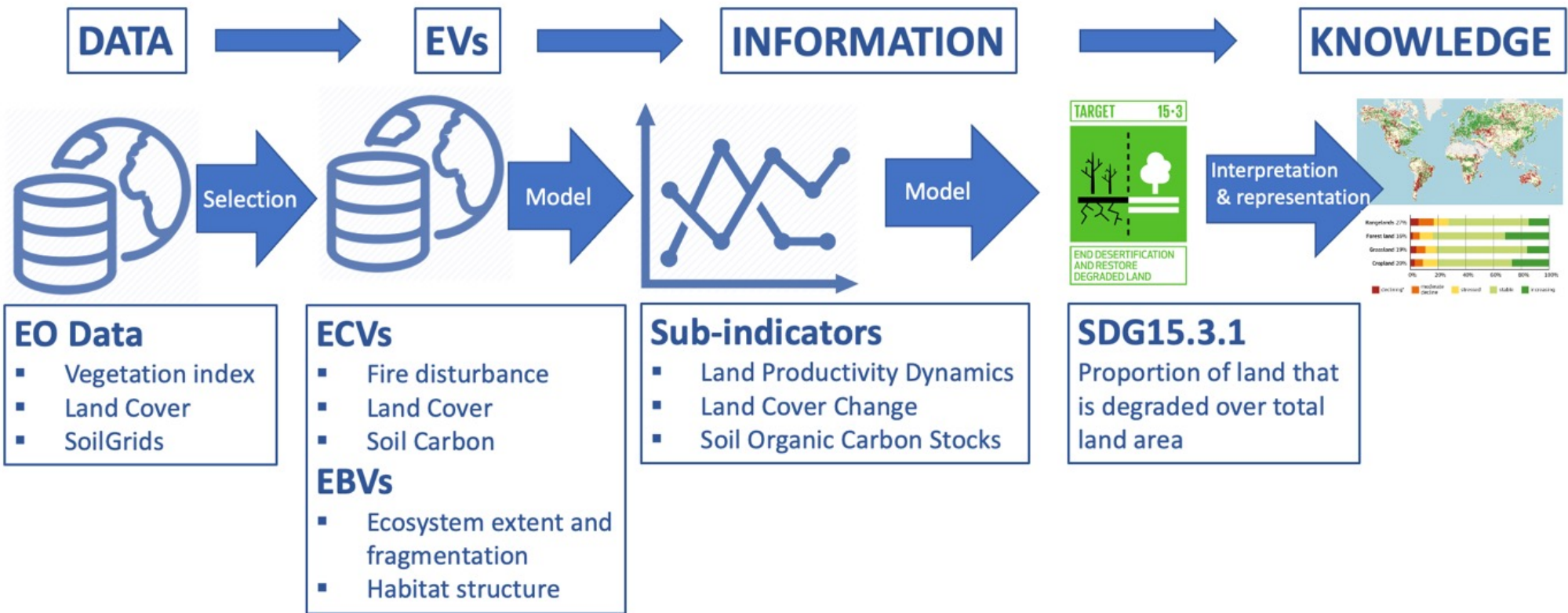
Lehmann A. et al., **Essential Variables from Earth Observation for environmental multi-scale indicators and policies.** *Submitted*



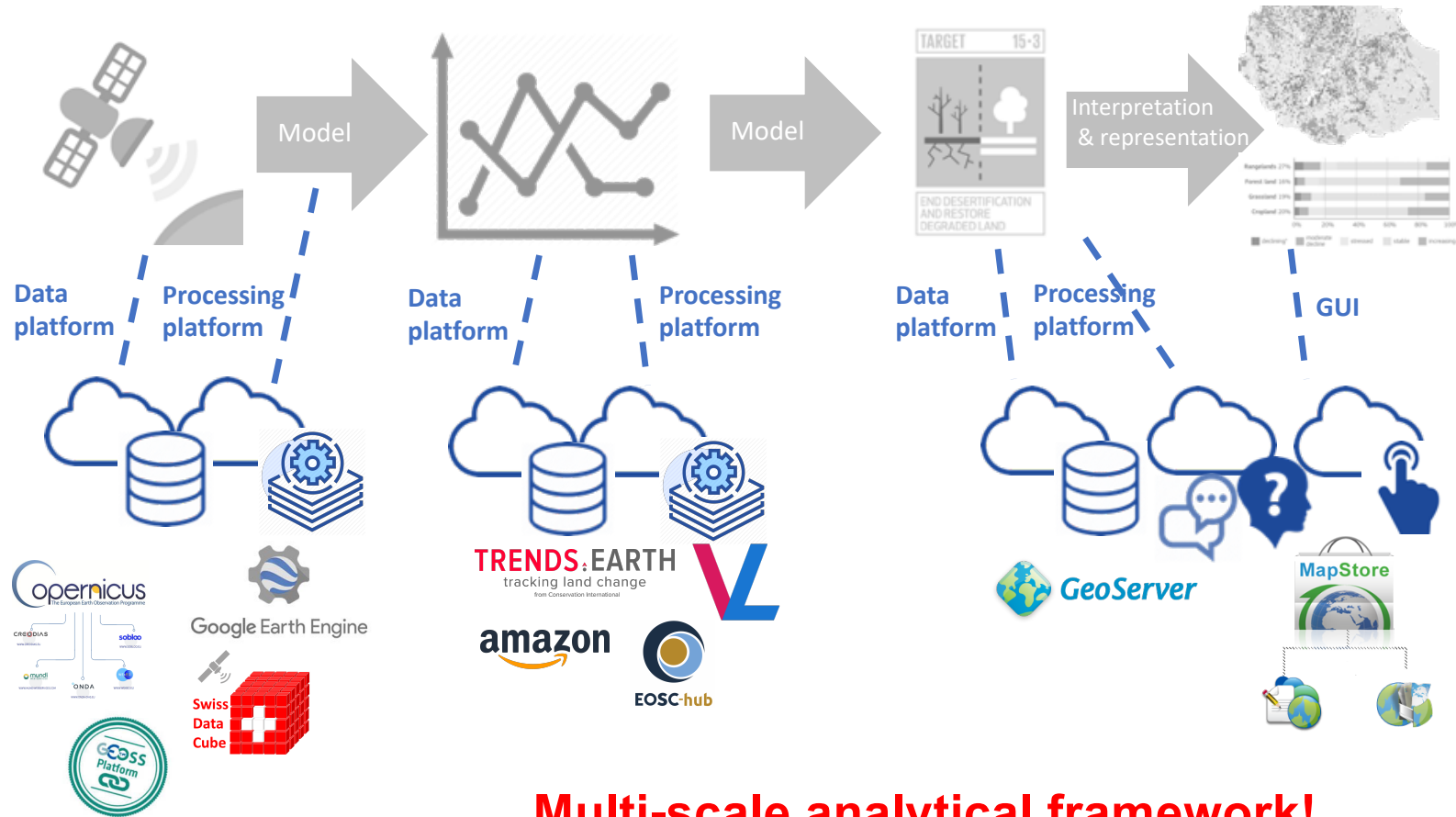
+ National statistics and other data sources

