
GROUP ON
EARTH OBSERVATIONS
OPEN DATA
& OPEN KNOWLEDGE
Workshop

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REVIEW ARTICLE

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Digital earth: yesterday, today, and tomorrow

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ABSTRACT

The concept of Digital Earth (DE) was formalized by Al Gore in 1998. At that time the technologies needed for its implementation were in an embryonic stage and the concept was quite visionary. Since then digital technologies have progressed significantly and their speed and pervasiveness have generated and are still causing the digital transformation of our society. This creates new opportunities and challenges for the realization of DE. 'What is DE today?', 'What could DE be in the future?', and 'What is needed to make DE a reality?'. To answer these questions it is necessary to examine DE considering all the technological, scientific, social, and economic aspects, but also bearing in mind the principles that inspired its formulation. By understanding the lessons learned from the past, it becomes possible to identify the remaining scientific and technological challenges, and the actions

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Digital Earth; digital transformation; sustainable development; data governance and ethic; citizen empowerment and industry engagement

"Digital Earth can play an insightful role to provide the basis for reliable and responsible scientific understanding and knowledge to support informed decisions and evidence-based policy advice. It can help to integrate different data describing the three dimensions of sustainability (economic, social, and environmental)"

SWISS DATA CUBE *in Numbers*

A unique Analysis Ready Data Archive

Updated every week!

39 years
FROM 1984 to 2023

10 sensors
LANDSAT 5/7/8/9;
SENTINEL-1AB/2AB/3/5P

Official gov. data
DEM; Climate models; Land Cover,...

EO data products
NDVI, NDWI, EVI, LAI, ... time-series

> 450 million
PIXELS

> 3000 billion
OBSERVATIONS

10-30-90m
PIXEL RESOLUTION

~ 80'000 images
INGESTED

~30 TB
ANALYSIS READY DATA

~40 millions CHF
COST OF DATA WITHOUT OPEN DATA ACCESS POLICY

GRID Genève · UNIVERSITÉ DE GENÈVE · University of Zurich[UZH] · WSL

Chatenoux B., Richard J.-P. Small D., Roeoesli C., Wingate V., Poussin C., Rodila D., Peduzzi P., Steinmeier C., Ginzler C., Psomas A., Schaepman M., Giuliani G. (2021) The Swiss Data Cube: Analysis Ready Data archive using Earth Observations of Switzerland, ***Nature Scientific Data***. *8:295* https://doi.org/10.1038/s41597-021-01076-6

Our vision

The Swiss Data Cube (operated by the University of Geneva and the United Nations Environment Programme/GRID-Geneva together with the University of Zurich and the Federal Institute for Forest, Snow and Landscape Research) is aiming at **providing a routine, reliable and operational service, using satellite Earth Observations (EO) to deliver decision-ready products** enabling policy makers, scientists, the private sector and civil society to address social, environmental and economic changes at the national scale and develop an ecosystem for innovation across sectors.

The Swiss Data Cube - Insight for action

The SDC will **improve our understanding of Switzerland's changing landscape**, providing much needed insights, knowledge and analysis for more informed, strategic and inclusive decision making across the country. This information will **benefit policy makers and public officials**, enabling them to make better decisions, and will **increase commercial efficiency and economic growth** for businesses and entrepreneurs across the country.

Our mission

The Swiss Data Cube will **process openly accessible and freely available data** to produce decision-ready products. **Working closely with different stakeholders' communities** (administrations, industry, scientists…), the Swiss Data Cube will be responsive to the information needs, challenges, and priorities of the Swiss institutions. It will ultimately leverage and build on existing capacity to enable the use of EO data to address key challenges across the country.

Environmental monitoring

Supporting national & cantonal monitoring activities

- Snow cover change over the last 35+ years
- Impact of droughts on vegetation and rivers
- Identifying new protection areas with high archeological potential
- Identifying impervious areas to support climate action plans
- Contribution to air quality monitoring
- Identifying dust to better predict concentration of pollutants

Collaborations

Who already benefits (or is interested) by the SDC?

- *National:* BAFU, swisstopo, FSO, …
- *Cantons:* Geneva, Vaud, Valais, Neuchâtel, Zurich, Ticino
- *International:* Australia, Brazil, Chile, UK, Greece, Israel, Armenia, …
- *Private sector:* Litix, WeGaw, PicTerra
- *Universities:* Bern, Basel, ETHZ, Lausanne, Geneva

SDG monitoring

Following progresses towards policy framework

- SDG 6.6.1: change in water extent
- SDG 11.7.1: urban green areas
- SDG 15.3.1: land degradation

SwissEnvEO

http://geonetwork.swissdatacube.org

2TB of freely available satellite-derived national time-series data products (NDVI, LAI, …) – FAIR compliant

Scientific impact

Enhancing environmental monitoring

- 26 publications
- > 60 presentations
- > 20 interviews, newspaper, …
- > 10 scientific projects supported

