REVEALING THE ROLE OF GEOSS AS THE DEFAULT DIGITAL PORTAL FOR BUILDING CLIMATE CHANGE ADAPTATION & MITIGATION APPLICATIONS

Eiffel
GEOSS APPLICATIONS FOR CLIMATE CHANGE

Factsheet #1

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EIFFEL: A game changer in the domain of Climate Change adaptation & mitigation by harvesting the benefits of the GEOSS data

Revealing the role of GEOSS as the default digital portal for building Climate Change adaptation & mitigation applications

Climate change (CC) adaptation and Earth observation (EO) are closely linked, as proper adaptation requires effective data-driven decision-making, which EO provides. Addressing the challenge of climate change adaptation requires effective tools that can utilize the vast amounts of Earth observation data available to facilitate decision-making.

The EIFFEL project enhances the GEOSS Portal (which connects millions of data sources with potential users) through AI-based cognitive search tools, metadata augmentation, novel methods of super-resolution, and data fusion to enhance the spatiotemporal resolution of Earth Observation data, as well as the application of best practices in quality metrics standardization.

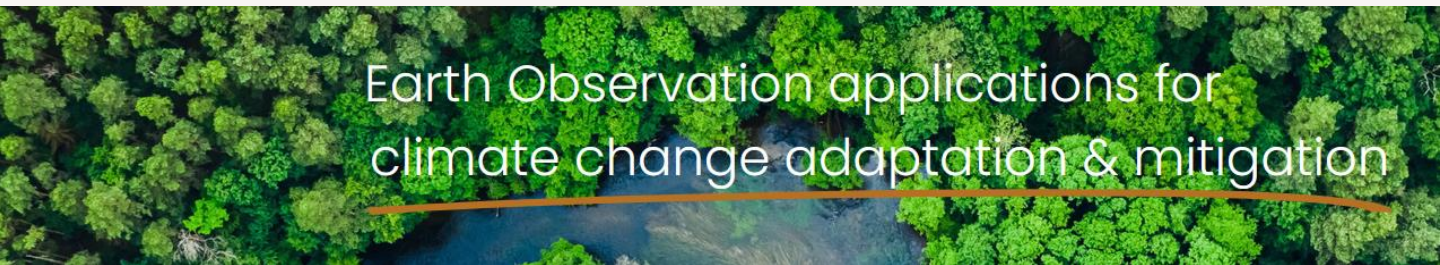
The project transforms this knowledge into climate action through five pilot projects across Europe, each addressing a specific sector affected by climate change: water and land use management, sustainable agriculture, transport management, sustainable urban development, and disaster resilience.

It directly involves local communities and stakeholders, aiming to ensure that decision-makers receive actionable insights. This involvement has facilitated the co-design of tools that align with climate change adaptation policies and mitigation strategies. GEOSS data, along with AI-based algorithms, were used to tailor nature-based solutions for climate adaptation, such as afforestation, resulting in improved resource management, reduced vulnerability to climate-related disasters, and increased community resilience.

Related links:

Climate ADAPT publication is available here

EIFFEL's approach goes beyond and serves as a model for countries and regions worldwide seeking to address climate change challenges using Earth observation data. The project demonstrates the value of GEOSS data for creating climate change applications while promoting data sharing, reusability, and scalability, contributing to building a better climate change-adapted future.



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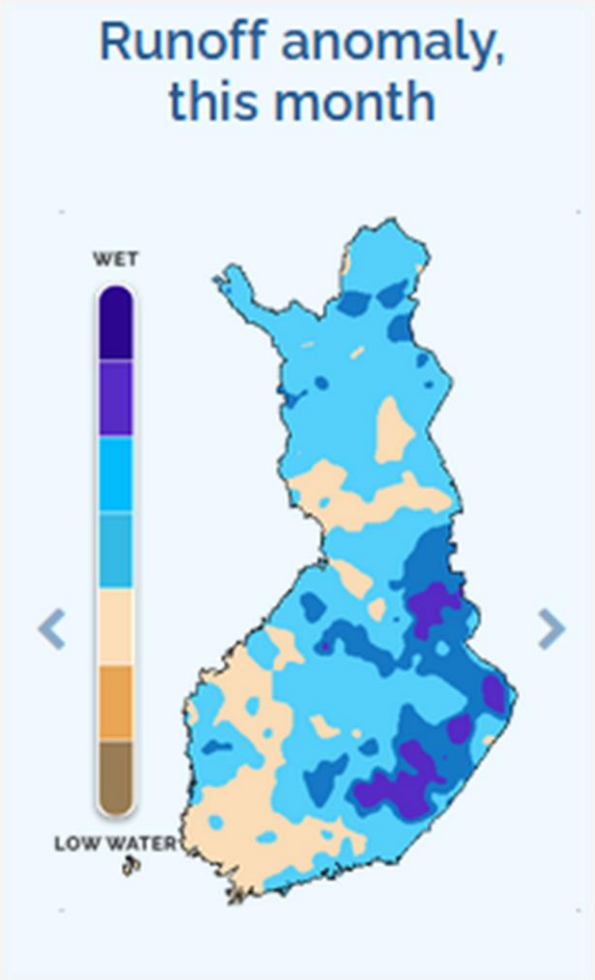
Finland's up-to-date water information portal