<https://www.geoessential.eu>

# SDG15.3.1 – Data to Knowledge



# SDG15.3.1 – Implementation in the GEOSS platform



**Multi-scale analytical framework!**



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**Search for a service to compute  
the SDG15.3.1 indicator**



Enter search words

ADVANCED SEARCH



# SDG15.3.1 – Service search



The screenshot displays the GEOSS Portal interface. At the top, it features the GEOSS logo, the text 'GEOSS Portal', and navigation icons for home, ESA, and language (English). A search bar contains the text 'land degradation'. Below the search bar, a 'FILTERS' dropdown is visible. The main content area shows a search result for 'SDG 15.3.1 - Land degradation service'. The definition provided is: 'Land degradation is defined as "the reduction or loss of the biological or economic productivity and complexity of rain fed...'. To the right of the definition is a 'SERVICES' icon. Below the definition, it indicates 'Sources: GEOSS Curated (1)'. At the bottom of the search results, there is a 'SEE ALSO' section with various related terms: 'land OR degradation', 'land AND degradation', 'weathering', 'imaging radars', 'environment', 'soil damage', 'organic pollutant', 'pesticide', 'toxic pollutant', 'pollutants', 'accessory terms', and 'general terms'. The background of the interface is a world map. At the bottom of the map, there is a scale bar for 2000 km, a 'NEW' badge, and links for 'Tutorial mode' and 'Send feedback'.



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# SDG15.3.1 – Model details



land degradation

GEOS GROUP ON EARTH OBSERVATIONS

GEOS Portal

esa English

**SDG 15.3.1 - Land degradation service**  
Land degradation is defined as "the reduction or loss of the biological or economic productivity and complexity of rain fed..."

**SERVICES**

**SDG 15.3.1 - Land degradation service**  
60 5.0

Land degradation is defined as "the reduction or loss of the biological or economic productivity and complexity of rain fed cropland, irrigated cropland, or range, pasture, forest and woodlands resulting from a combination of pressures, including land use and management practices".

See more

Sources: GEOSS Curated (1)

1 of 1

**SEE ALSO**

land OR degradation land AND degradation weathering imaging radars environment soil damage organic pollutant pesticide  
toxic pollutant pollutants accessory terms general terms

© OpenStreetMap Contributors to DSM.  
Administrative boundaries: © Esri/DeLorme, © Esri/GeoGraphics, © FAO (UN), © TurStat Source: European Commission – Eurostat/GISCO.  
Disclaimer: The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the European Union.

2000 km REW tutorial mode Send feedback



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**Execute the model**

# SDG15.3.1 – Workflow



The screenshot displays the GEOSS Portal interface. A central window titled "Workflow & Runs" is open, showing a workflow diagram for "LAND DEGRADATION - TRENDS.EARTH". The diagram includes input fields for "Land Cover", "Productivity", "Soil Carbon", and "Area of interest", which all feed into a central process box labeled "Land Degradation - Trends Earth". Below this process box, three output fields are shown: "Tiff File", "Map of Land Degradation", and "Summary File". The workflow window also features a "See this Workflow" link and a "RUNS" button. The background of the portal shows a map and various navigation options.



