Earth observations for soil health in support of EU Mission implementation

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Abstract

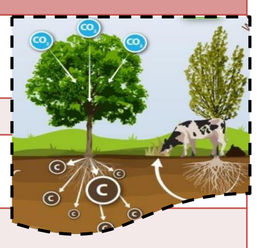
The EU's "Horizon Europe" research and innovation program for 2021-2027, which is mission-oriented, introduces five Missions, including the "A Soil deal for Europe". The Mission 'A Soil Deal for Europe' is one of the 5 EU Missions launched in September 2021. The mission aims to establish 100 living labs and lighthouses through the Horizon Europe programme to improve soil health by 2030. Healthy soils are critical to food systems, water, biodiversity, and climate resilience. However, it is estimated that around 60-70% of EU soils are unhealthy. Soils are crucial in providing ecosystem services and contributing to UN SDGs. These vital ecosystem services include the production of healthy food, protection of ground and surface water quality, carbon capture to mitigate climate change, reduction of greenhouse gas emissions, and preservation and enhancement of biodiversity at the landscape level. The Mission suggests six fundamental soil health indicators: 1) Presence of soil pollutants, excess nutrients, and salts; 2) Vegetation cover; 3) Soil organic carbon; 4) Soil structure, including soil bulk density and absence of soil sealing and erosion; 5) Soil biodiversity; 6) Soil nutrients and acidity (pH) (Caring for Soil is Caring for Life, 2020). While vegetation cover and soil sealing are not direct indicators of soil health, they are included due to their direct impact on soil health in agricultural, forestry, and urban settings. Thermal infrared data from satellites (3–14 μm) is most suitable for estimating soil moisture. Parameters such as vegetation indices, surface radiant temperature measurements, and land parameter classification may be considered as indicators of soil moisture. The integration of UAS with sensor networks/IoT and big-data/AI methods and technologies allows for the upscaling of various soil quality/health parameters. Present state and future perspectives of soil health estimation through EO data is presented in brief.

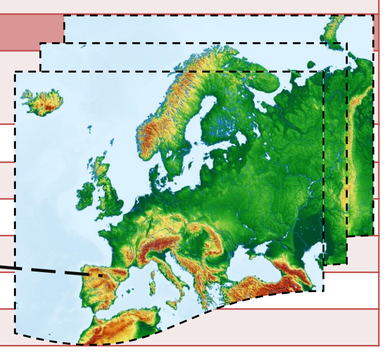
Highlights

- Data from EO sensors have high potential to support soil health reporting for the three vegetation indicators of ***soil health*** (***vegetation cover***, ***forest cover*** and ***landscape heterogeneity***).
- Selected soil indicators (***sealing***, ***erosion features*** and ***landslips***) and some proxies of management activities for soil health for early reporting.
- EO data is also very useful for upscaling field scale soil measurements such as from ***LUCAS*** or EU member states national monitoring programmes to produce national and European maps of ***soil health*** indicators.
- There are several R&D and technical challenges to the use of use of EO data for ***soil health*** assessment. These include inferences based on radiance or reflected energy that attempt to mirror 'complex' laboratory techniques, vegetation masking the target and limited investment in systems specifically targeting soil characteristics.
- Ongoing research is exploring the potential of EO for assessing ***soil carbon level*** and ***changes in stocks***.
- There are still some technical issues relating to ***spatial resolution***, ***temporal frequency*** of data and ***harmonising of classification*** which need further work.
- A few products/services are operational but most are in development, or semi-operational. Many require further development.

List of ongoing Projects / Services by EO soil health indicators

Project/Service	Description
EU Projects	
SAFERS (H2020)	https://safers-project.eu/
MAIL (H2020)	http://marginallands.eu/
RapidAI4EO (H2020)	https://cordis.europa.eu/project/id/101004356
NextGEOSS (H2020)	https://cordis.europa.eu/project/id/730329
NextLand (H2020)	https://ec-nextland.eu/
BENCHMARKS | AI4SoilHealth | SOIL O-LIVE | INBESTSOIL | NOVASOIL | SOILVALUES | NATI00NS | HuMUS	https://rea.ec.europa.eu/news/eu-mission-soil-deal-europe-ten-new-projects-prepare-ground-transition-towards-healthy-soils-2030-2022-12-05_en
Landschaftsveränderungsdienst	https://www.d-copernicus.de/fileadmin/Content/pdf/Beispiele-aus-Deutschland/stadtplanung/Laverdi-pdf_DE_aktuell.pdf
ESA Projects	
Sentinel-2 for Global Land Cover Classification (S2GLC)	http://s2glc.cbk.waw.pl/extension https://mapy.geoportal.gov.pl/imap/Imgp_2.html?gpmap=gp0
DesertWatch	http://due.esrin.esa.int/page_project118.php
Climate-Resilient Rural Livelihoods in Mongolia (EOTAP)	https://esamultimedia.esa.int/docs/EarthObservation/EOTAP/overview.pdf
EOStat	https://sdg.esa.int/activity/eostat-poland-4417 https://www.esa.int/Applications/Observing_the_Earth/Copernicus/Sentinel_data_enables_new_system_for_agricultural_monitoring_in_Poland
Soil Health Space-Based Evaluation	https://business.esa.int/projects/soil-health-space-based-evaluation
SoilSignal	https://business.esa.int/projects/soilsignal
MANTIS	https://www.esa.int/Applications/Observing_the_Earth/Two_ESA_Ph-lab-enabled_satellites_launched
Linking Soil Health and Ecological Resilience	https://esajournals.onlinelibrary.wiley.com/doi/pdf/10.1002/fee.2594
Other Projects	
Naturemap (Nature Map Earth)	https://explorer.naturemap.earth/map https://naturemap.earth/
SoilAqChar (BIOSTRATEG III)	http://www.soilaqchar.pl/
AGREEO project (ADEME)	https://www.terranis.fr/en/project/agreeo/
Terramap Services	http://www.terranis.fr
SATFARM Services (FFG)	https://projekte.ffg.at/projekt/3769932
Deepplanet	https://www.deepplanet.ai
Agri-EPI	https://agri-epicentre.com/





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