Waterinfo.fi is a website full of facts about water, made by the *Finnish Environment Institute* and other groups. It covers things like water levels, droughts, floods and water quality.



The aim is to help people understand and look after water better. It's useful for everyone, from regular folks who want to know more about water to experts in fields like the environment and water management.

The site shares updates on observed river and lake water levels, forecasts about floods and droughts, and tools like the **Water footprint calculator** to help users see how much water they use.

By using smart maps and working with experts, Waterinfo.fi gives detailed info that helps people make good choices about water.

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Carbon Monitoring System for Lithuanian Soils

Comprehensive maps have been created to pinpoint the most appropriate areas in Lithuania for various agricultural practices under the Common Agricultural Policy (CAP), both currently and in the future.

These maps evaluate the impact of each practice on Soil Organic Carbon content in comparison to conventional methods. The emphasis is on four key practices - winter wheat farming, crop rotation diversity, preservation of grasslands, and the adoption of organic farming methods - demonstrating their influence on Soil Organic Carbon based on local conditions using causal Artificial Intelligence and big Earth Observation data. The results are presented in a user-friendly online tool.

Soil Organic Carbon is crucial for soil fertility and sustainable agriculture. This method not only offers an overview of how these activities affect overall soil health but also allows for the identification of specific effects on different areas. This enables tailored advice for local farmers to comply with CAP regulations and improve their farming practices in a sustainable manner. The maps will be distributed as shapefiles containing detailed plot data, drawing on information from Lithuania's Land Parcel Identification System, pending approval from Lithuanian authorities.

Related links:

Carbon Monitoring System for Lithuanian Soils. Maps tool https://portfolio.i-bec.org/Eiffel/

Articles:
Towards assessing agricultural land suitability with causal machine learning

Personalizing Sustainable Agriculture with Causal Machine Learning

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Optimizing Soil Assessment in Lithuania: The Bare Soil Identification Tool

The Bare Soil Identification (BSI) tool helps find bare soil areas in Lithuania each year. It uses a free software called *OpenDataCube* to bring in satellite data from a certain time and place. The tool looks at data from the Sentinel-2 satellite and uses different measurements to figure out where there's bare soil. After this, it removes land covers areas or unclear data, giving a final map with details down to 10 meters.

By leveraging the BSI tool, users can effectively identify bare soil areas within their designated region through a semi-automated process. This tool streamlines the analysis by processing Sentinel-2 satellite data and applying index thresholds to distinguish between bare soil and other land cover types.

The inclusion of various indices calculated from specific spectral bands ensures a comprehensive assessment of the area's soil composition while excluding vegetation and unclassified pixels.

Ultimately, the generated layers offer detailed insights into bare soil distribution with a spatial resolution of 10m, enhancing the precision and efficiency of soil identification processes.

Related info:

Journal article: Soil Data Cube and Artificial Intelligence Techniques for Generating National-Scale Topsoil Thematic Maps: A Case Study in Lithuanian Cropland

Open Data Cube https://www.opendatacube.org

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EIFFEL: A game changer in the domain of Climate Change adaptation & mitigation by harvesting the benefits of the GEOSS data

Climate adaptation in the transboundary Aa of Weerijs for addressing water scarcity challenges

The transboundary Aa of Weerijs river catchment is shared between Belgium (upstream) and the Netherlands (downstream). Out of its total surface area of 364 km2 about 149 km2 are in the Ditch province of Noord Brabant, which is the focus of this case study.

