Earth Engine or How we stopped worrying and start learning to love remote sensing

16 mei 2024

nmi soil for life

Google Earth Engine

LOCALYSE.
PUT YOUR LOCATION DATA TO WORK

Earth Eng w we stopped w nd start learning t note sensing

Sven Verweij
Project Manager / Soil Data Scientist
bij NMI Agro

16 mei 2024

Who are NMI?

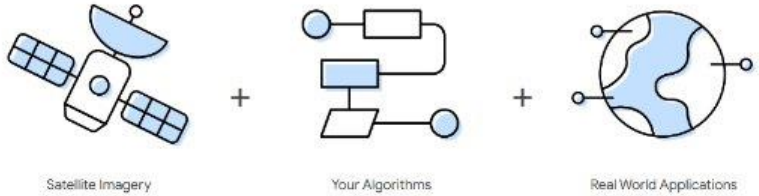
Applying agronomic research since 1934

- Located in Wageningen (NL)
- Independent group of researchers
- Well known experts in the field of soils and agriculture
- Providing knowledge as a service for farmers, advisors, policy makers, product managers and business analysts

NMI & GEE

Meet Earth Engine

Google Earth Engine combines a multi-petabyte catalog of satellite imagery and geospatial datasets with planetary-scale analysis capabilities. Scientists, researchers, and developers use Earth Engine to detect changes, map trends, and quantify differences on the Earth's surface. Earth Engine is now available for commercial use, and remains free for academic and research use.

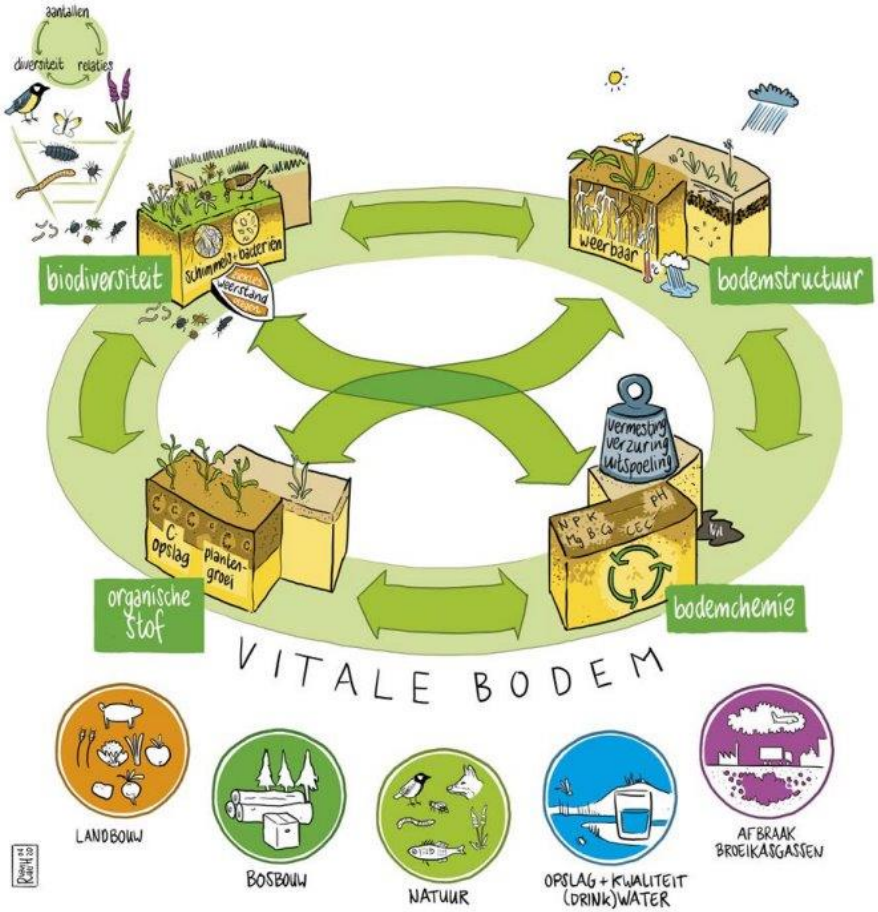


Learn More

Sustainable Agriculture with healthy soils

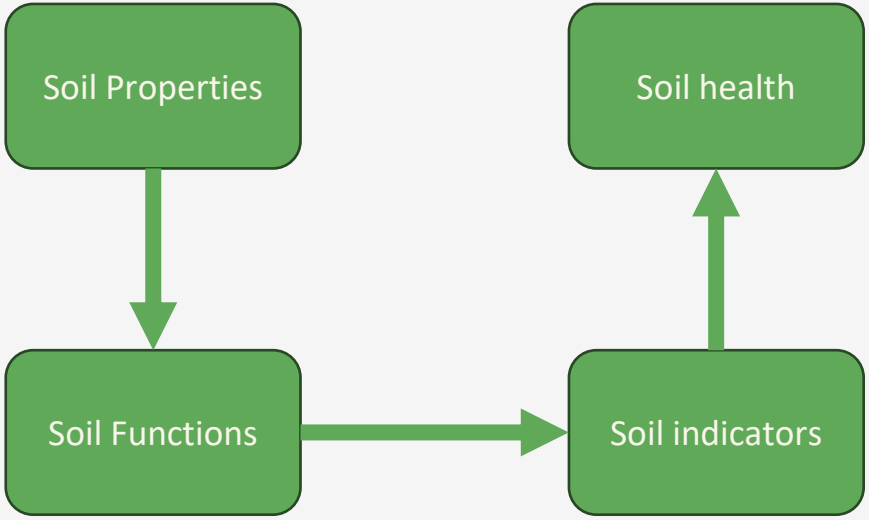
What is a healthy soil?

A healthy soil can provide various ecosystem services for which it is used and is resilient to external forces.



Soil for Life

How to assess soil health



OPEN BODEMINDEX

Environmental Science & Technology

pubs.acs.org/est

Article

An Open Soil Health Assessment Framework Facilitating Sustainable Soil Management

Gerard H. Ros,* Sven E. Verweij, Sander J. C. Janssen, Janjo De Haan, and Yuki Fujita

Cite This: Environ. Sci. Technol. 2022, 56, 17375−17384 | Read Online

ACCESS | Metrics & More | Article Recommendations | Supporting Information

ABSTRACT: The crucial role of healthy soil in achieving sustainable food production and environment is increasingly recognized, as is the importance of proper assessment of soil quality. We introduce a new framework, open soil index (OSI), which integrally evaluates soil health of agricultural fields and provides recommendation for farming practices. The OSI is an open-source modular framework in which soil properties, functions, indicators and scores, and management advice are linked hierarchically. Soil health is evaluated with respect to sustainable crop production but can be extended to other ecosystem functions. The OSI leverages the existing knowledge base of agronomic research and routine laboratory data, enabling its application with limited cost. The OSI is a generic framework that can be adopted for specific regions with specific objectives. As a proof of concept, the OSI is implemented for all (>700,000) Dutch agricultural fields and illustrated with 11 pairs ("good" and "poor") of local fields and 32 fields where soil quality and crop yield have been monitored. The OSI produced reasonable evaluation for most pairs when soil physical functions were refined with on-site soil visual assessment. The soil functions are sufficiently independent and yet together reflect complex multidimensionality of soil quality. The framework can facilitate designing sustainable soil management programs by bridging regional targets to field-level actions.