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# SDG15.3.1 – Data input



**Workflow & Runs**

Input name	Chosen resources	Actions
Land Cover*	✗ Default	Select resources ↕
Productivity*	✗ Default	Select resources ↕
Soil Carbon*	✗ Default	Select resources ↕

\* required fields [Show expert options](#)

**CLOUD PLATFORM SELECTION**

AWS  EUROPEAN OPEN SCIENCE CLOUD  CREODIAS

**RUN NAME**

Run name

Run ▶

# SDG15.3.1 – Runs



**My Workspace / Saved Runs**

- Land degradation on Lesotho 2019-2020** Completed - Success  
ID: 2354  
Outputs: Tiff File, Map of Land degradation  
[Create a dashboard](#) | [Show log](#)
- Land degradation on Rwanda 2018-2021** Completed - Success  
ID: 2354  
Outputs: Tiff File, Map of Land degradation  
[Create a dashboard](#) | [Show log](#)
- Land degradation on Ghana 2017-2020** Completed - Success  
ID: 2354  
Outputs: Tiff File, Map of Land degradation  
[Create a dashboard](#) | [Show log](#)

**Download & Visualize the outputs**

### Workflow & Runs

#### LAND DEGRADATION - TRENDS.EARTH

See this Workflow

RUNS

Name	Run ID	Add
------	--------	-----

**Rwanda\_test2**  
ID: 3103

EXECUTING

Show Log

**Rwanda**  
ID: 3002

COMPLETED - SUCCESS

- Outputs:
- Tiff File
  - Map of Land Degradation
  - Summary File

**Create a dashboard  
& share knowledge**



### Workflow & Runs



Rwanda\_test2

ID: 3103

EXECUTING

Show Log

Rwanda

ID: 3002

COMPLETED - SUCCESS

Outputs:

Tiff File

Map of Land Degradation

Summary File

Show Log

Create dashboard

testGG

ID: 3001

COMPLETED - SUCCESS

Outputs:

Tiff File

Map of Land Degradation

Accept

Decline

# SDG15.3.1 – Dashboard creation



# SDG15.3.1...


## ...GEOEssential Dashboard



## SDG15.3.1 indicator Land Degradation

Home / EO Workflows / SDG15.3.1

### Monitoring Land Degradation - The need for action



The Summary for Policymakers of the landmark Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) Assessment Report detailed the dangers of land degradation, which cost the equivalent of about 10 % of the world's annual gross product in 2010 through the loss of biodiversity and ecosystem services, together with a catalogue of corrective options.

Avoiding, reducing and reversing land degradation and restoring degraded land is an urgent priority to protect the biodiversity and ecosystem services that are vital to life on Earth.

Land degradation through human activities is undermining the well-being of at least 3.2 billion people, and is

### SDG15.3.1 - Proportion of land that is degraded over

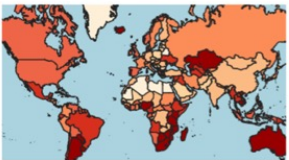
The indicator is generated using the Trends.Earth model published in the GEOEssential Virtual Laboratory (VLab). In order to assess the area degraded, SDG indicator 15.3.1 uses information from sub-indicators:

1. Land cover
2. Land productivity
3. Carbon stocks

Trends.Earth allows the user to compute each of these subindicators in a spatially explicit way generating raster maps which are then integrated into a final SDG 15.3.1 indicator map and produces a table result reporting areas potentially improved and degraded for the area of analysis.


More information on the indicator 15.3.1: United Nations SDG Indicators - Metadata Repository

### SDG15.3.1 - National value (model)



0.0 - 2.0
2.9 - 7.0
7.0 - 10.5
10.5 - 14.3
14.3 - 19.4
19.4 - 29.5
29.5 - 78.3

### SDG15.3.1 - Disaggregation



No data
Degradation
Stable
Improvement

**Spatial extent:** Switzerland, Europe, World

**Dashboard link:** <https://geoessential.unepgrid.ch/mapstore/#/dashboard/36>

**Temporal extent:** 2001-2015

**EVs used:** Land cover, NDVI, Precipitation, Temperature, Soil Moisture

**Inputs:** Land cover, NDVI, Precipitation, Temperature, Soil Moisture,

### Data Story

Global Land Degradation (GlobLD) - A global map of land degradation for the SDGs  
<https://geoessential.unepgrid.ch/mapstore/#/geostory/74>

### Videos

Video Show Case presented at the GEO plenary in Canberra on the European Commission & ESA booth: GEOSS Platform: a Land Degradation use case  
<https://www.youtube.com/watch?v=TN1VC0rOjvE>