This catchment faces challenges with water retention and biodiversity due to historical reasons, related mainly to extensive drainage and canalization for enabling flood protection and agricultural activities, resulting in about 65% of the area currently being used for agriculture, with natural spaces covering the 23%, and urban zones about 12%.

Climate change has exacerbated summer droughts in the area, putting increased pressure on water resources and increasing agricultural water use, while sandy soils with low water and soil carbon retention have further intensified irrigation needs. In addition, the citizens of urban areas demand more protected and dedicated natural and recreational areas.

To address these challenges, this pilot of the EIFFEL project has developed local climate adaptation strategies using Nature-Based Solutions (NBS) to enhance water retention and soil carbon levels in the catchment. These strategies have been designed and analyzed by an integrated hydrological model, considering different climate change scenarios. To improve the resilience of the region, drought-related Key Performance Indicators (KPIs) such as surface water availability, groundwater availability and soil moisture index, have been the basis for assessing and comparing the effectiveness of these adaptation measures for the Aa of Weerijs river basin. For some of the NBS-based adaptation strategies soil carbon sequestration has been calculated using a separate soil-carbon model that was coupled with the hydrological model.

Related info:

More detailed info available in https://eiffel.un-ihe.org/EIFFEL-prod/

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Climate adaptation in the transboundary Aa of Weerijs for addressing water scarcity challenges

Challenges:

The Aa of Weerijs river catchment faces significant challenges due to climate change, including the escalating impact of more severe summer droughts and increased anthropogenic water use, the degradation of water retention and biodiversity due to past drainage and canalization works, the presence of sandy soils with low water retention and soil carbon exacerbating water scarcity issues. There are also high demands for protected nature and recreation areas from local citizens, and the complex tasks of co-designing effective climate adaptation strategies with Nature-Based Solutions are very challenging amidst competing interests and demands in the region. Balancing these challenges while aiming to improve water retention and soil carbon levels in the catchment requires a comprehensive and collaborative approach involving various stakeholders and innovative solutions.

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To face this, the study on the Aa of Weerijs catchment explores four different climate change scenarios (developed by the Royal Dutch Meteorological Institute, KNMI, in 2023), combining diverse levels of greenhouse gas emissions ('High' and 'Low') with different levels of 'wetness' ('wet' and 'dry'). The scenarios are prepared for two different 30-year periods in the future, centered around years 2050 (period 2036-2065) and 2100 (period 2086-2115), for which the results are then compared to the reference condition of 1991-2020. Drought conditions in the Aa of Weerijs are then analyzed by comparing the decades of the base (current) period (2010-2019) and future (2050-2059) under climate change. Potential evapotranspiration (temperature-related) and precipitation predictions under these CC scenarios have been used as inputs to the developed hydrological model for assessing the impact of climate change on the hydrology of the area, with special focus on the summer droughts.

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Objectives:

- Develop a hydrological model: Set up an integrated hydrological model, that captures the surface-sub-surface interactions, to test nature-based solutions for managing water shortages and droughts in the Aa of Weerijs catchment.
- Assess GEOSS data: Evaluate the usefulness of GEOSS data for modelling water-related adaptation measures in transboundary catchments, emphasizing the importance of high-resolution data for effective climate resilience strategies.
- Identify drought-related Key Performance Indicators in discussion with key stakeholders: Analyse and select KPIs that are relevant for the key stakeholders such as the main water management organizations, the 'Water Board of Brabantse Delta', and the Province of Noord Brabant.
- Design adaptation strategies based on nature-based solutions (NBSs): Use the developed model to design adaptation strategies based on NBSs to assess the impact of adaptation measures on water scarcity within the catchment area, using the identified KPIs.
- Expand carbon sequestration modelling: Couple the developed hydrological model with a soil carbon sequestration model to enable rapid assessments of soil carbon changes with the proposed adaptation strategies.
- Establish a decision support application: Create a web-based decision support application to present the performance of the adaptation strategies.

This application can subsequently facilitate collaborative decision-making among stakeholders for selecting local climate adaptation measures, enhancing the process of designing and implementing effective strategies for climate resilience in the Aa of Weerijs catchment.

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Solutions

The nature-based solutions considered are *"actions to protect, sustainably manage and restore natural or modified ecosystems that address societal challenges (e.g. climate change, food and water security or natural disasters) effectively and adaptively, simultaneously providing human wellbeing and biodiversity benefits"*, according to the International Union for Conservation of Nature (IUCN), the agency that introduced the concept.