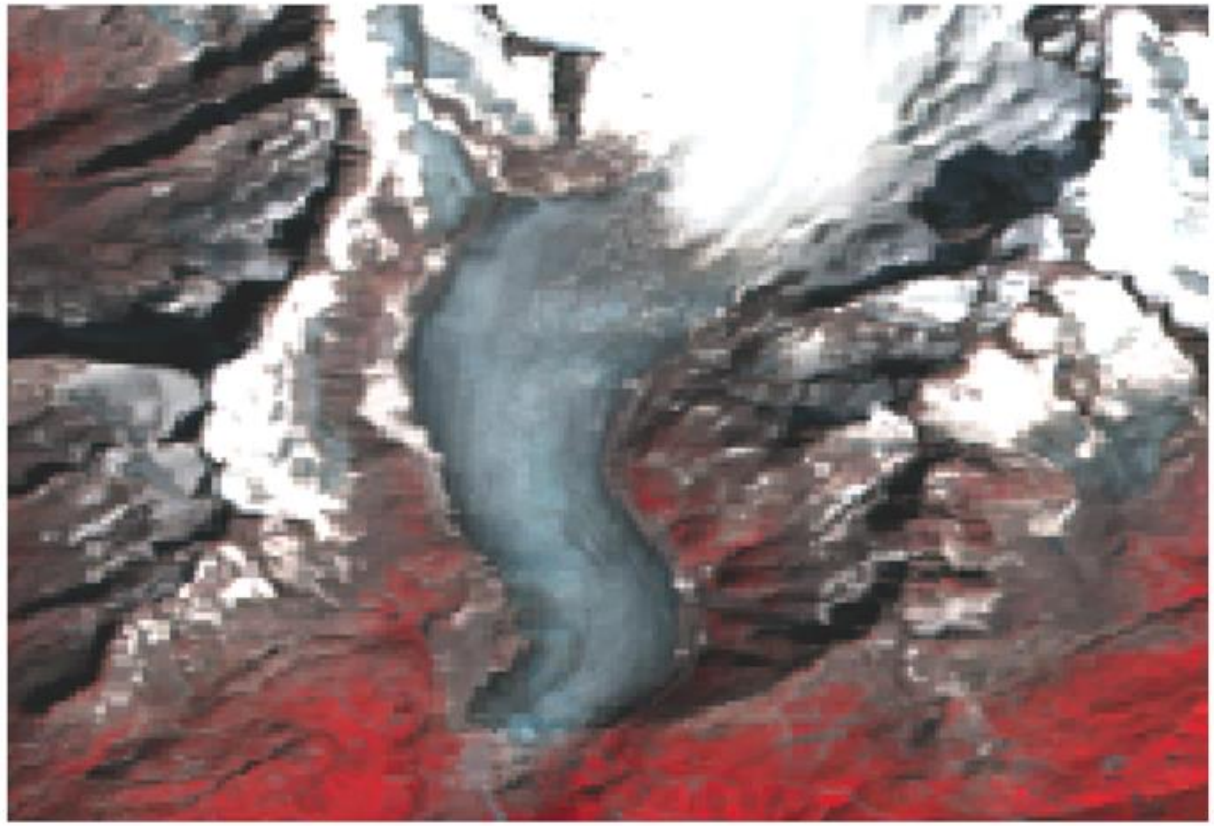
Data & Analysis services

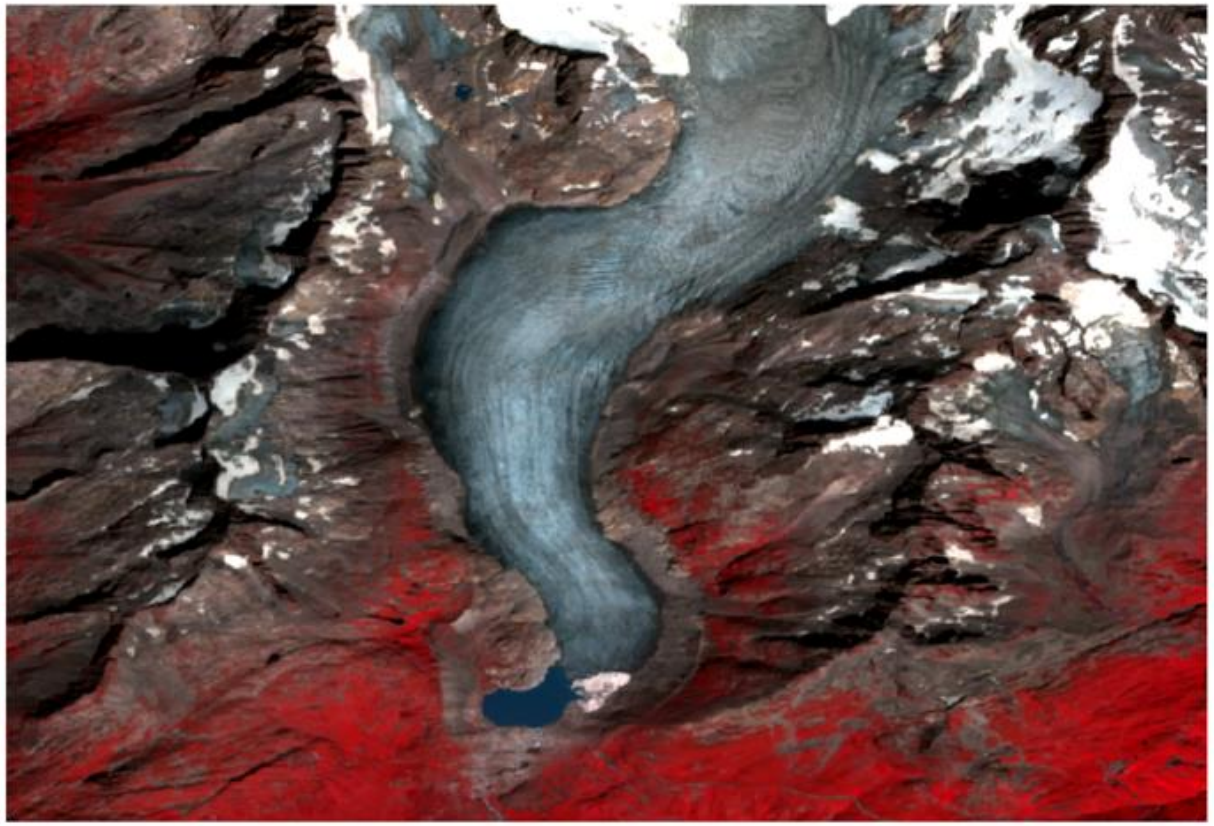
Seamless access to the SDC content

- OGC: *https://ows.swissdatacube.org/*
- STAC: *https://explorer.swissdatacube.org/stac*
- Jupyter Hub: *https://jupyterhub.swissdatacube.org/*

Value proposition

The Swiss Data Cube (SDC) will **deliver a unique capability to track changes across Switzerland** to process, interrogate, and present Earth observation satellite data in response to environmental issues of Switzerland. This near real-time information can be **readily used as an evidence** base for the design, implementation, and evaluation of national policies. It will also support innovation and growth in the digital economy; improve the management of natural resources; and improve efficiency and effectiveness of government investments.





11 SUSTAINABLE CITIES AND COMMUNITIES

Modelling Accessibility to Urban Green Areas Using Open Earth Observations Data: A Novel Approach to Support the Urban SDG in Four European Cities

by Gregory Giuliani [1,2,*], Ekkehard Petri [3], Eduard Interwies [4], Veronika Vysna [3], Yaniss Guigoz [1,2,5], Nicolas Ray [1,5] and Ian Dickie [6]

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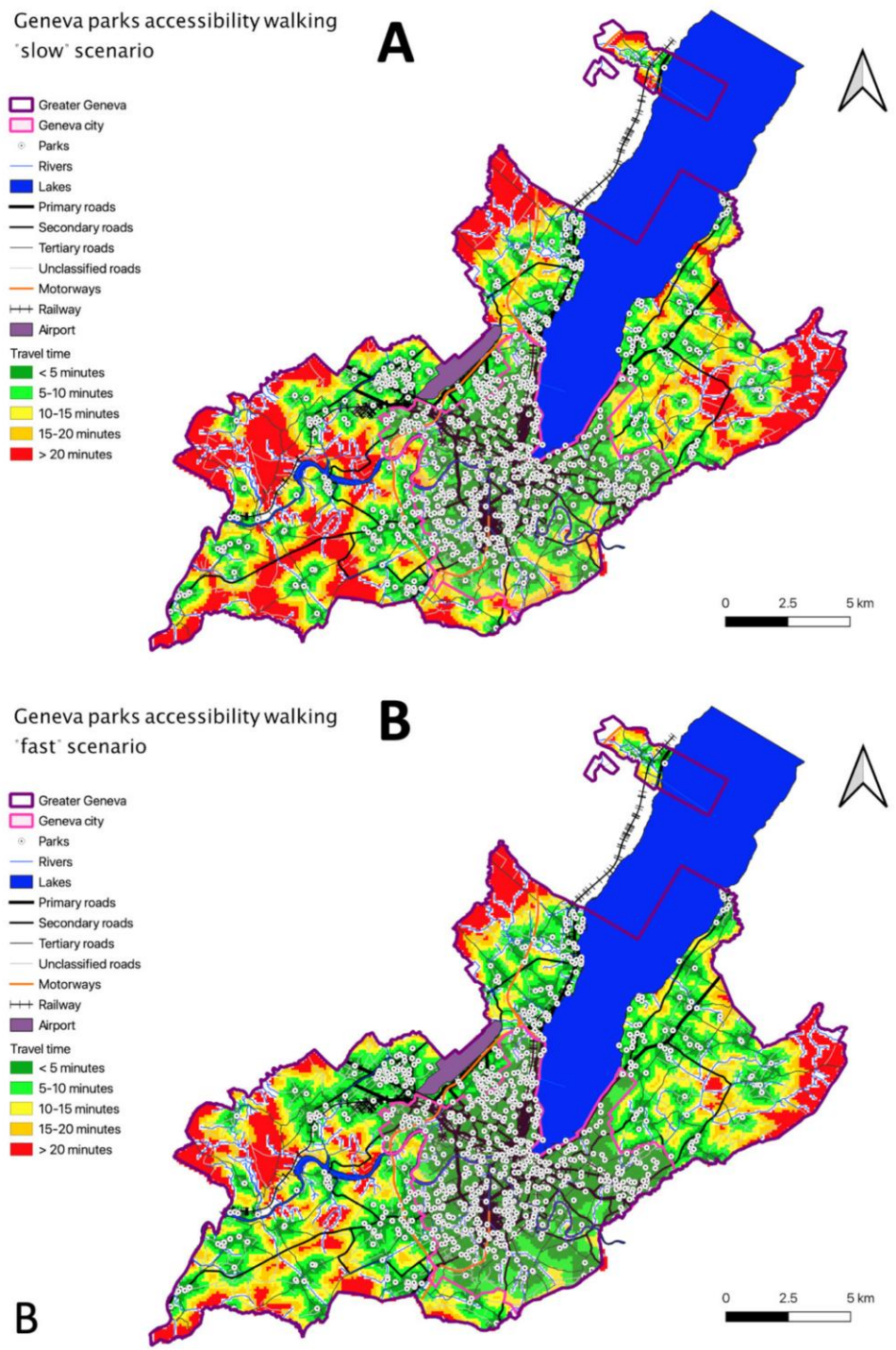