### Poster

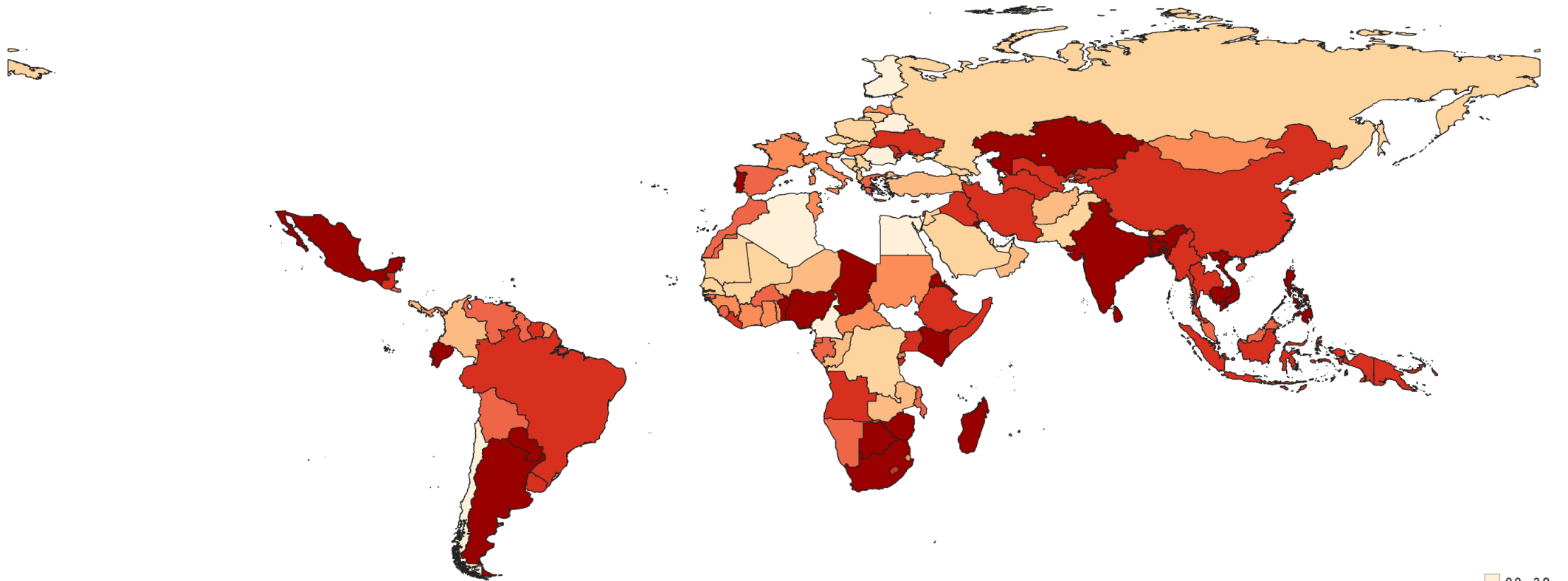
Giuliani G. et al. (2020) Knowledge generation using satellite Earth Observations to support Sustainable Development Goals (SDG): a use case on Land Degradation.