KEYWORDS: holistic soil health assessment, agricultural fields, sustainable crop production, valorization, open-source framework, farming practices

Soil properties

How to obtain the input data for soil health assessment?

nmi soil for life

Challenges with soil data

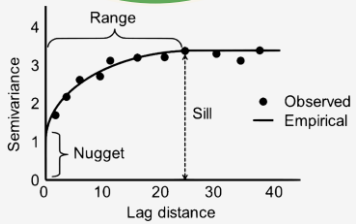
Sampling + Analysis is expensive

+

Soils are heterogeneous in space (and sometimes in time too)

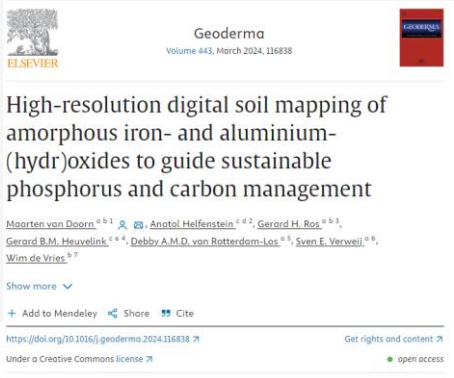
=

Lack of detailed soil data



Leveraging remote sensing

- BodemSchat6
- Mapping 24 soil parameters for every agricultural field in NL
- Collected over 150 covariates per field
- Training based on NABA
- Next version:



Geoderma
Volume 443, March 2024, 116838

High-resolution digital soil mapping of amorphous iron- and aluminium-(hydr)oxides to guide sustainable phosphorus and carbon management

Maarten van Doorn [a b 1], Anatol Helfenstein [c d 2], Gerard H. Ros [a b 3], Gerard B.M. Heuvelink [c e 4], Debby A.M.D. van Rotterdam-Los [a 5], Sven E. Verweij [a 6], Wim de Vries [b 7]

Show more

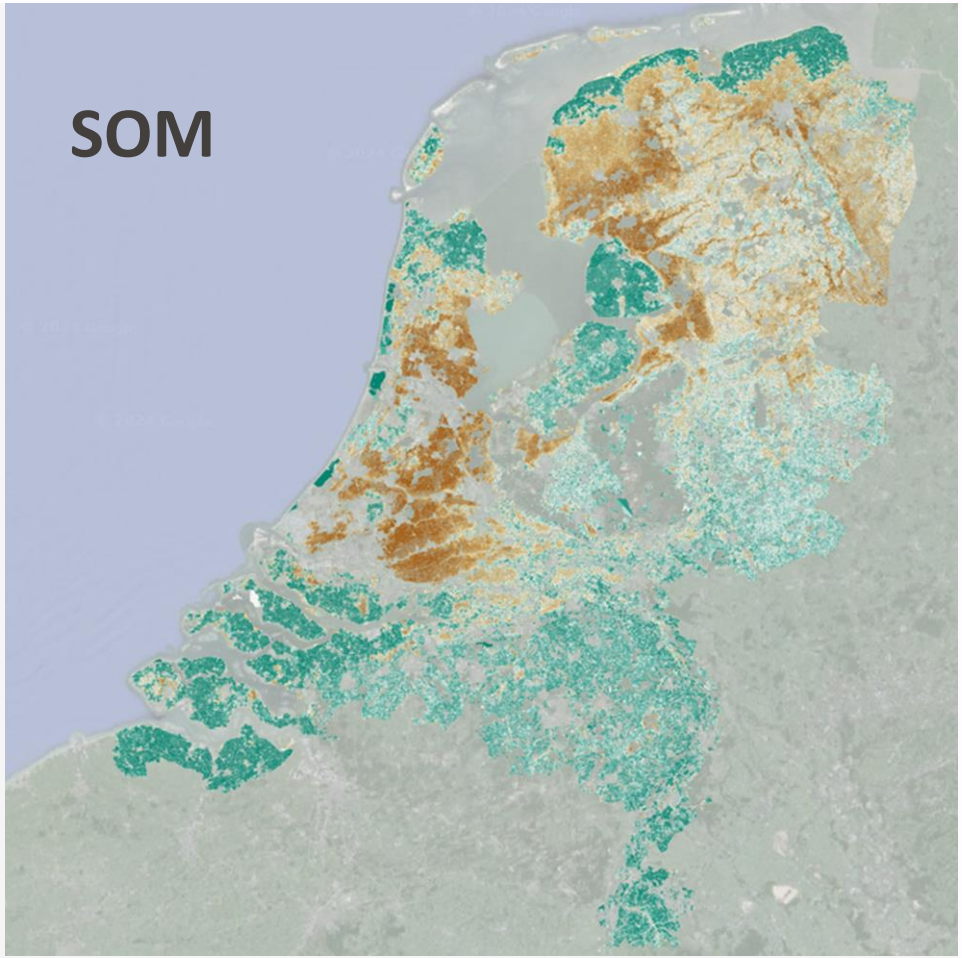
Add to Mendeley Share Cite

https://doi.org/10.1016/j.geoderma.2024.116838

Get rights and content

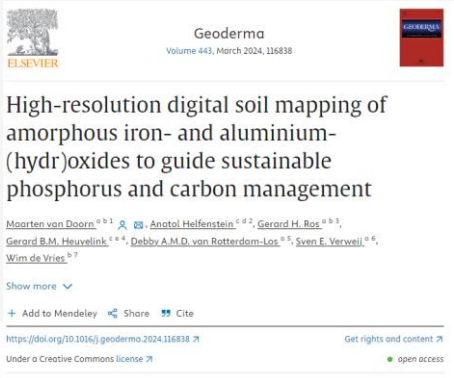
Under a Creative Commons license

open access



Leveraging remote sensing

- BodemSchat6
- Mapping 24 soil parameters for every agricultural field in NL
- Collected over 150 covariates per field
- Training based on NABA
- Next version:



Geoderma
Volume 443, March 2024, 116838

High-resolution digital soil mapping of amorphous iron- and aluminium-(hydr)oxides to guide sustainable phosphorus and carbon management

Maarten van Doorn [a b 1], Anatol Helfenstein [c d 2], Gerard H. Ros [a b 3], Gerard B.M. Heuvelink [c e 4], Debby A.M.D. van Rotterdam-Los [a 5], Sven E. Verweij [a 6], Wim de Vries [b 7]