11 SUSTAINABLE CITIES AND COMMUNITIES

Open Access Article

Modelling Physical Accessibility to Public Green Spaces in Switzerland to Support the SDG11

by Camille Chênes [1], Gregory Giuliani [1,2] and Nicolas Ray [1,3,*]

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Figure 3. Travel time to reach centroids of urban green spaces, using a walking and motorized model: (**A**) nationally, (**C**) for the canton of Zurich, (**E**) for the canton of Vaud; and using a walking-only model: (**B**) nationally, (**D**) for the canton of Zurich, (**F**) for the canton of Vaud.

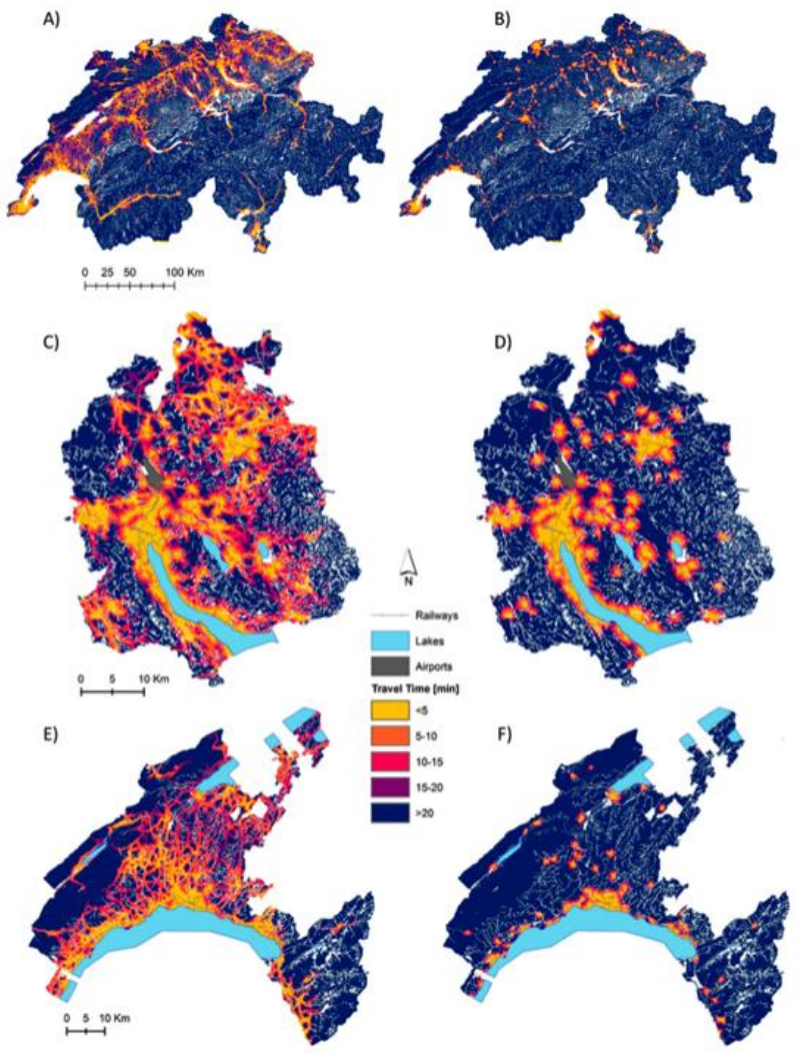
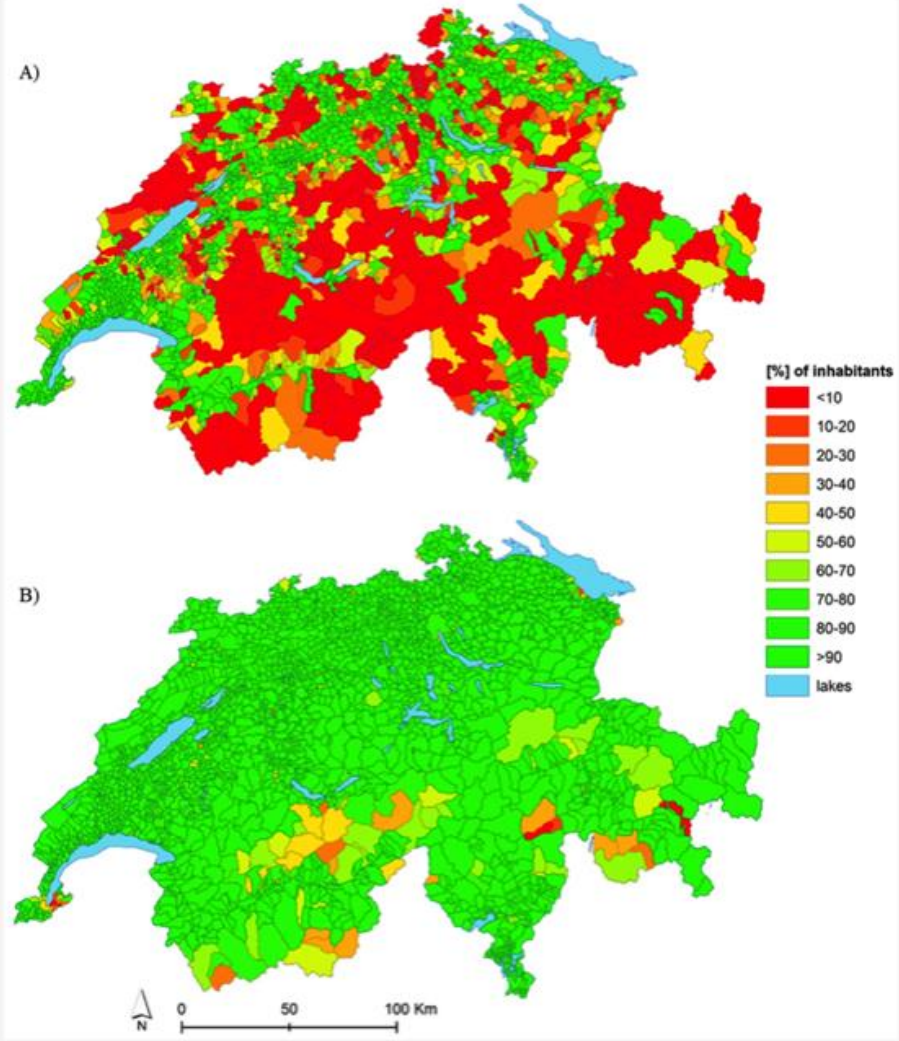
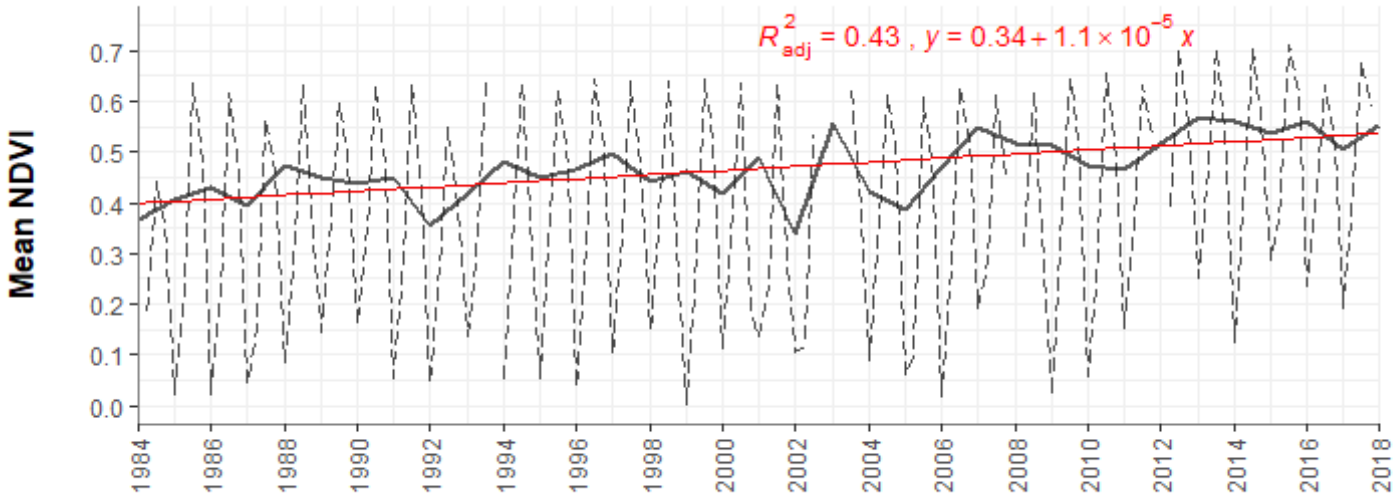
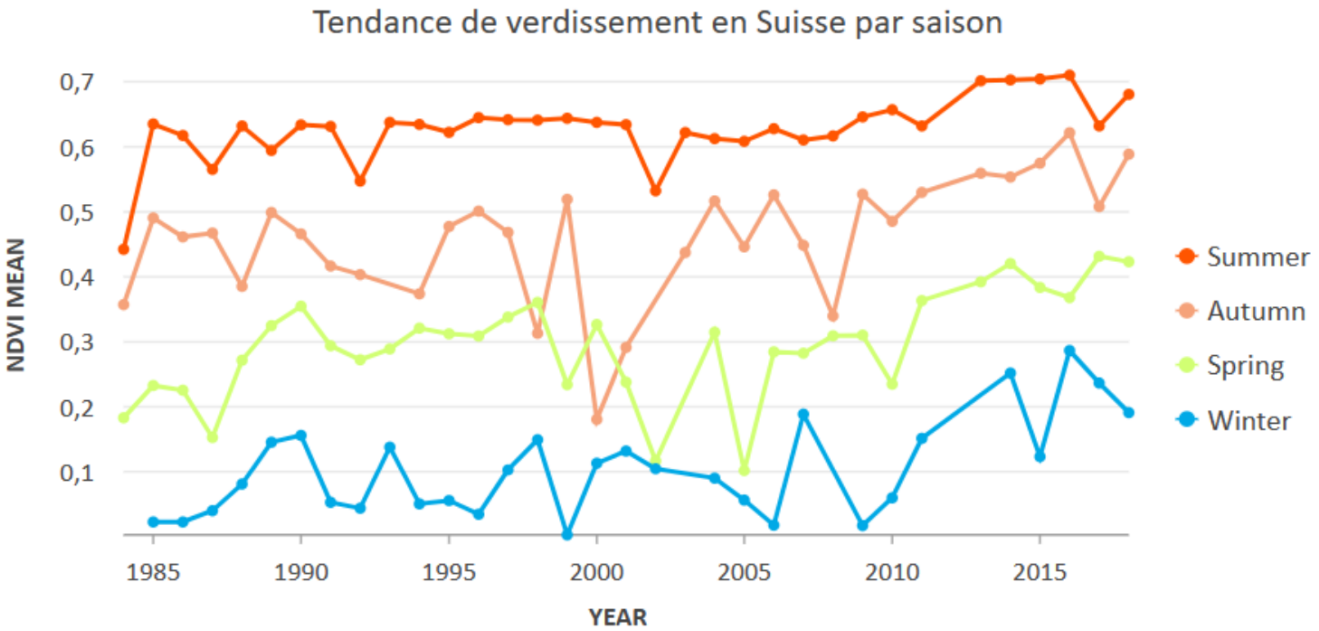


