Soil Moisture

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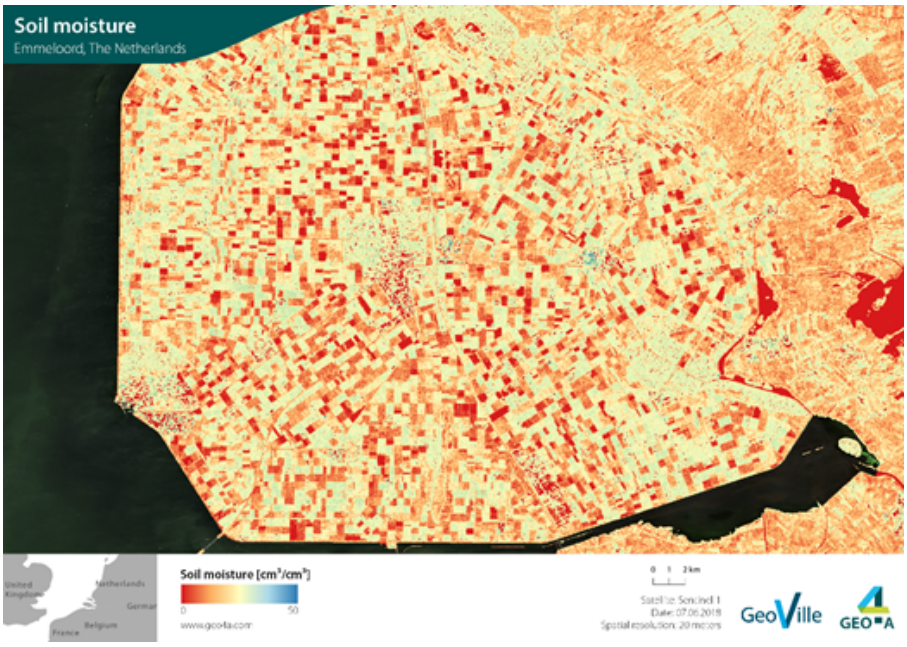

High resolution soil moisture based on Sentinel-1 (Emmeloord, The Netherlands) (Source: GeoVille/Geo4A)

Category

☑ Product Development	☑ Product Sales	☑ Underwriting	☑ Loss Adjustment	☑ Claims Handling

PRODUCT DESCRIPTION

Soil moisture plays an important role for the environment and the climate system. Affected by precipitation, temperature, soil characteristics and more factors, soil moisture refers to water stored in the soil. It influences hydrological and agricultural processes as well as runoff generation and many other processes. Earth observation provides global, seamless surface soil moisture information, measuring the moisture content of the top five centimetres of soil. Based on this, root zone soil moisture can be modelled. This seamless observation is a clear advantage compared to point based in-situ measurements, and recent developments allow to obtain also high-resolution satellite soil moisture observations.

The ESA Climate Change Initiative (CCI) Soil Moisture provides a +40-year dataset of daily soil moisture [m³/m³] at 25 km, updated yearly. Based on active and passive sensors this consistent global dataset provides valuable information at larger scales but does not meet the need for real time soil moisture information at field level. The Copernicus Global Land Service provides Surface Soil Moisture (SSM) and the Soil Water Index (SWI) with a resolution of 1 km for the layer over Europe and 12,5 km at global scale, every day. Recently, also higher resolution (e.g. 100 m as well as 10 m) near real time soil moisture products are being made available using the Copernicus Sentinel Constellation and offered by commercial Earth observation companies.

The data may be used as an indicator for insurance portfolio's drought/flood monitoring and loss adjustment procedures to benchmark the areas affected/unaffected by risk event. A more accurate and robust underwriting with additional rating instruments to be applied based on the soil moisture data.

PRODUCT SPECIFICATIONS

Main processing steps

High resolution soil moisture is estimated by a multi-sensor, time-series data-based approach. Data from various satellites with different spatial resolutions is combined. Additionally, the NDVI is used as a proxy because of its sensitivity to surface soil moisture patterns. Statistical downscaling procedures using Deep Learning methods are applied to combine data with different spatial resolutions and transfer them to higher resolutions. By using this method, data can be generated also on a local, regional or national level and at a higher spatial resolution than the European and global layers.

Input data sources

Optical: n.a.

Radar: Sentinel-1, SMAP, MetOp ASCAT

Supporting data: in-situ data

Spatial resolution and coverage

Spatial resolution: 10m – 25km

Coverage: Local/regional/national/global level

Availability: globally available

Accuracy / constraints

5-10% RMSE / not applicable in densely forest areas

Limitations

Currently available products indicate the surface soil moisture of the top few centimetres soil from coarse to high spatial resolution. However, it is not possible to directly observe root zone soil moisture.

Frequency / timeliness

Frequency: various time steps and long historic archives

Timeliness: near-real time

Delivery / output format

Data type: GIS-ready data formats; Raster; API (depending on customer needs)

File format: NetCDF, GeoTIFF, CSV

Accessibility

Freely available products are provided e.g. through the Copernicus Land Monitoring Service (https://land.copernicus.eu/global/themes/vegetation). Products from ESA's CCI Soil Moisture initiative with global coverage are open and freely available for registered users (https://www.esa-soilmoisture-cci.org/).

Products with higher resolution are commercially available on demand from EO service providers.

CHALLENGES ADDRESSED - USE CASE(S)

Product Development:

- Market analysis
- Index insurance: Toolbox for indices
- Index insurance: Risk / crop modelling (Correlation of EO data with in-situ data)
- Index insurance: Relation between weather events and impact on crop productivity
- Index insurance: Parcel/Field and regional yield statistics
- Index insurance: Platform for crop health products
- Identification of specific stresses and vegetation problems and their underlying causes
- Radar data (eliminated cloud cover effects)
- Risk exposure (product design and customer communication)
- Parametric insurance products

Product Sales:

- Pre-contractual consulting (show-case risk exposure)
- Greater acceptance of index covers by farmers
- Regular market penetration review
- Risk alerts

Underwriting:

- Seasonal portfolio monitoring
- Online platforms or easy-to-use interfaces integrating various data sources (e.g. vegetation stress, field boundary changes, comparison, etc.)
- Risk / crop zoning
- Actual crop health (vegetation)
- Procure better reinsurance terms/capacity from enhanced insurance practice
- Crop calendar and practices
- Regular assessment of risk pricing and product rating

Loss Adjustment:

- Regularly updated consistent long-time series of reliable data for index insurance
- Benchmark physical field observations against yield loss detection (e.g. product calibration)
- Risk-mapping against crop's vegetation stages
- Increase credibility of loss adjustment (e.g. show EO data/visualization to support loss adjustment communication to farmer)
- Enhance field survey (better precision with EO data support)
- Detect crop damage at field level
- Assess crop damage at field level
- Distinct field heterogeneity with crop damage
- Soil type data

Claims Handling:

- Identification of actual damage size (tons (volume) / ha (area) / price (yield value)
- Quality control assessment of claims before pay-out
- Fraud detection
- Obtaining timely, reliable and consistent data to speed-up the indemnity pay-outs