Show more

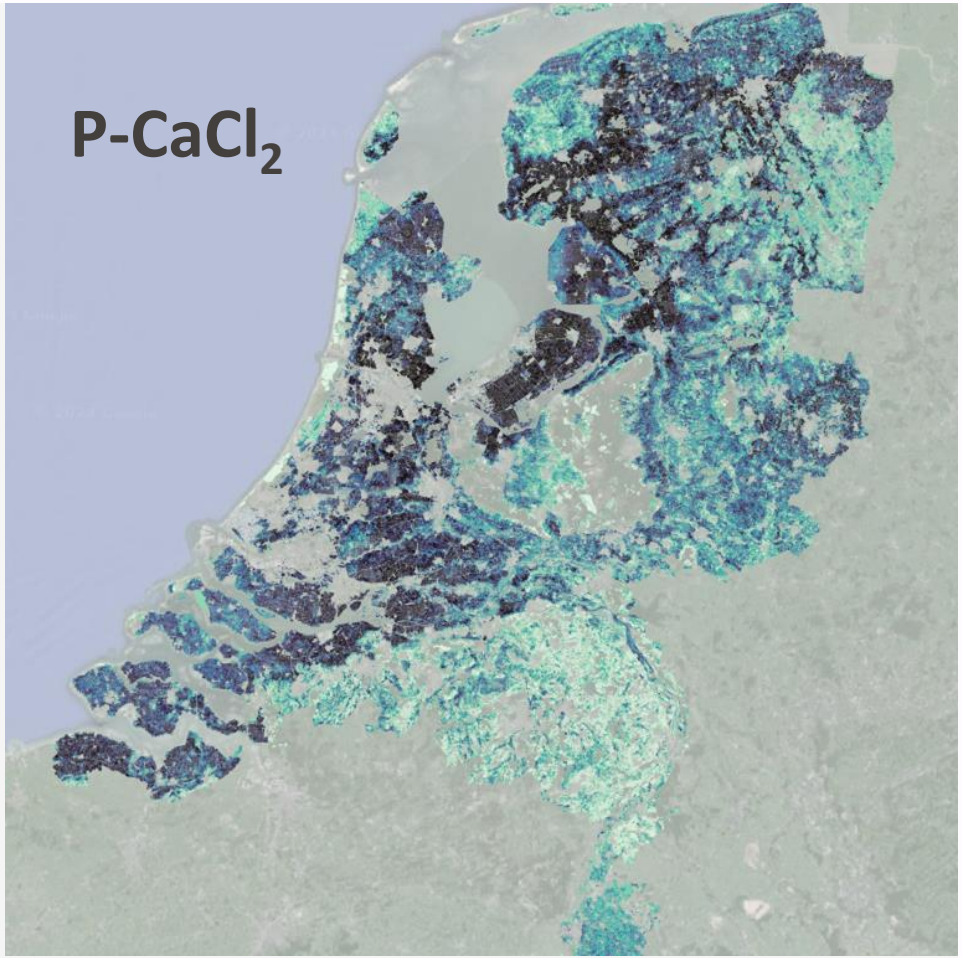
Add to Mendeley Share Cite

https://doi.org/10.1016/j.geoderma.2024.116838

Get rights and content

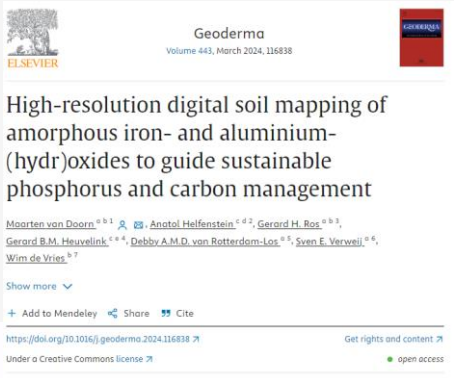
Under a Creative Commons license

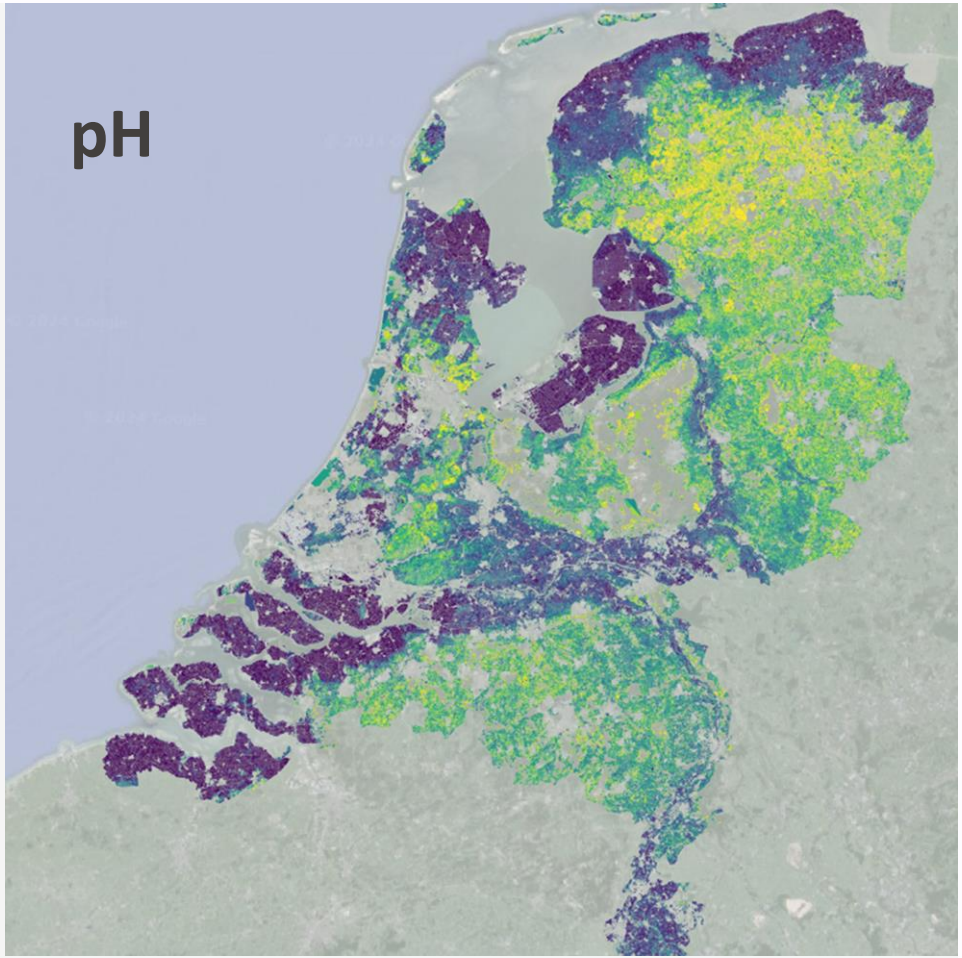
open access



Leveraging remote sensing

- BodemSchat6
- Mapping 24 soil parameters for every agricultural field in NL
- Collected over 150 covariates per field
- Training based on NABA
- Next version:

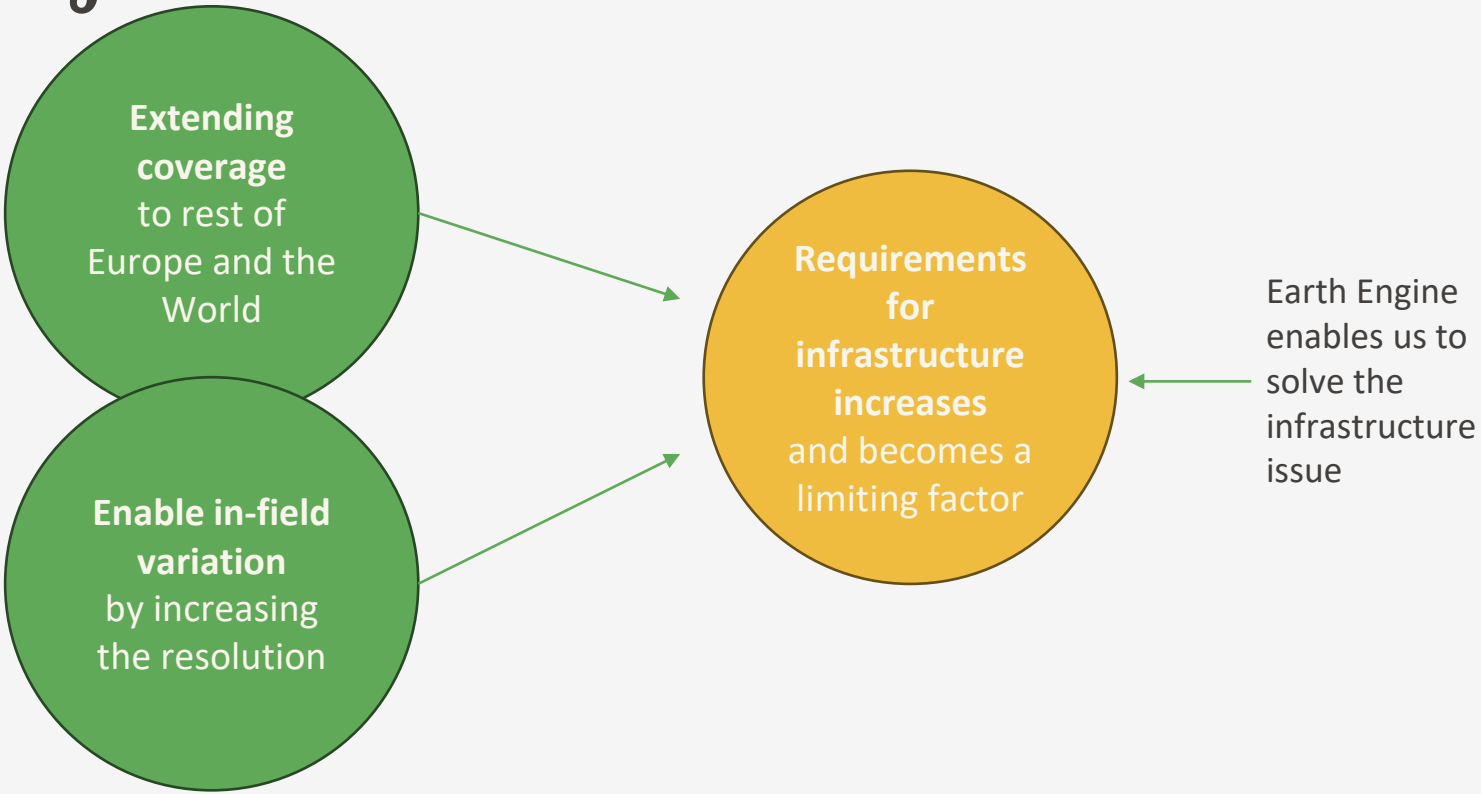




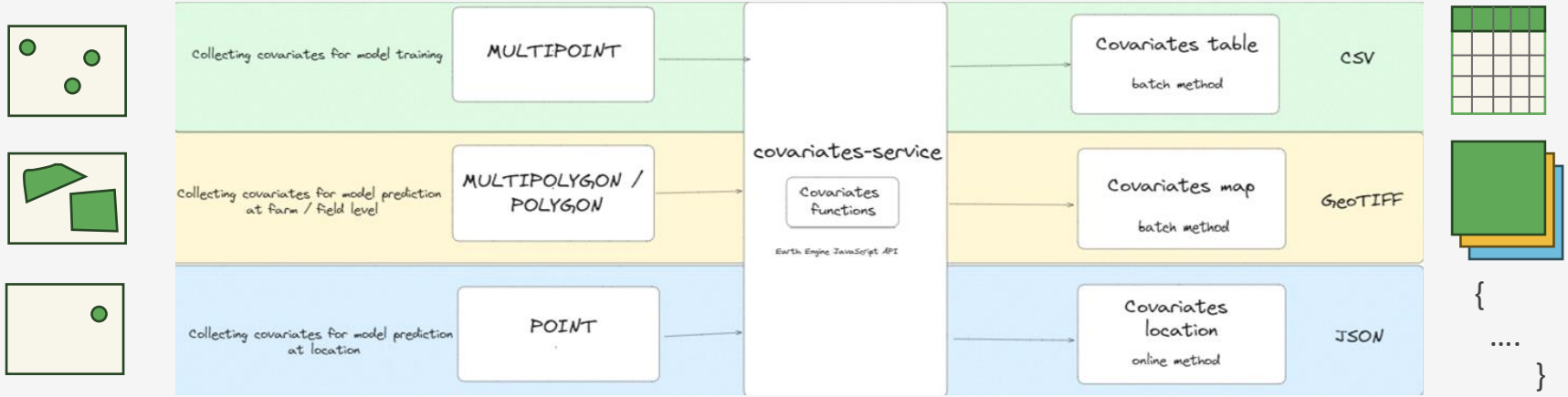
Challenges with upscaling

nmi soil for life

Challenges


Extending coverage to rest of Europe and the World
Enable in-field variation by increasing the resolution
Requirements for infrastructure increases and becomes a limiting factor
Earth Engine enables us to solve the infrastructure issue