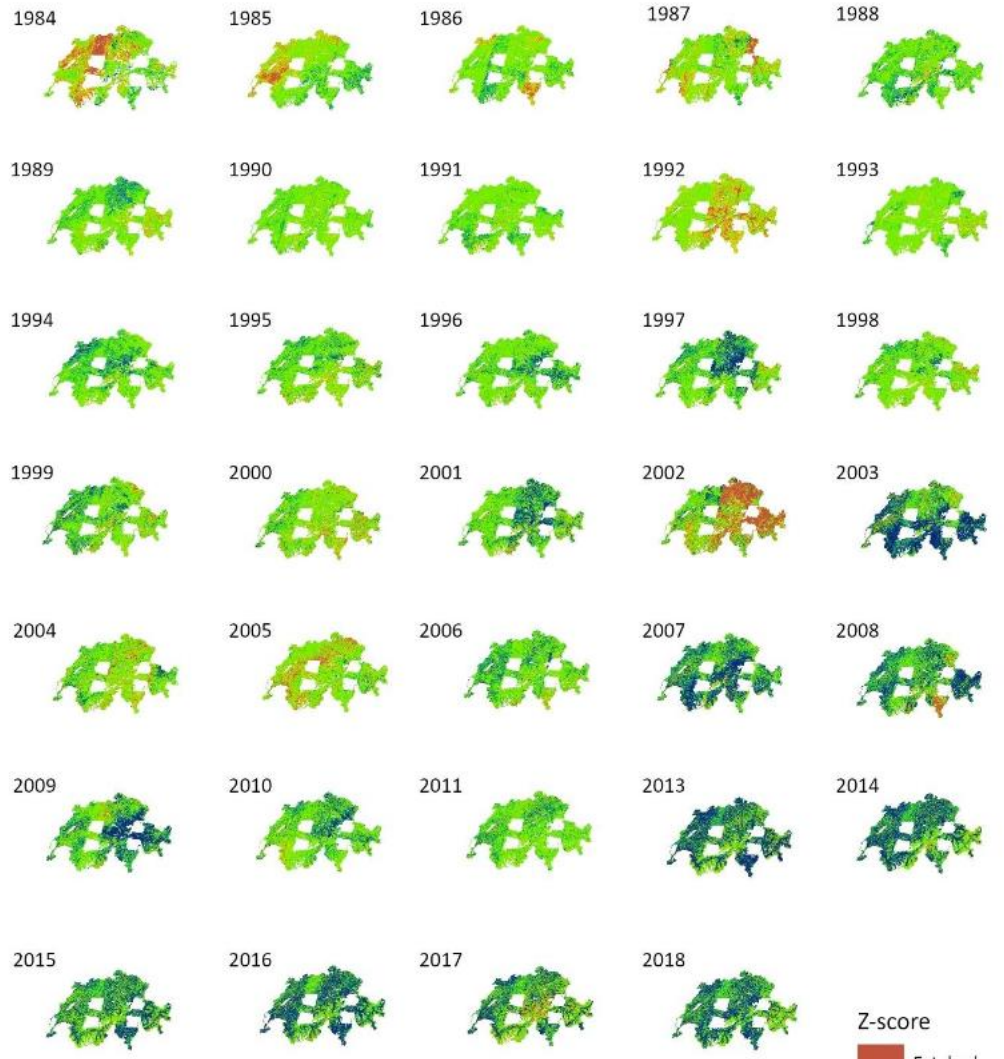
Figure 5. (**A**) percentage of the population, per municipality, that have access within 15 min (walking and motorized scenario) to (**A**) the centroid of the nearest urban green space, and to (**B**) the nearest forest patch.