DOI: 10.1016/j.jag.2020.102068

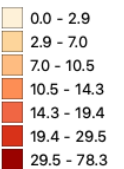
**How this approach has been used?**

# SDG15.3.1...

...UNSD SDG Indicators Global Database

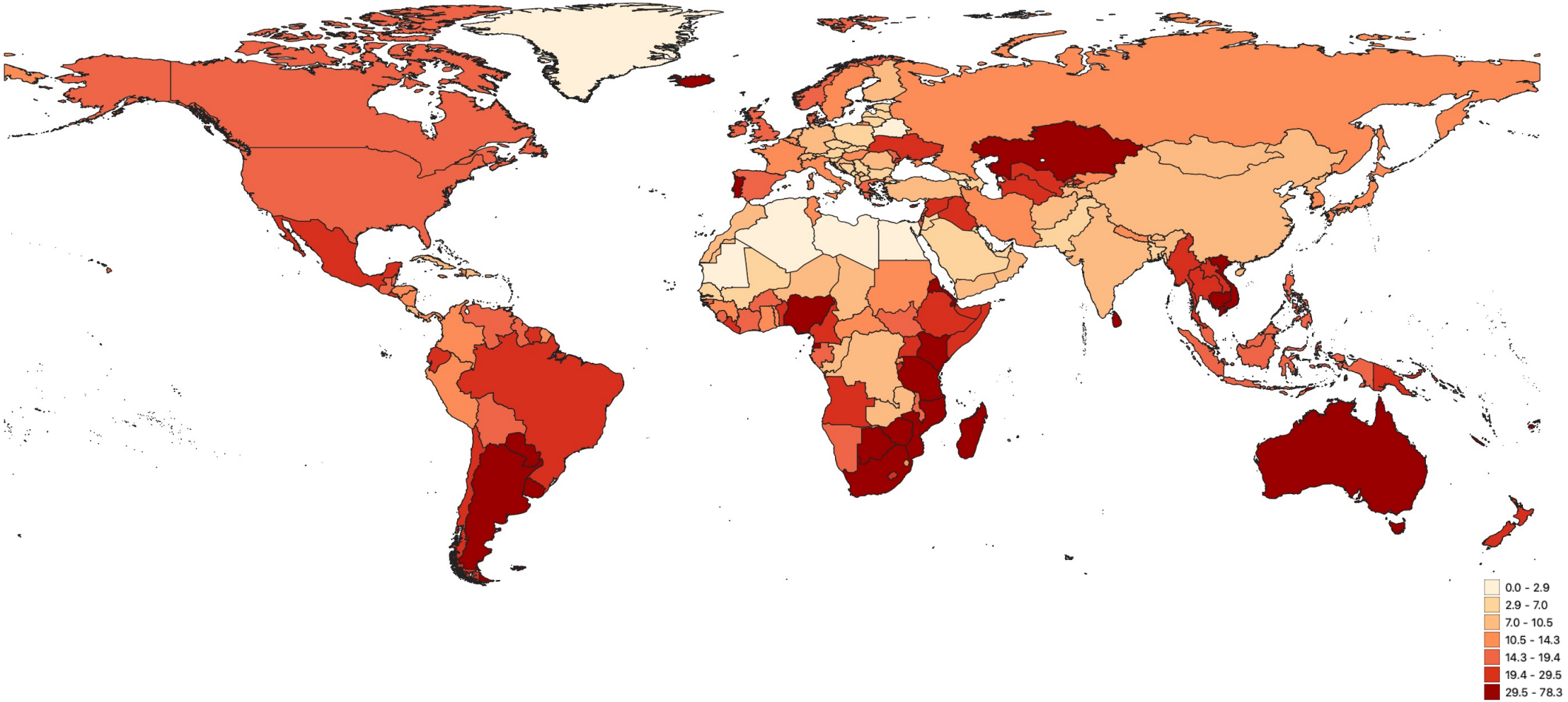


Only 50% of the countries have reported a value [2018]



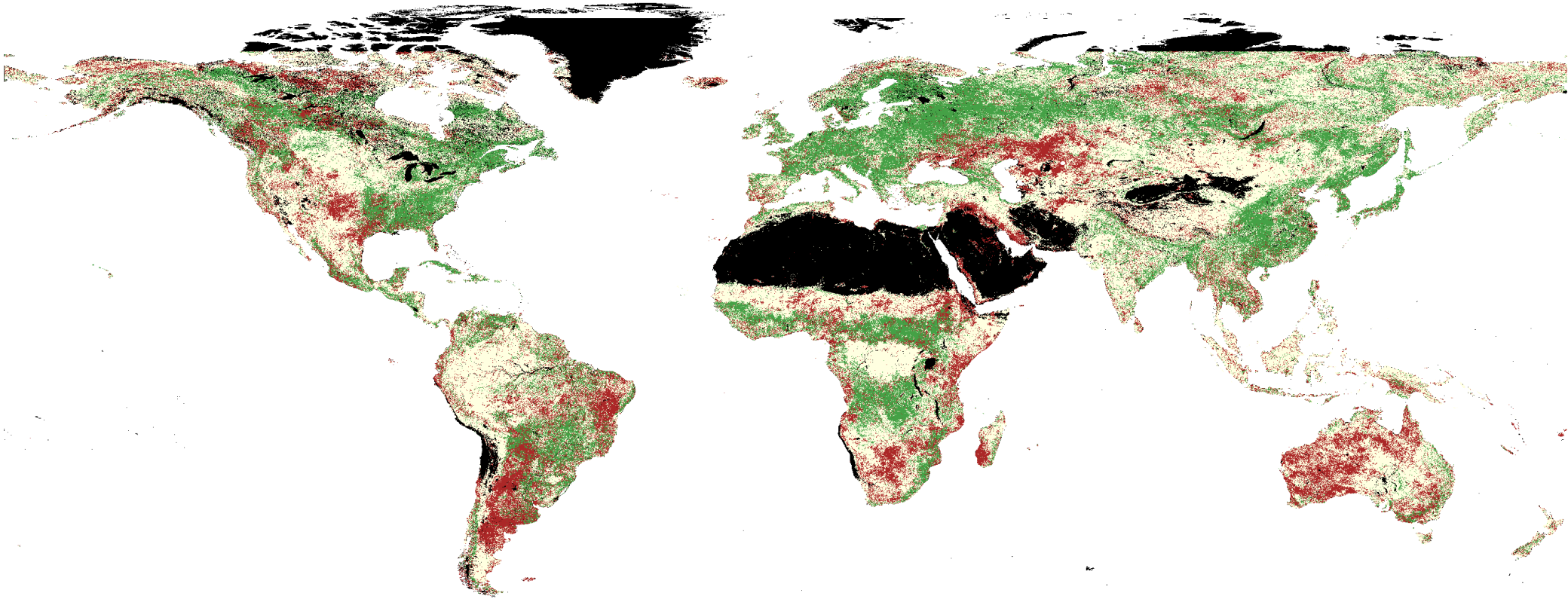
# SDG15.3.1...