How we use Google Earth Engine



Example: Carbon

How do we accurately and cost-effective monitor carbon stock at farm level?

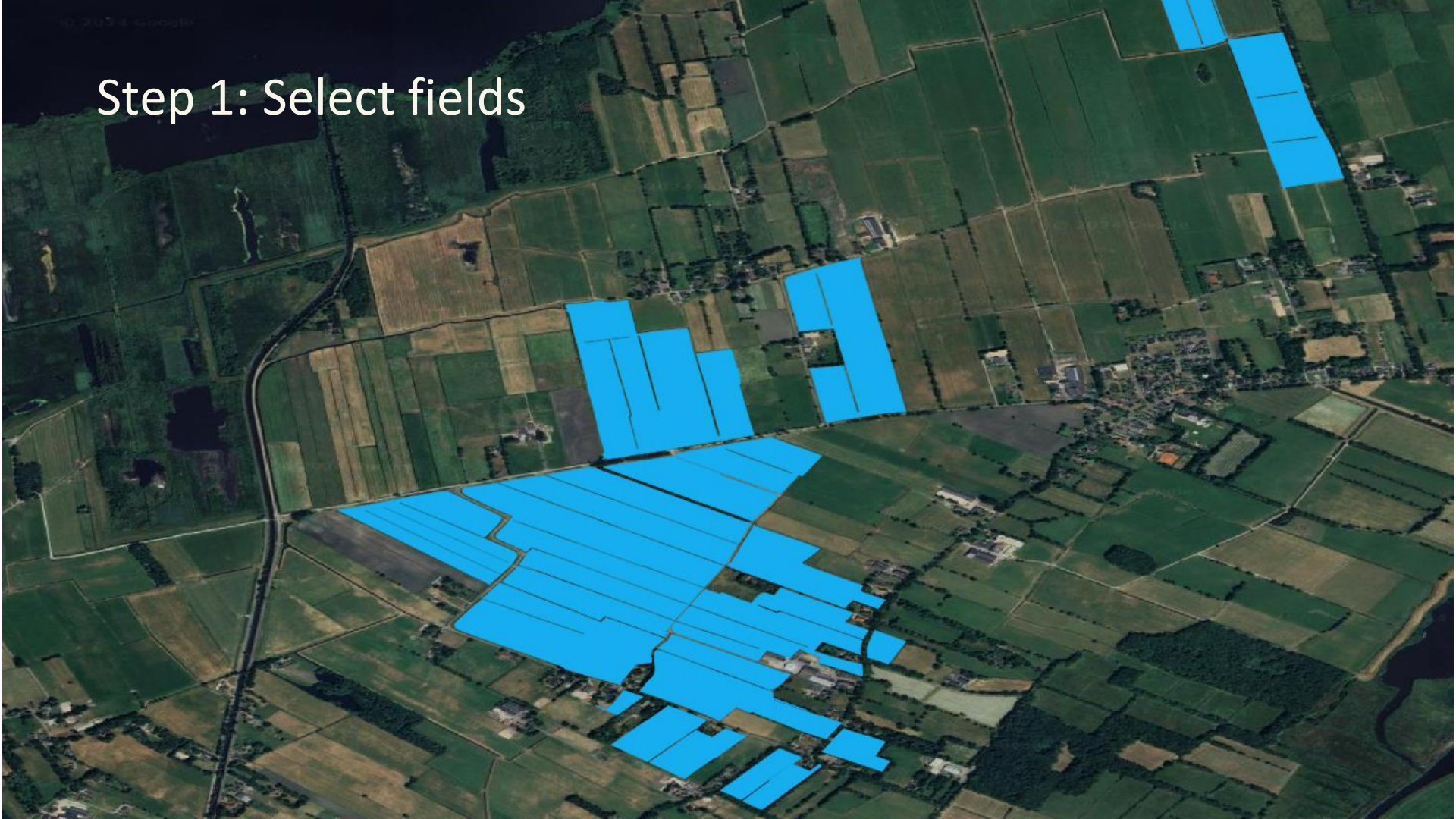
nmi soil for life

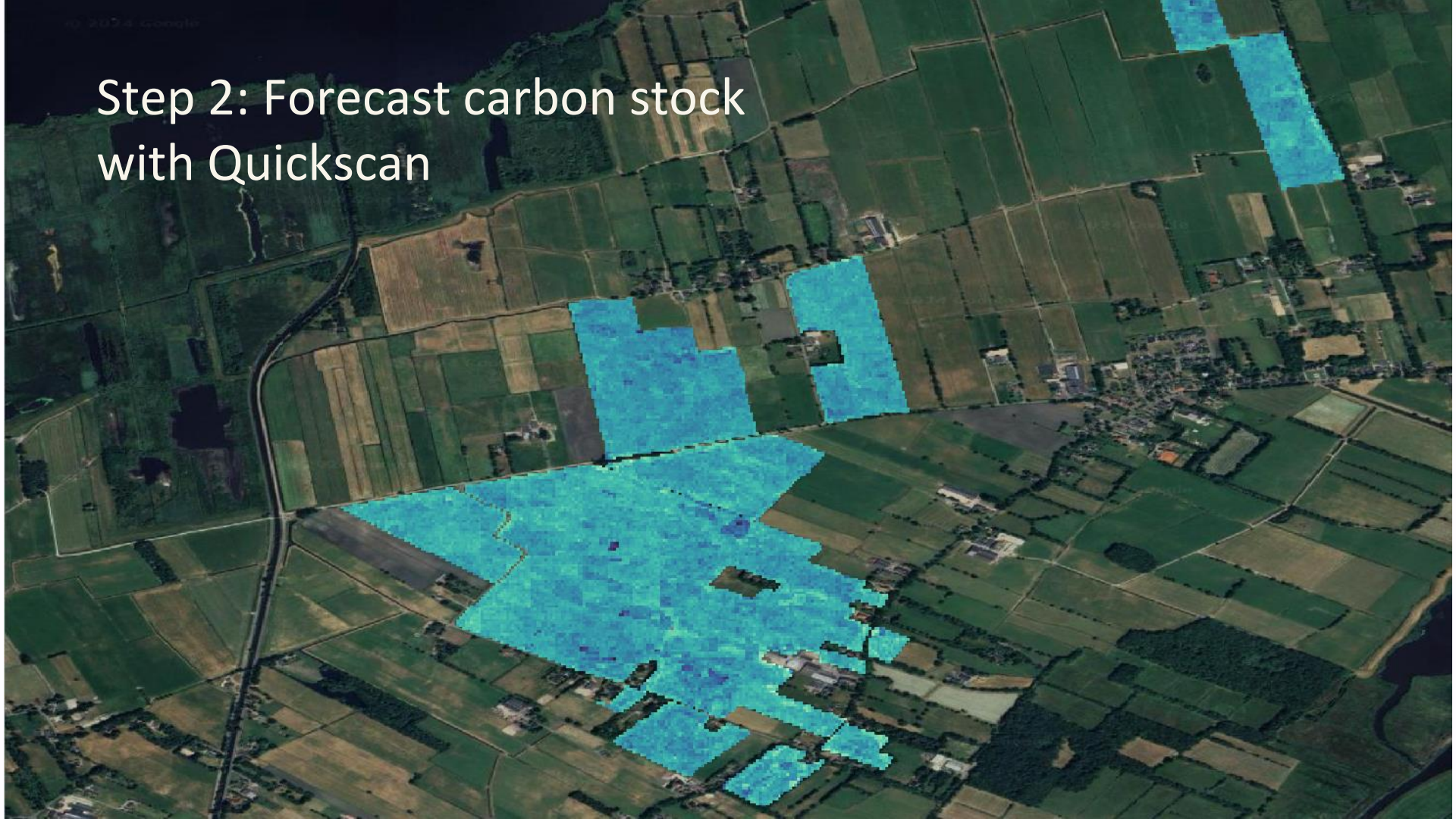
Why do we want to know carbon content of soil?