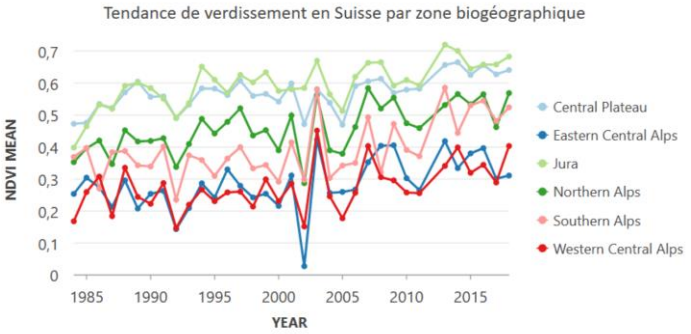


Vegetation greening in Switzerland









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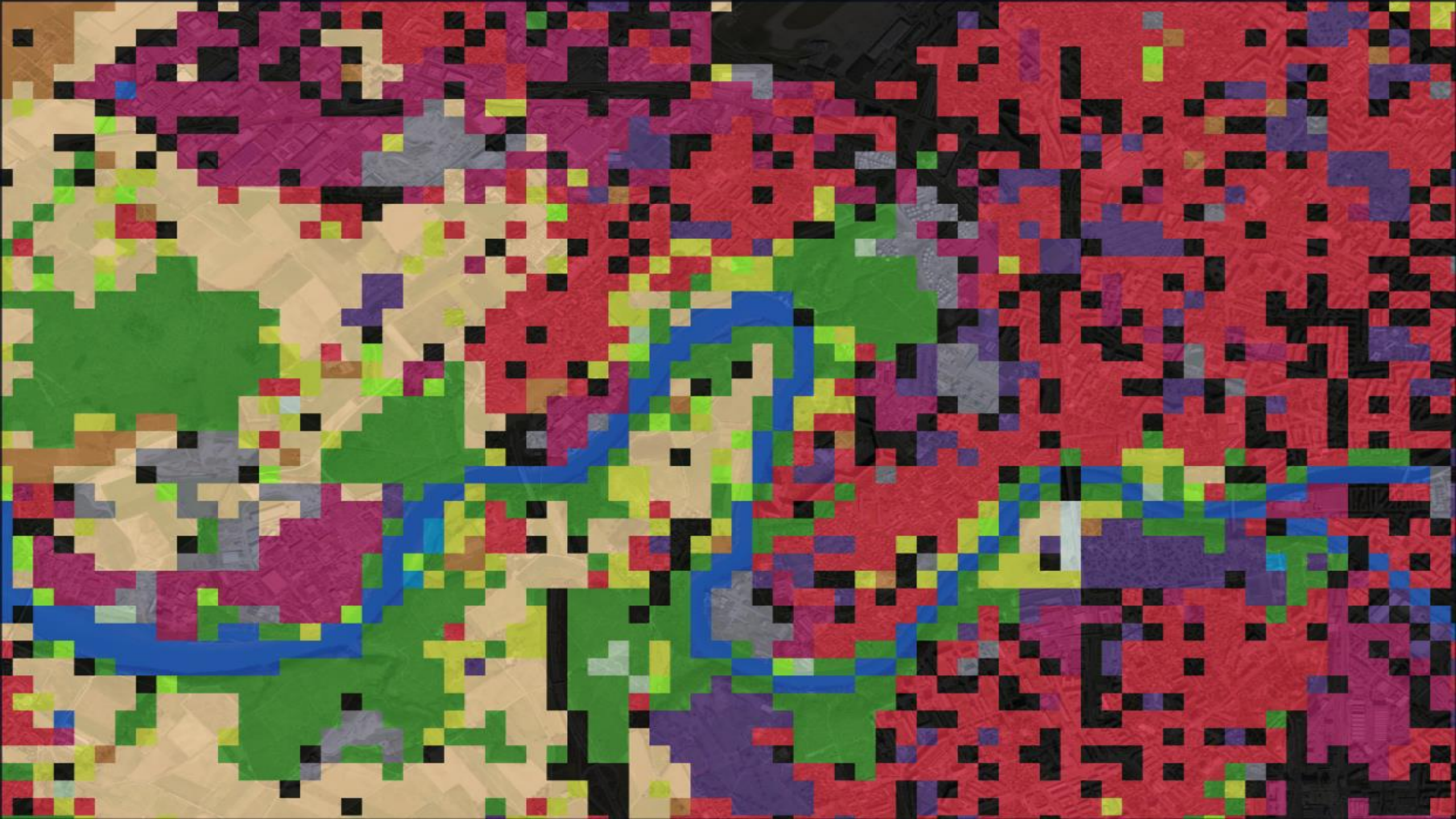