In the Aa of Weerijs catchment, decades of efforts to manage water excess through engineering measures have led to a modified ecosystem and landscape transformation. Initially, these interventions were necessary to address the water challenges. However, the current water scarcity situation demands a shift towards nature-based solutions that can retain more water in the catchment.

The following NBS (6) have been proposed to address this problem, and considered spatially both as 'single-measure' and 'combined' strategies:

- *Ditch blocking:* To prevent water flow to larger streams can reclaim land for alternative uses, increasing surface water for infiltration, enhancing soil moisture, and recharging groundwater aquifers while reducing peak discharge in small streams.
- *Wetlands restoration:* To keep and store water. It helps to clean water, support wildlife, and increase biodiversity. Different types of wetlands like floodplains and swamps can be used. Wetlands mainly help store water.
- *Infiltration Ponds:* To trap sediment and promote biodiversity supporting aquatic plants. Main job is to help water seep into the ground, increasing soil moisture and recharging groundwater.
- *Heathlands restoration:* To transform areas with dense tree cover into open spaces with less vegetation. It allows more water to reach the soil, improving soil moisture and groundwater recharge, and improves water absorption.

EIFFEL: A game changer in the domain of Climate Change adaptation & mitigation by harvesting the benefits of the GEOSS data

Climate adaptation in the transboundary Aa of Weerijs for addressing water scarcity challenges

Solutions *(continuation)*

- *Tree planting*: To improve absorption and release of water, enhance water infiltration and retention in the soil.
- *Brook bed barriers:* To slow the flow of water and reduce erosion, so water has more time to soak into the soil downstream.

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More detailed info available in https://eiffel.un-ihe.org/EIFFEL-prod/

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Adaptation Strategies

Initially, several adaptation strategies have been tested, each with a single type of Nature-Based Solutions implemented in the Dutch part of the Aa of Weerijs catchment. For spatial location of all these NBSs the pilot used results from some past projects where the so-called 'opportunity maps' for their implementation have been developed in the Dutch part of the catchment.

To clearly evaluate the effectiveness of the single-measure adaptation strategies, they have been tested under the most severe climate change scenario 'HD' (high emissions and dry summer conditions).

Considering the Surface water availability, groundwater availability and the Soil moisture index -the Key Performance Indicators of this research-, each of the Nature-Based Solutions have been tested, obtaining that best results have been obtained using Ditch blocking, Infiltration ponds and Heatland restoration. On the other side, Tree plantation has been assessed to have negative effects in different sections of the catchment, primarily due to increased evapotranspiration rates. Finally, Wetlands restoration and Brook bed barriers have been assessed with mixed effects (both positive and negative, in different sections of the catchment). Soil carbon sequestration difference (compared to current conditions) has been calculated for tree planting, heathland restoration and wetland restoration.

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Climate adaptation in the transboundary Aa of Weerijs for addressing water scarcity challenges

Two adaptive strategies have been developed to enhance groundwater availability indicators by combining the most effective individual NBS across various designated areas, to optimize the use of natural solutions for improving groundwater availability.

Related info:

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Strategy 1: Combined single measure NBSs covering the existing Nature Management Plan (NMP): This strategy involved evaluating individual adaptation measures, such as ditch blocking, wetland restoration, infiltration ponds, and heathland restorations, for their positive impact on GWA. Measures with significant positive effects were prioritized, while locations with negative impacts were excluded. The final locations of all interventions was restricted to areas determined by the existing NMP of the Province of Noord Brabant.

Strategy 2: Expanded Spatial Distribution: This strategy followed a similar methodology to Strategy 1 but expanded the spatial distribution to include the so called "Green Blue Mantel" (GBM) area, in addition to the NMP. The GBM represents a buffer zone surrounding the Nature Network of Brabant and is identified to serve as a secondary function for nature and water management. According to North Brabant Province's policy, the GBM is intended for the development of a climate-proof and resilient water system, as well as nature and landscape enhancement.

As a summary, **Strategy 2 provided superior results** due to larger NBS areas, notably enhancing groundwater availability over surface water availability, with implemented NBS zones showing more positive effects, particularly downstream near Breda. The absence of NBSs in the Belgian catchment area resulted in negligible effects there.