- Carbon is related to various soil processes:
  - Soil fertility
  - Water retention
  - Workability
  - Disease preventions

- Soils are major sinks of carbon
  - Relevant for Corporate Sustainability Reporting Directive (CSDR) and for Science Based Targets initiative (SBTI)
  - Insetting & Offsetting

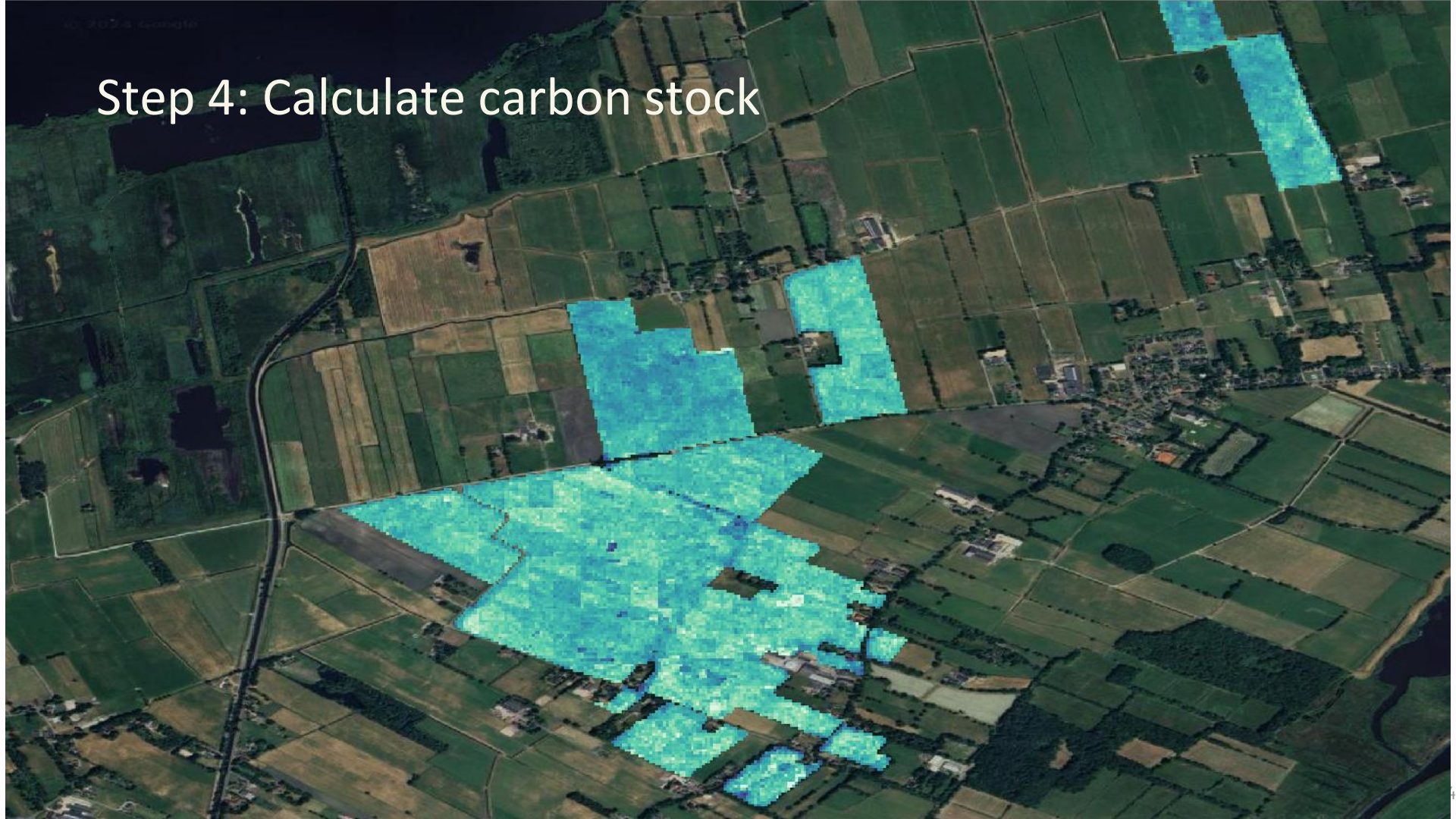
Step 1: Select fields




Step 2: Forecast carbon stock
with Quickscan

Step 3: Create sampling design

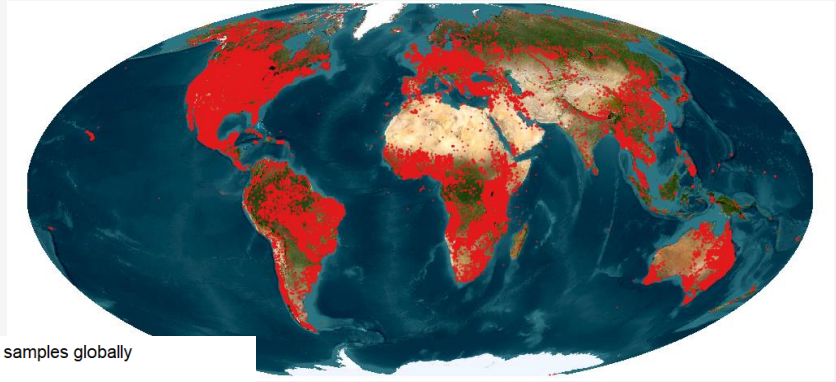
Step 4: Calculate carbon stock

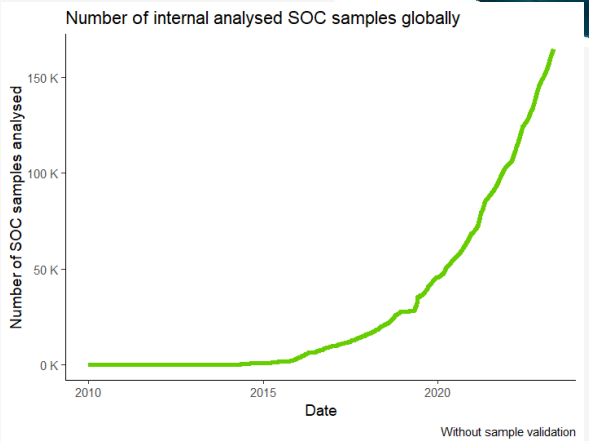


Step 1: Initial carbon stock assessment

Predict SOC stocks with global model

- Model based >250,000 sites from open datasets and 123,668 in-house validated analyses
- Covariates o.a. Sentinel I, II MERIT and WorldCover (no SoilGrids)
- Global predictions at 10m resolution
- Model for SOC and bulk density
- Trained with XGBoost using Bayesian optimization for hyperparameter tuning
- Resolution is often not fine enough to capture variation at farm level: 10m resolution instead of 250m





Step 2: Going beyond bird's-eye view

What?

Ensure reliable carbon stock estimate

&

Minimize number of samples required

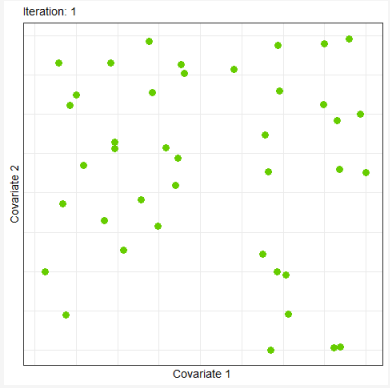
How?

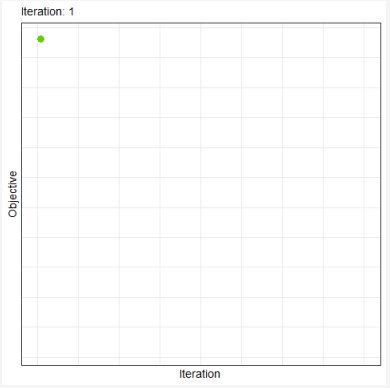
Prevent sampling at similar locations

Try to create a distribution that represents reality

With?