XX SBSR
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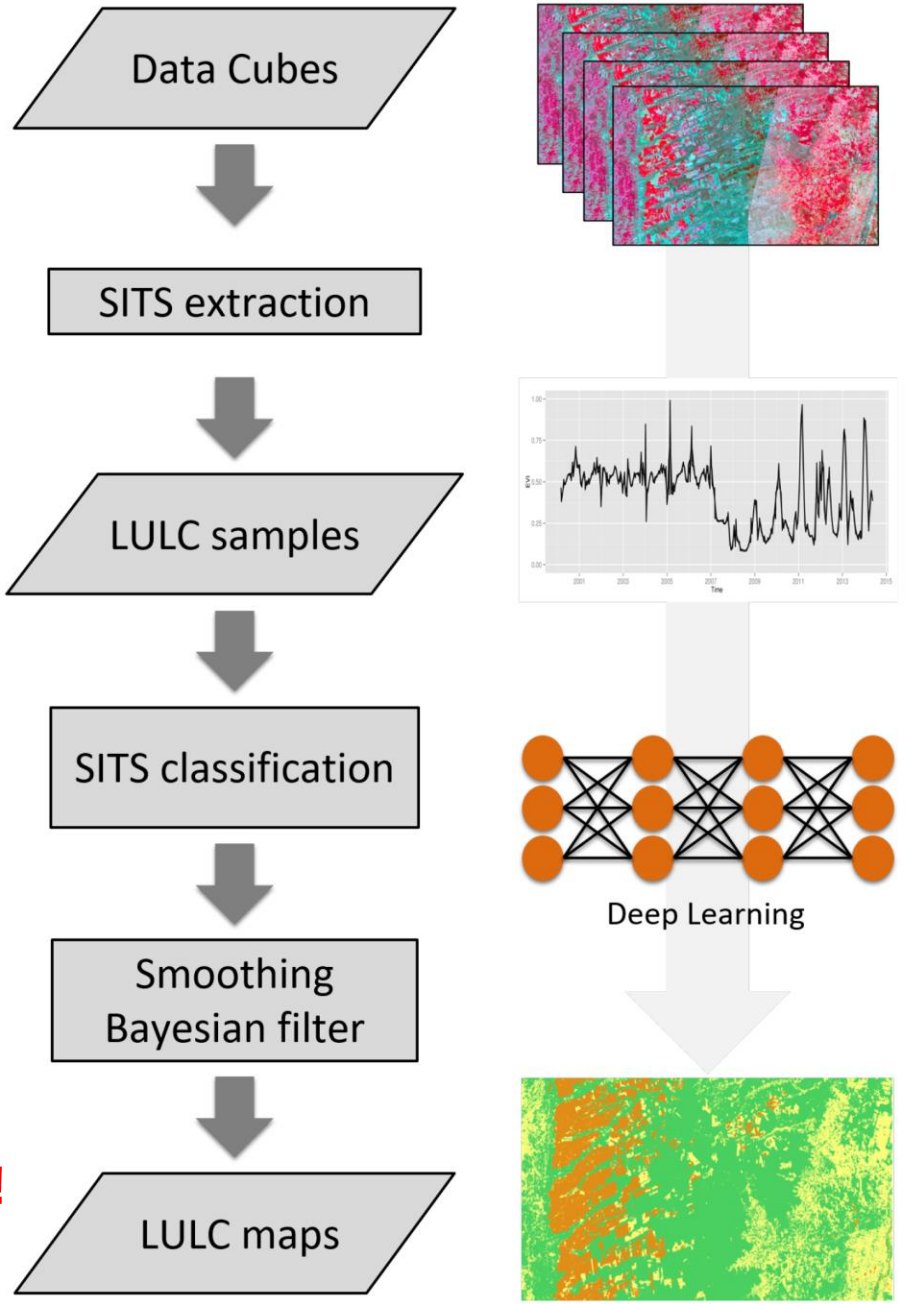
SulSoft
VISIONA

LC4SDG project

…developing new methods for Land Cover mapping using the ArealStatistik & Satellite imagery

- To improve spatial and temporal resolution of land cover data of Switzerland, while keeping the thematic richness of the "*Arealstatistik*".
- The *"ArealStatistik"* is a unique data set providing 4 million points ground-reference for each period of time (4 in total). **Part of this data set can be used for both the training, testing and validation stages of classification**.
- The availability of more than 39 years of satellite **EO Analysis Ready Data over Switzerland, made available by the Swiss Data Cube** (https://www.swissdatacube.ch), together with HPC and AI algorithms, allow envisioning developing an innovative approach to produce a yearly 10/30m consistent time-series of LC and its changes, informing on class stability and transitions.

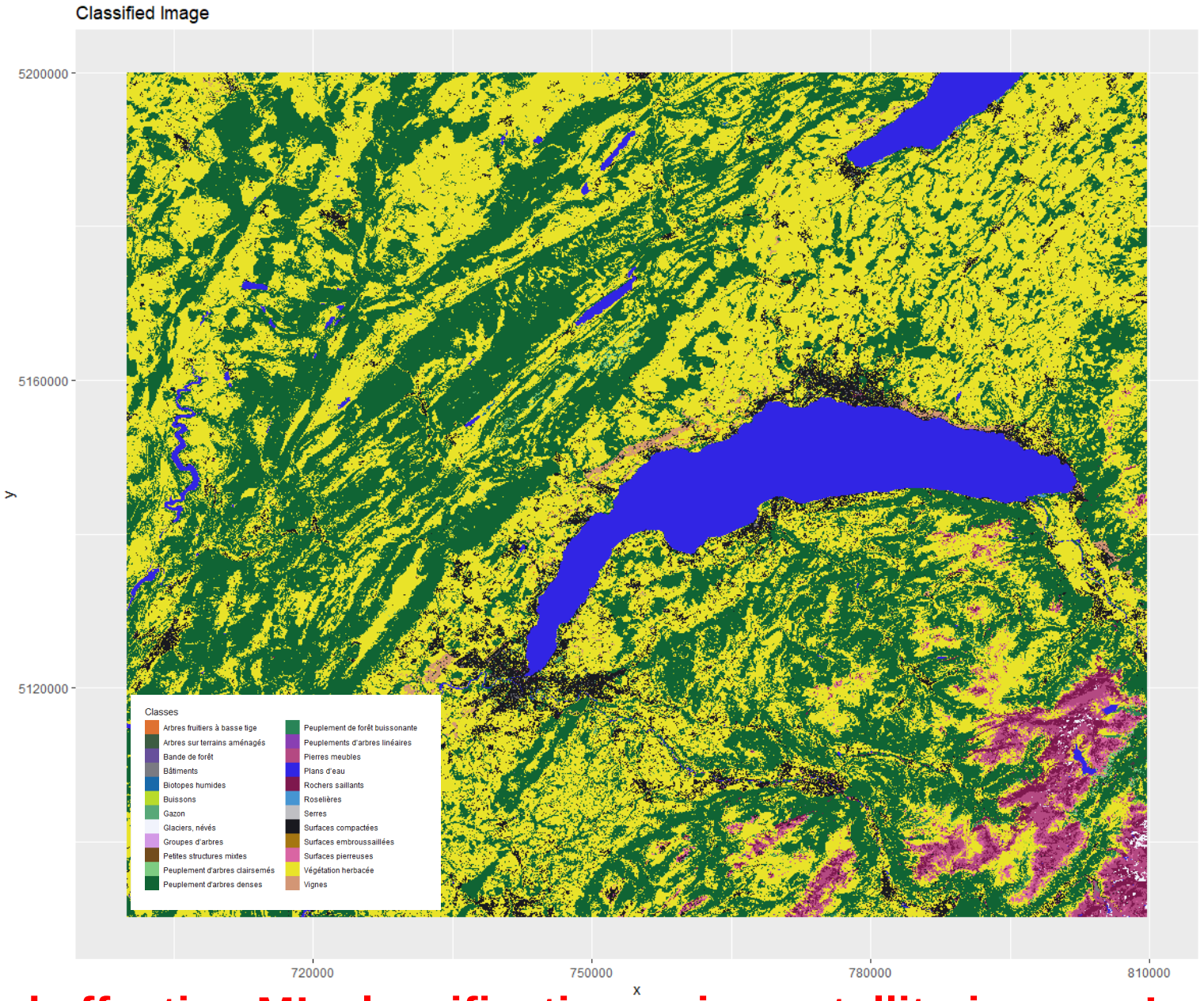
Using the SITS package developed the Brazil Data Cube team!



LC4SDG project

…initial results

- The workflow has been tested over the Lake Léman region to classify one year (2018) of Sentinel-2 images (113 images).
- A Random Forest model has been developed with 6 and 27 classes based on 410'000 samples from the *Arealstatistik* (287'000 for training (70%); 123'000 for validation (30%)).
- The overall accuracy is: 0.88
- Hyperparameters tunning + Lightweight Temporal Attention Encoder (LightTAE) & Temporal CNN (tempCNN) allowed to reach 94% accuracy!