...Modelled using EO data



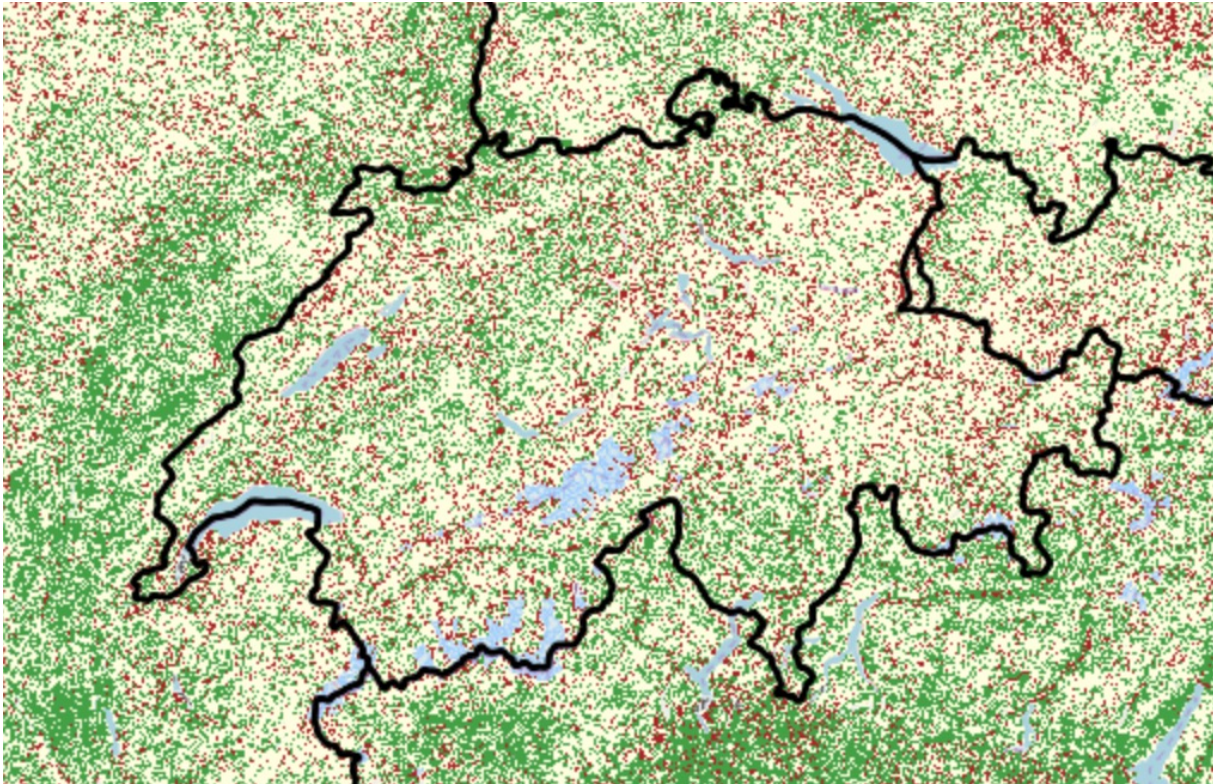
# SDG15.3.1...

...Disaggregation



## SDG15.3.1...

...at the national scale



Using the Swiss Data Cube & Landsat data

**Official value: 4.7%**

**SDC value: 9.7%**

Official definition in Switzerland is based only on soil sealing and do not consider land productivity!

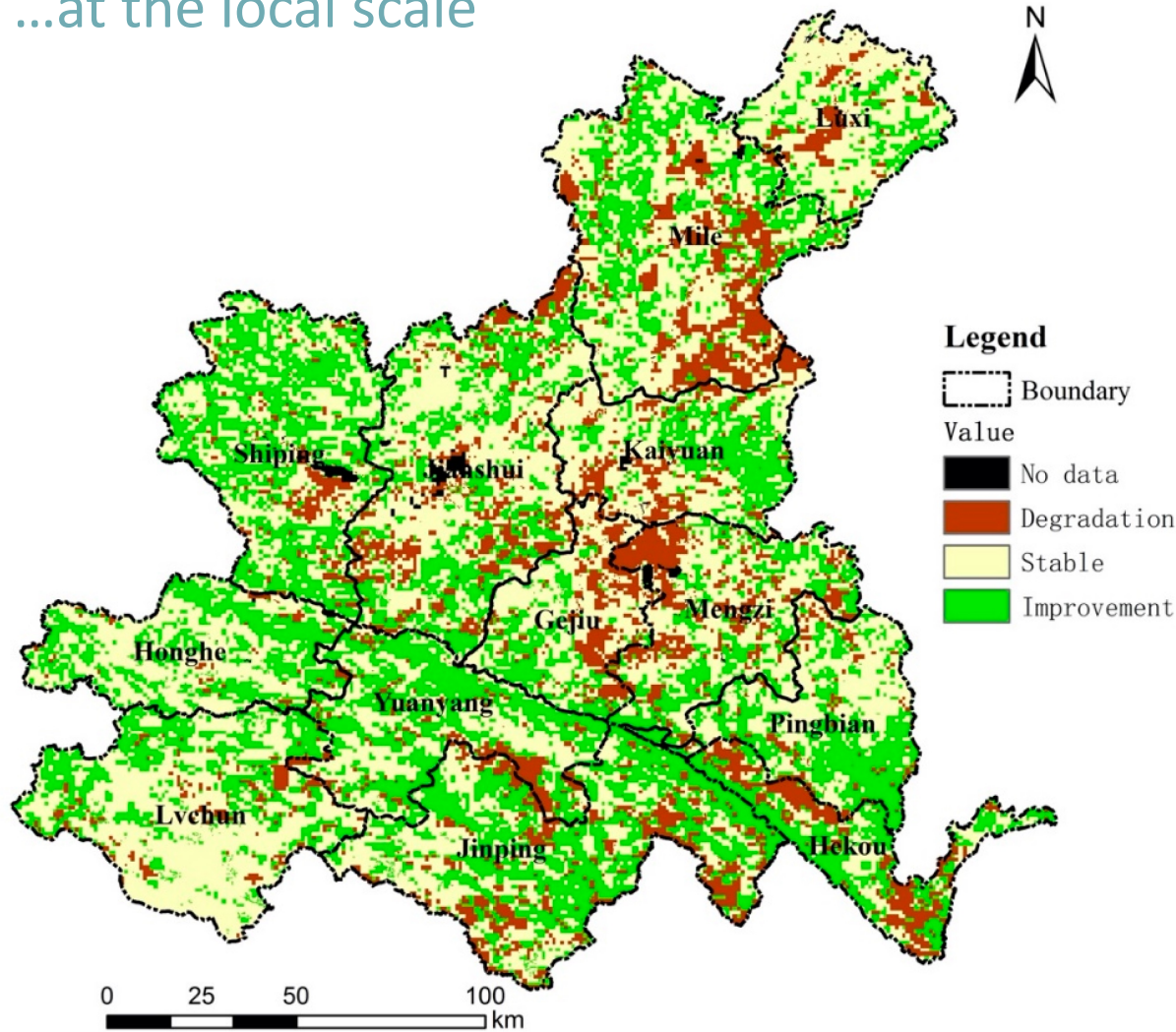
**Do not comply with the official UN definition!**