Conditioned Latin Hypercube sampling with Global Model prediction as input

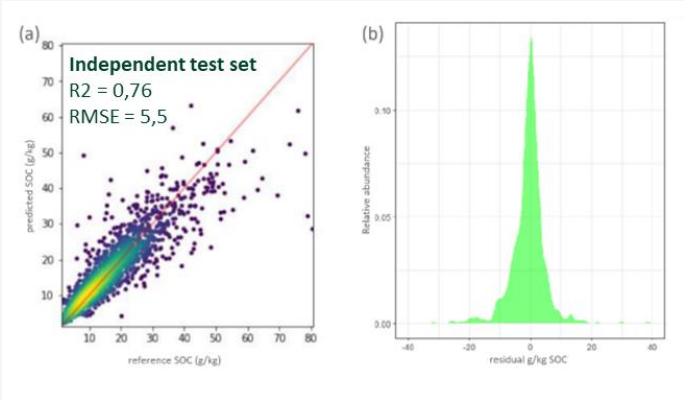




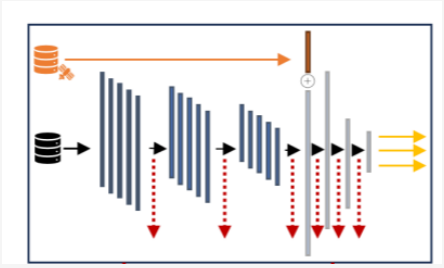
Step 3: Measure the soil

Obtain the residuals from global model

- Use NIR scanner to reduce analysis costs and thus enables to take more measurements
- Measure each sampling location individually (no mixture sampling) to reduce random device error
- HH AgroCares gives reliable and unbiased estimates of SOC and BD

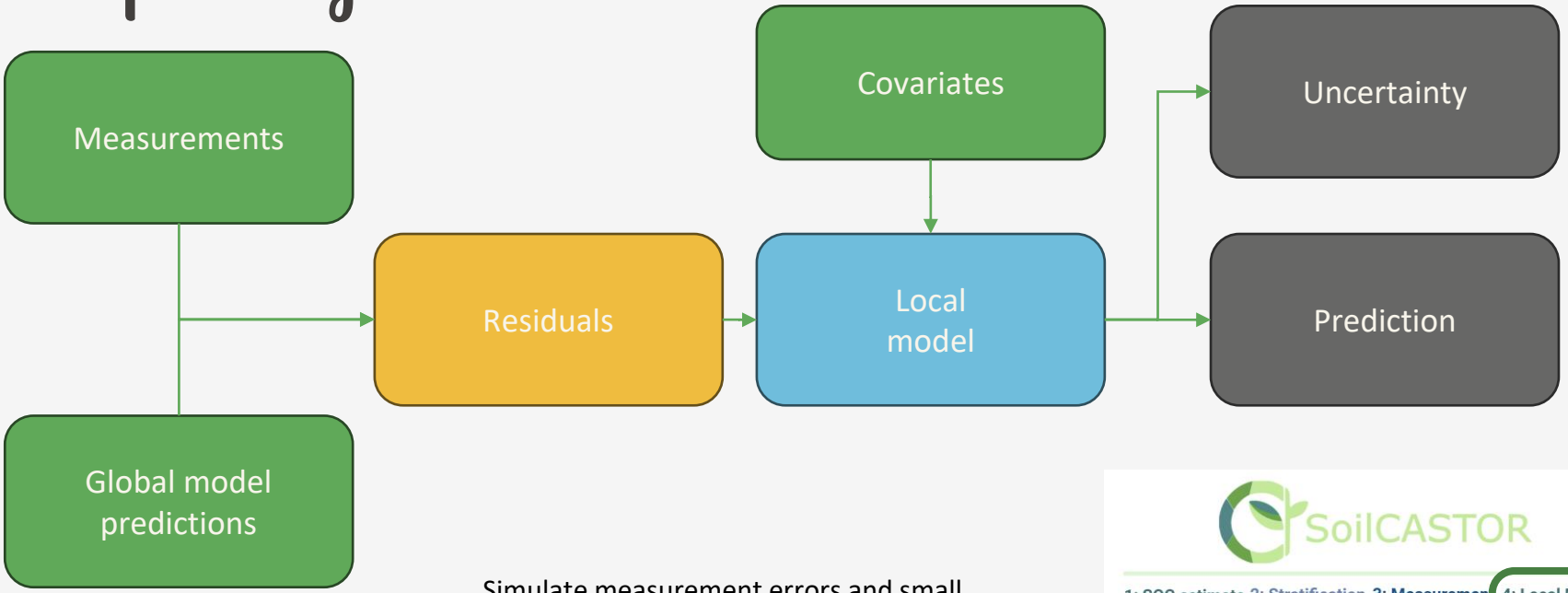


Note: used for C stocks on farm level. No point comparison



Kok et al. (in press)

Step 4: Go local



Simulate measurement errors and small sampling design adaptions to calculate confidence interval on farm C stocks

Proven technology

Grants4Tech 2022

Home > Agronomy for Sustainable Development > Article

Enabling soil carbon farming: presentation of a robust, affordable, and scalable method for soil carbon stock assessment

Research Article | Open access | Published: 08 February 2023

Volume 43, article number 22, (2023) Cite this article

Download PDF

You have full access to this open access article

Tessa Sophia van der Voort, Sven Verweij, Yuki Fujita & Gerard H. Ros

6004 Accesses 2 Citations 4 Altmetric Explore all metrics →

The winning solution should be:

- Accurate
- Scalable
- Reliable
- Cost-effective
- Fast

Aligned with VMD0042

Aligned with SBTi

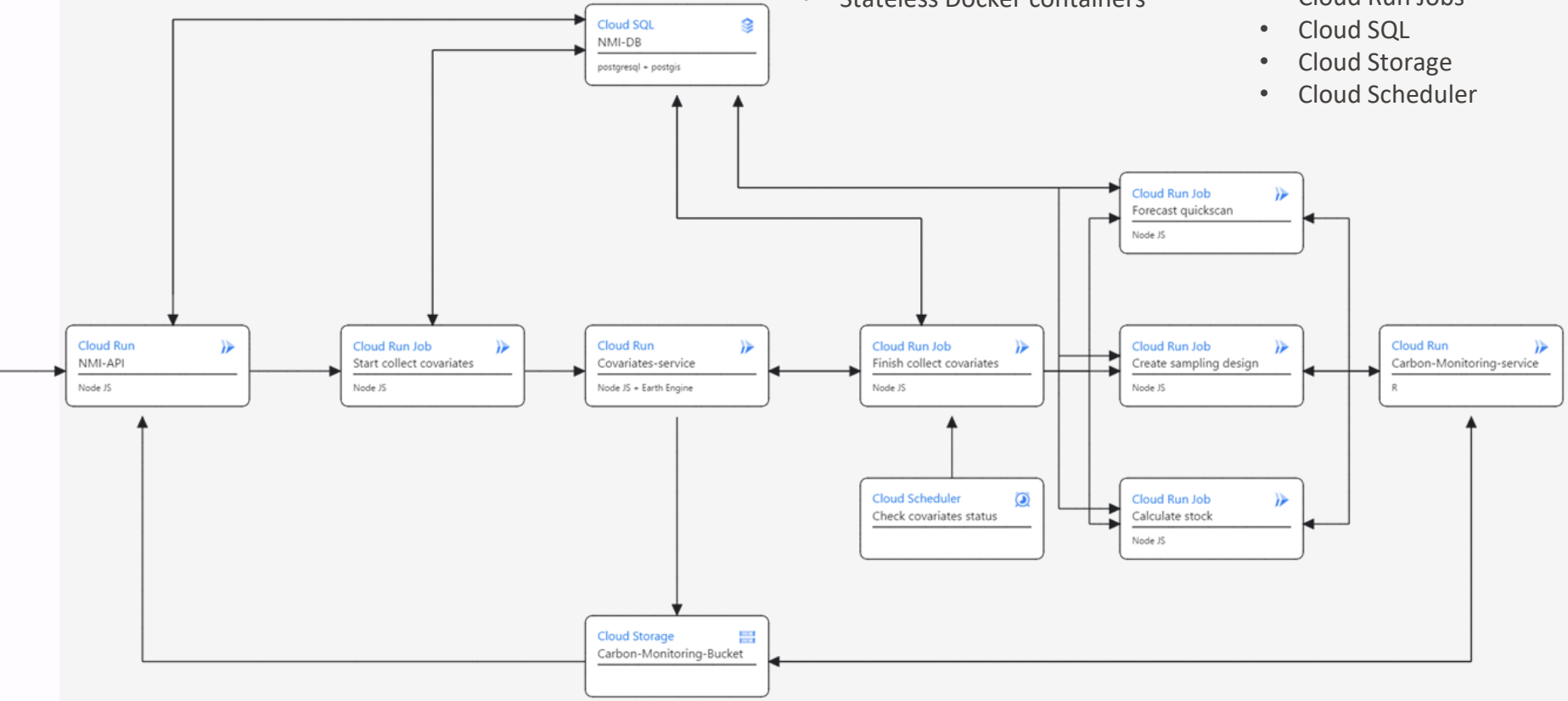
Behind the scenes

nmi soil for life

Behind the scenes

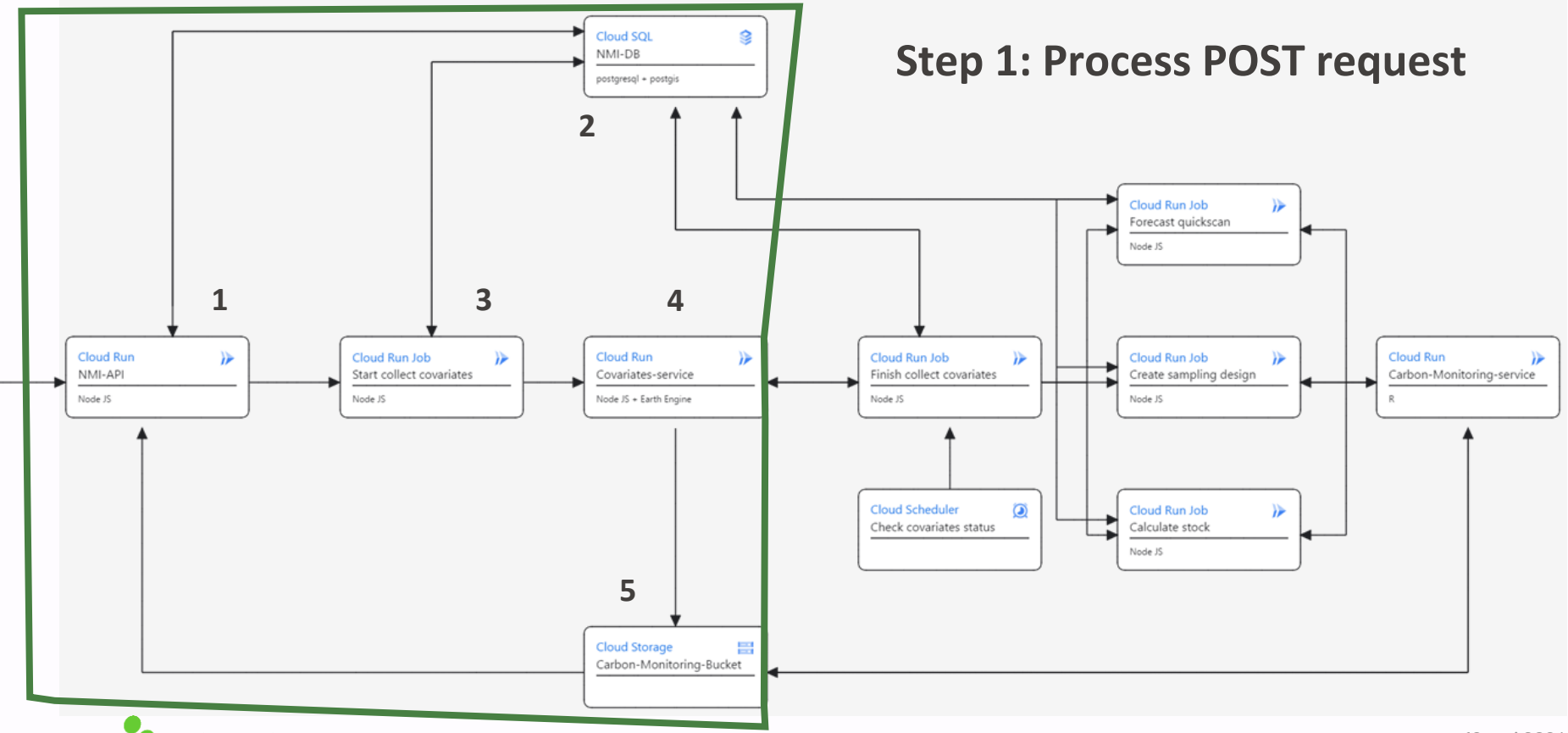
- Accessible via NMI API (REST)
- Stateless Docker containers

- Runs fully on Google Cloud:
  - Cloud Run Services
  - Cloud Run Jobs
  - Cloud SQL
  - Cloud Storage
  - Cloud Scheduler