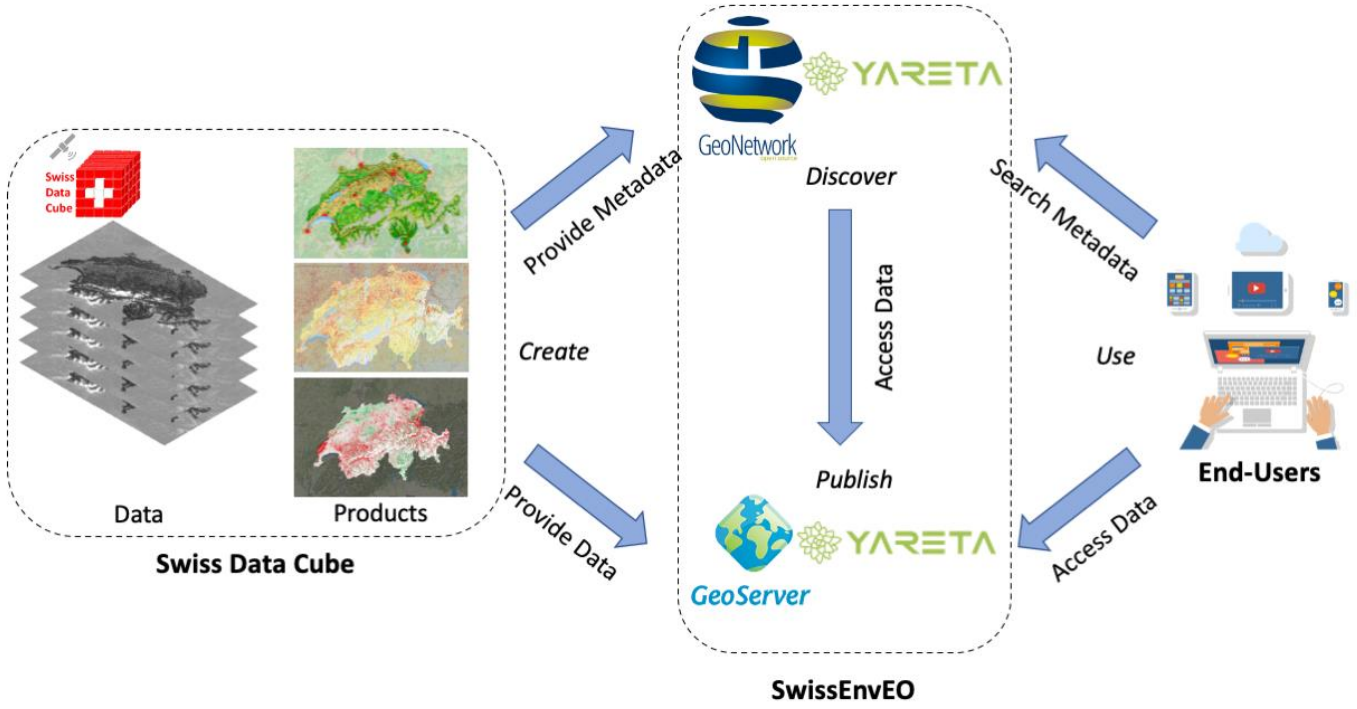
Arealstatistik is key for efficient and effective ML classification using satellite imagery!

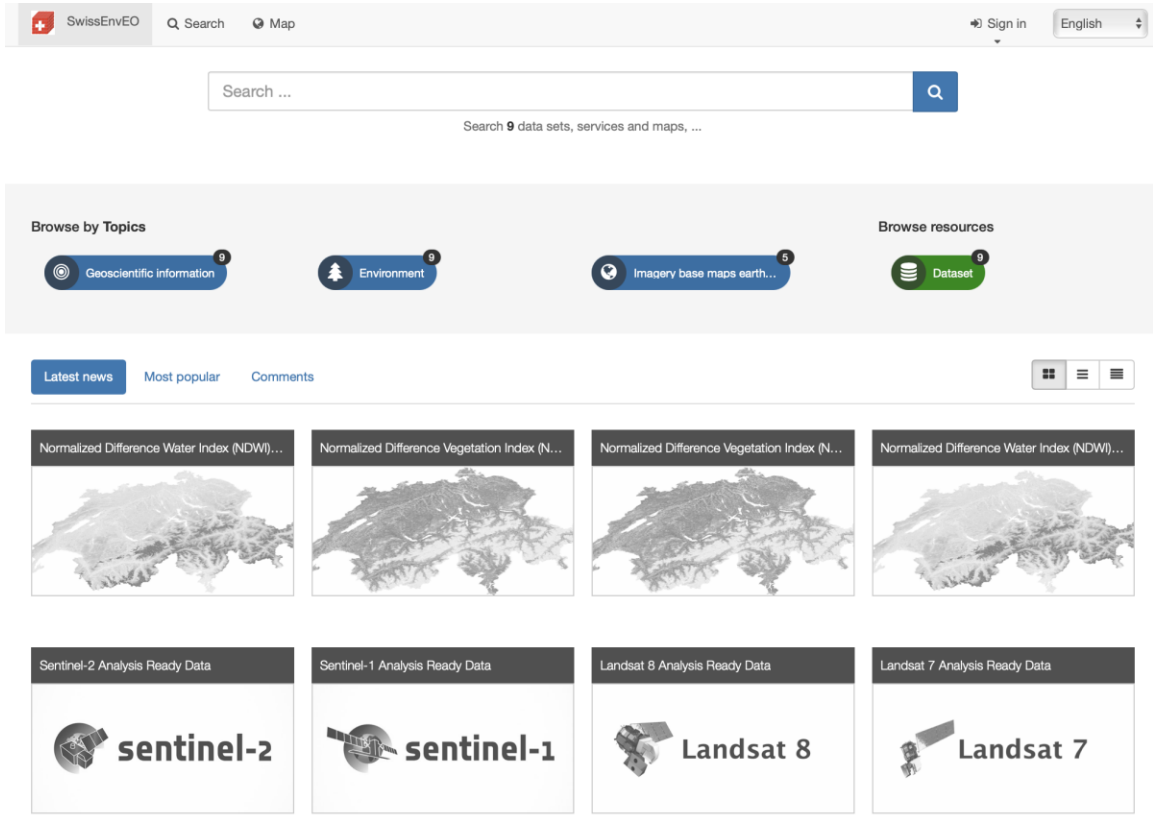
- GIVE PEOPLE THE TOOLS TO MAKE CLEAN DATA
- CLEAN DATA IS MORE REUSABLE AND INTEGRATABLE
- DATA FROM VARIOUS PIPELINES TO BE USED ACROSS DIFFERENT SYSTEMS