Giuliani G. et al. (2020) **Monitoring land degradation at national level using satellite Earth Observation time-series data to support SDG15 – exploring the potential of data cube.**

DOI: 10.1080/20964471.2020.1711633

# SDG15.3.1...

...at the local scale



Honghe prefecture; Yunnan Province of China

Land degradation is mostly caused by urban expansion

**Main drivers: loss of land productivity & land cover change.**

Wang T. et al. (2020) Supporting SDG15: Identifying Main Drivers of Land Degradation in Honghe Prefecture between 2005 and 2015. DOI: 10.3390/ijgi9120710



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9

Altmetric



Research Article

## Beyond the SDG 15.3.1 Good Practice Guidance 1.0 using the Google Earth Engine platform: developing a self-adjusting algorithm to detect significant changes in water use efficiency and net primary production

Andrea Markos, Neil Sims & Gregory Giuliani

Received 11 Feb 2022, Accepted 08 May 2022, Published online: 19 Jun 2022

Download citation <https://doi.org/10.1080/20964471.2022.2076375>



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Views

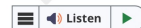
28

CrossRef

citations to date

13

Altmetric



Technical Note

## Monitoring land degradation at national level using satellite Earth Observation time-series data to support SDG15 – exploring the potential of data cube

Gregory Giuliani, Bruno Chatenoux, Antonio Benvenuti, Pierre Lacroix,

Mattia Santoro & Paolo Mazzetti

Pages 3-22 | Received 25 Sep 2019, Accepted 20 Dec 2019, Published online: 16 Jan 2020

Download citation <https://doi.org/10.1080/20964471.2020.1711633>



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Volume 88, June 2020, 102068



# Knowledge generation using satellite earth observations to support sustainable development goals (SDG): A use case on Land degradation

Gregory Giuliani <sup>a, b</sup>, Paolo Mazzetti <sup>c</sup>, Mattia Santoro <sup>c</sup>, Stefano Nativi <sup>d</sup>, Joost Van Bemmelen <sup>e</sup>, Guido Colangeli <sup>e</sup>, Anthony Lehmann <sup>a, f</sup>

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# Stakeholders and impact



- Registered in the GEO Knowledge Hub: <https://doi.org/10.60566/s20ze-v4821>

The screenshot shows the GEO Knowledge Hub interface. At the top, there is a dark blue header with the GEO Knowledge Hub logo, a search bar, and navigation links for 'Communities' and 'Marketplace'. On the right side of the header, there are 'Log in' and 'Sign up' buttons. Below the header, the page content is organized into several sections:

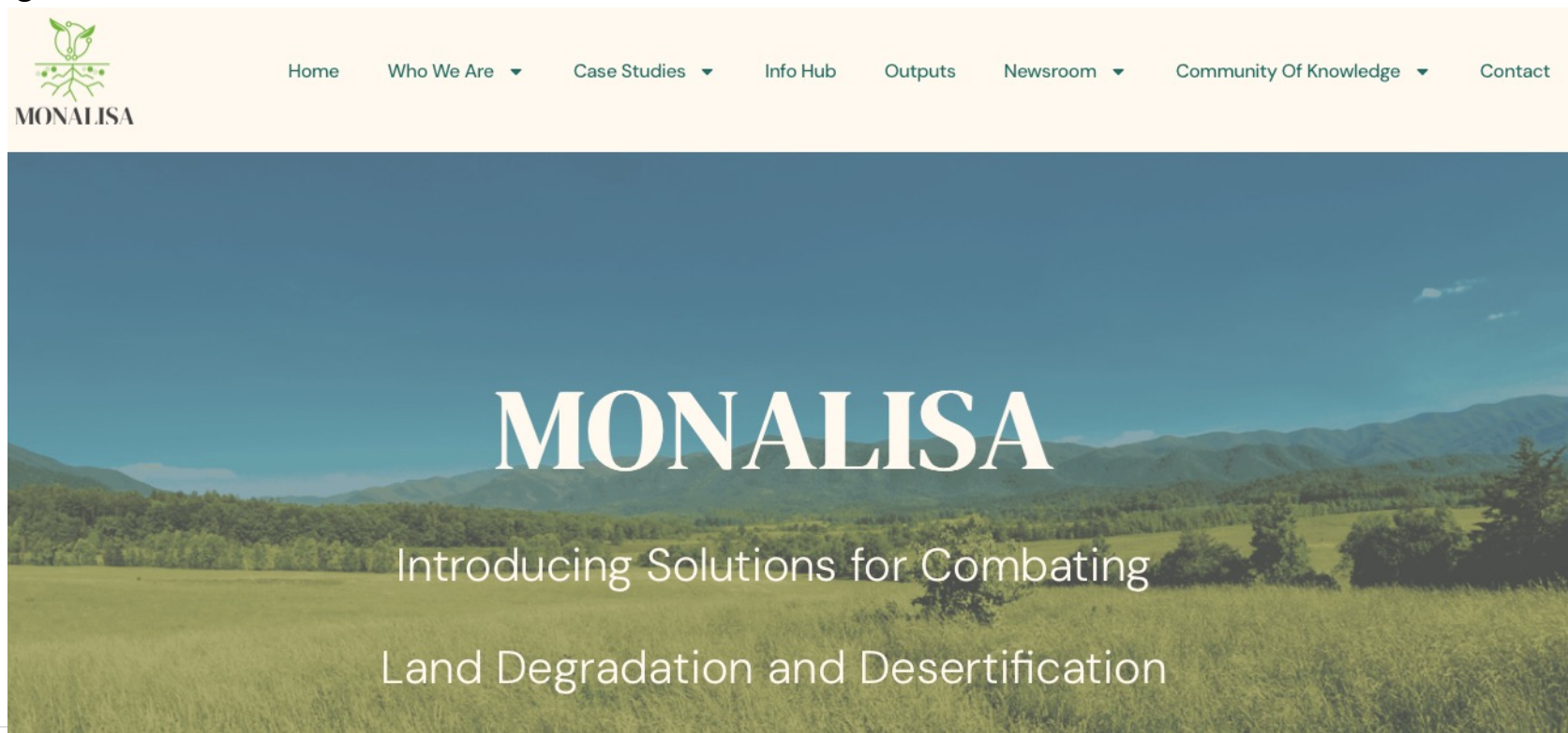
- Metadata:** Published December 10, 2024 | Version 1.0. Includes tags for 'GEO-LDN', 'Knowledge Package', and an 'Open' button.
- Title:** GPP - SDG15.3.1
- Author:** Giuliani, Gregory (with ORCID icon). A 'Show affiliations' button is present.
- Project leader:** Van Bemmelen, Joost
- Project members:** Mazzetti, Paolo; Santoro, Mattia; Scremin, Alessandro; Krupa, Piotr. A 'Show affiliations' button is present.
- Citation:** A section with a 'Style' dropdown menu set to 'APA'. The citation text is: Giuliani, G. (2024). GPP - SDG15.3.1 (1.0). GEO Knowledge Hub. <https://doi.org/10.60566/s20ze-v4821>. A 'Download' icon is visible.
- Description:** Land degradation is a critical issue globally requiring immediate actions for protecting biodiversity and associated services provided by ecosystems that are supporting human quality of life. The latest Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services Landmark Assessment Report highlighted that human activities are considerably degrading land and threatening the well-being of approximately 3.2 billion people. In order to reduce and ideally reverse this prevailing situation, national capacities should be strengthened to enable effective assessments and mapping of their degraded lands as recommended by the United Nations Sustainable Development Goals (SDGs). The indicator 15.3.1 ("proportion of land that is degraded over total land area") requires regular data production by countries to inform and assess it through space and time. Earth Observations (EO) can play an important role both for generating the indicator in countries where it is missing, as well complementing or enhancing national official data sources. In response to this issue, this paper presents an innovative, scalable and flexible approach to monitor land degradation at various

On the right side of the page, there are several interactive panels:

- Need training?:** A dark blue button.
- Versions:** A dropdown menu showing 'Version 1.0 (Dec 10, 2024)'.
- Any question?:** A button labeled 'Ask the provider'.
- Feedback space:** A button labeled 'Learn the community experience with this content'.
- GEO Theme:** A section with a 'Download' button and a graphic of wheat stalks.



- Further developments are expected in MONALISA > link with Living Earth
- Strengthen the link with GEO LDN



# Conclusions



The proposed approach enhance:

1. *Reproducibility*: users can reproduce the experiment (same data/same analysis)
2. *Replicability*: users can replicate the experiment (different data /same analysis) >> use of national/local datasets instead of global ones.
3. *Reusability*: users can reuse/apply the approach in different contexts >> change the model and/or data sources.

GPP will further evolve the GEOSS infrastructure with users' required functionalities to **access tailor-made information & actionable knowledge**.

GPP will enable *services to non-specialists* in the domain of *adaptation to extreme climatic events* and to *changes in climatic conditions*.

Open Data, Source, Algorithms, Standards/FAIR principles > **one step towards reproducible science**.

**Facilitate connecting/utilizing** existing (European) developments and knowledge, in a collaborative way.

**Promoting collaborative approaches for Policy implementation**

**GEO role** in connecting and facilitating some existing “dots”, incubating possible “ecosystems”.



*“In my lifetime, I’ve witnessed a terrible decline.  
In yours, you could witness a wonderful recovery!”*

Sir David Attenborough, COP26 Summit, November 1, 2021



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