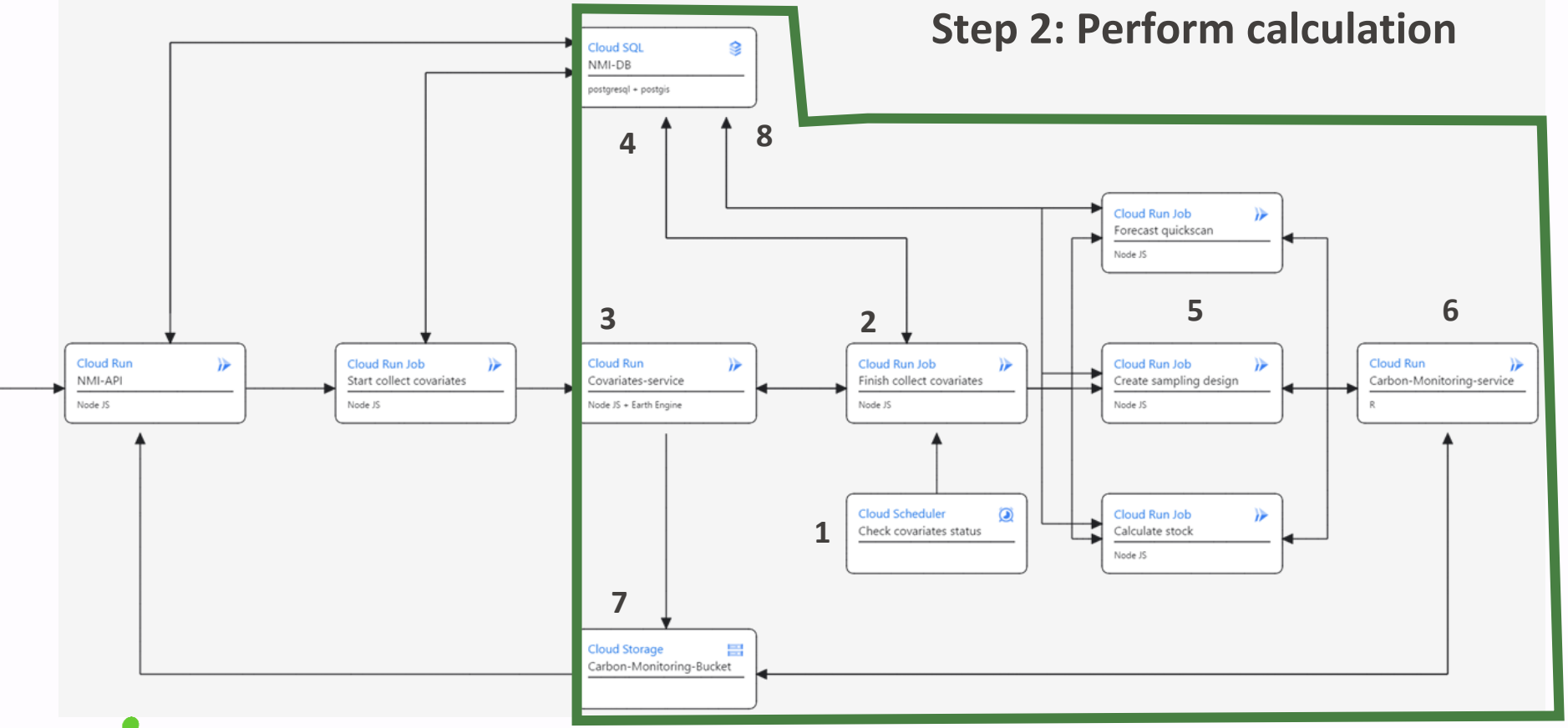
Behind the scenes

Step 1: Process POST request



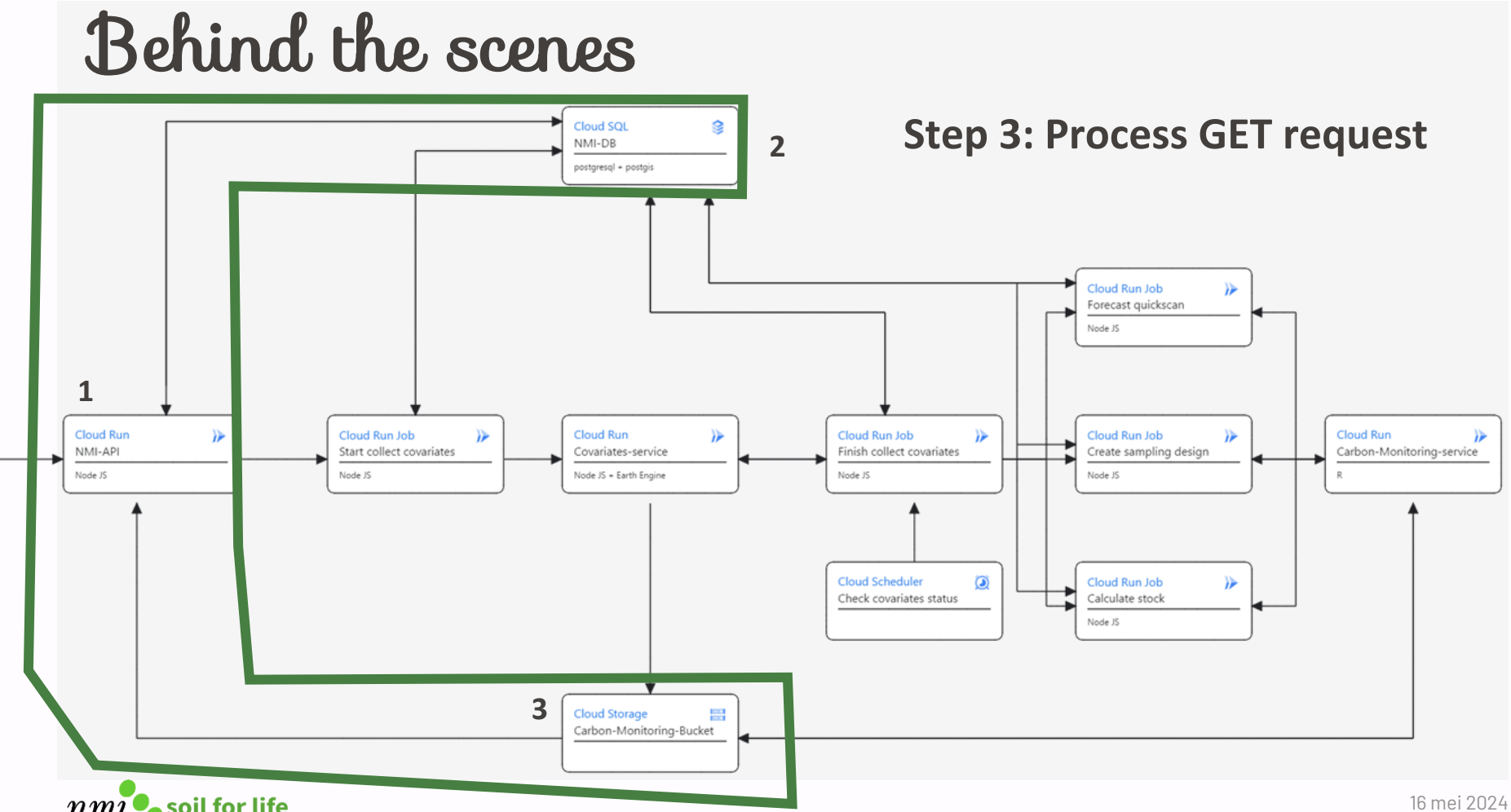
Behind the scenes

Step 2: Perform calculation



Behind the scenes

Step 3: Process GET request



Our experience and outlook

nmi soil for life

Our experience with Earth Engine

Achieved

- Global mapping of Carbon at 10m resolution
- Faster development of new covariates and models
- Reliable product with limited time spent on maintaining infrastructure

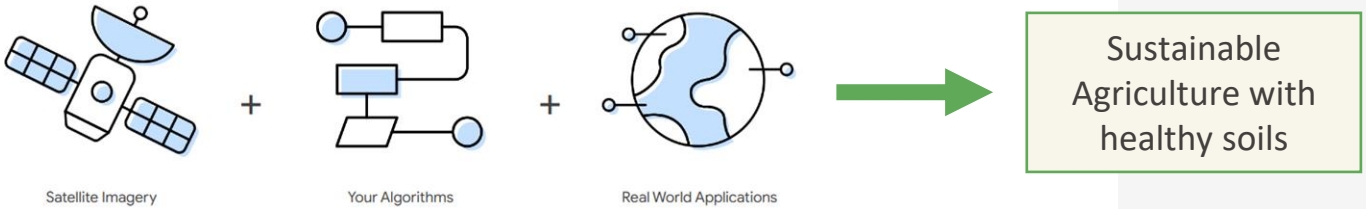
Current development

- Mapping for other elements:
  - Nitrogen (N)
  - Phosphorus (P)
  - Potassium (K)
- Extending advices to other ecosystem services

Challenges

- Difficult to estimate cloud consumption
- Takes some time to learn
- Misses sometimes full integration with Google Cloud

Our experience with Earth Engine



Earth Engine provides us the tools to advice farmers, policy makers and analysts on the transition to a sustainable agriculture with healthy soil

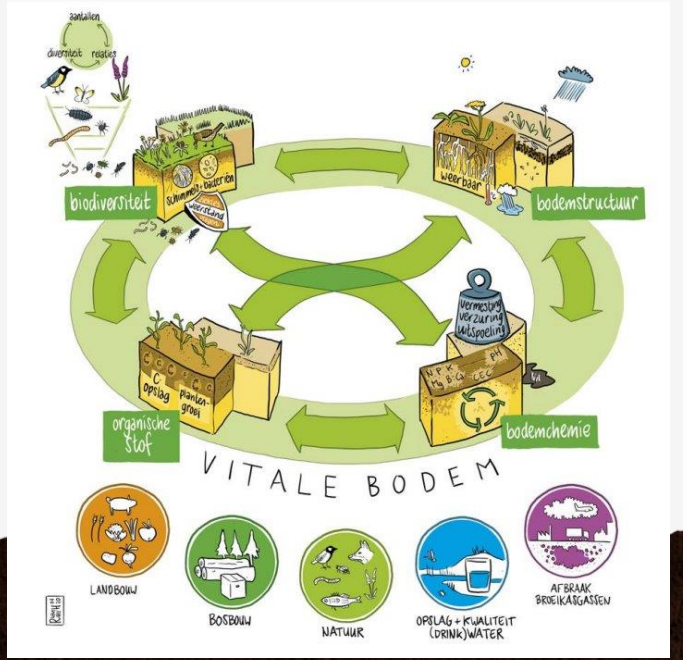
nmi Soil for life

LOCALYSE. PUT YOUR LOCATION DATA TO WORK

Google Earth Engine

Thanks for your attention!

- sven.verweij@nmi-agro.nl
- linkedin.com/in/sven-verweij/
- github.com/SvenVw
- researchgate.net/profiel/Sven-Verweij



nmi soil for life

References

- Ros, G.H., Verweij, S., Janssen, S., de Haan, J., & Fujita, Y. (2022). An Open Soil Health Assessment Framework Facilitating Sustainable Soil Management. Environmental Science & Technology, 56, 17375 - 17384. DOI:10.1021/acs.est.2c04516
- van der Voort, T.S., Verweij, S., Fujita, Y., & Ros, G.H. (2023). Enabling soil carbon farming: presentation of a robust, affordable, and scalable method for soil carbon stock assessment. Agronomy for Sustainable Development, 43, 1-12. DOI:10.1007/s13593-022-00856-7
- Kok M., Sarjant S., Verweij S., Vaessen S., Ros. G.H., (2024). On-site Soil Analysis: A Novel Approach Combining NIR Spectroscopy, Global Data and Deep Learning. Geoderma *In press*
- van Doorn, M., Helfenstein, A., Ros, G.H., Heuvelink, G.B., van Rotterdam-Los, D.A., Verweij, S., & de Vries, W. (2024). High-resolution digital soil mapping of amorphous iron- and aluminium-(hydr)oxides to guide sustainable phosphorus and carbon management. Geoderma. DOI:10.1016/j.geoderma.2024.116838