Scriberia

SwissEnvEO: a FAIR national EO environmental database

http://geonetwork.swissdatacube.org





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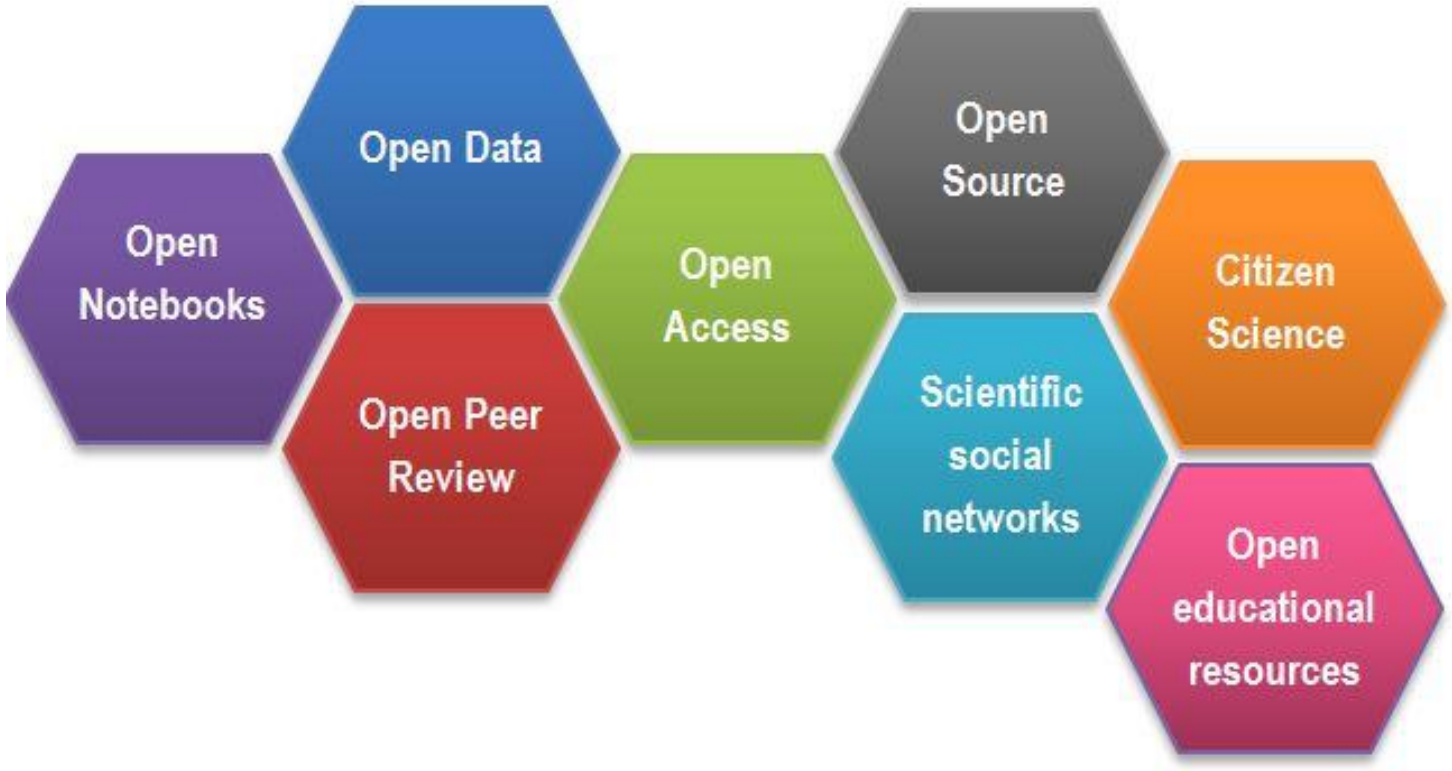
SDC Open & Reproducible EO Science

- **Open Data:** Landsat 5,7, 8 ARD; Sentinel 1-2 ARD + All scientific/decision-ready products are freely, openly available & FAIR compliant
- **Open Notebooks:** All algorithms are documented and openly available
- **Open Access:** All publications
- **Open Source:** All applications
- **Open Educational Resources:** Bringing ODC into practice



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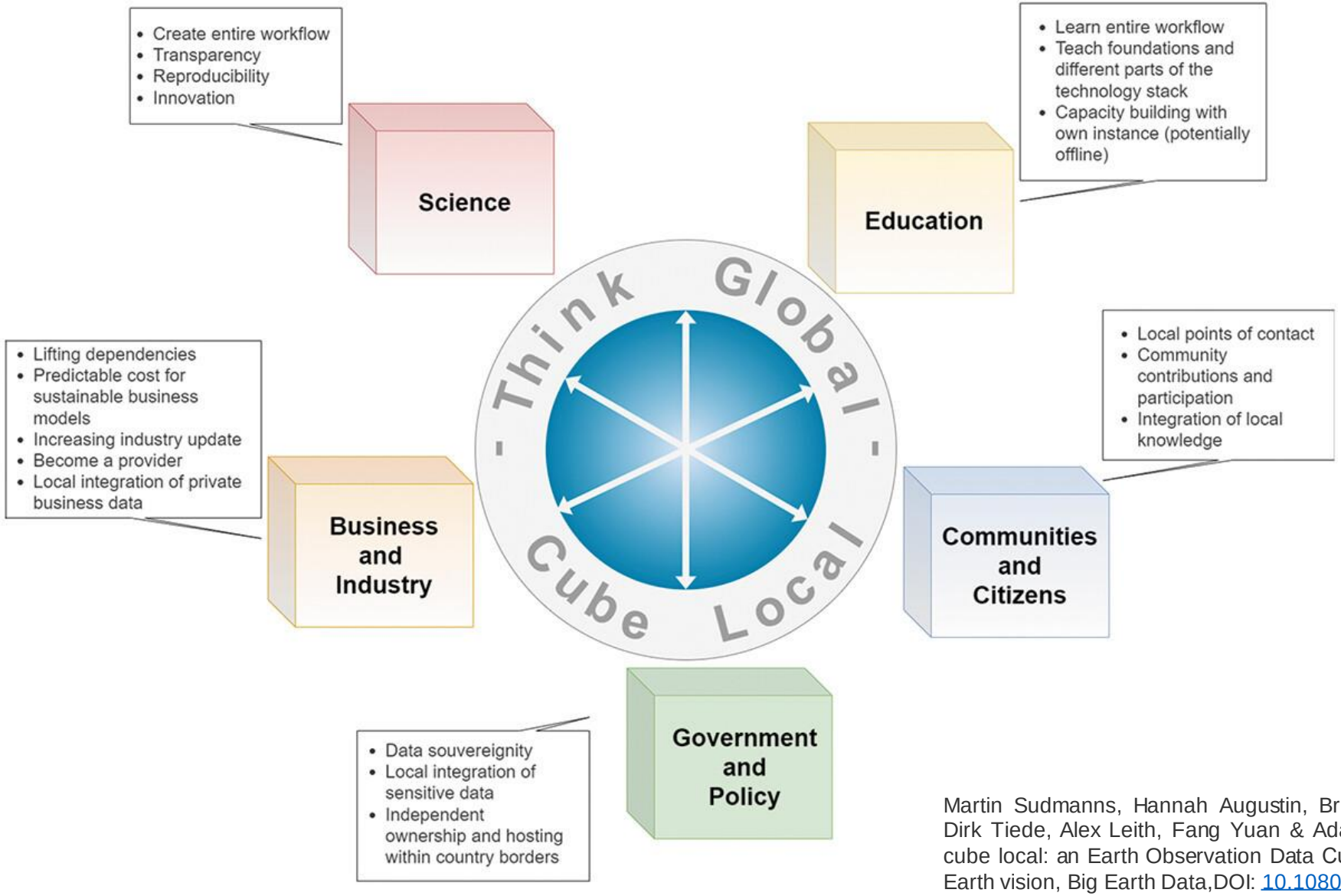
Global Impact…

…but essential to consider the local context!



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EO Data Cubes have the potential…

… to enhance scientific accountability and credibility

Without trust and shared knowledge:

- Doing science can be difficult
- Taking sound decisions can be problematic
- And envisioning a sustainable development can be complicated

CONTACT DETAILS

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