GEO-AIYLRF

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<p style="color: rgb(210, 45, 64); font-size: 19px;">GEO-AI forecasting of Crops Yield Loss Risk in Central Europe using remote sensing and climate data</p>

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<p style="color: dark blue; font-size: 18px;">Big Terra Alpha</p>

Timely and reliable estimations of crop production are essential to address climate caused production variability, stabilize grain market, and achieving target yields, aligned with sustainable development goal (SDG-2) of ‘zero hunger’ and (SDG-13) ‘Climate Action’. Europe has remained to be the hotspot of extreme events in recent decades, with increased drought’s frequency in western, central, and southern countries. The recent drought of 2022, combined with high temperature impacts in the crop growing season caused a substantial yield loss in summer crops, causing a total agricultural estimated loss of 13 billion Euros in EU-27. Since 1992, the Monitoring Agricultural Resources (MARS) Unit of the European Commission’s Joint Research Centre (JRC) has initiated MARS Crop Yield Forecasting System (MCYFS) for accurate crop monitoring and timely crop yield forecasting in EU-27 and neighbouring countries. The system incorporates multi data sources including agrometeorological from 4000 EU weather stations, WOFOST based crop simulations, along with advanced statistical analysis and expert evaluation. Although, existing EU crop monitoring system (MCYFS) is well established and operationally mature but exhibits potential limitations in its capacity to address climate induced future yield loss in EU. The short-term seasonal forecasting of currently adopted system cannot perform yield loss forecasting under climate trajectories such as CMIP6 SSP scenarios at spatially granular scale. Therefore, this project will urgently provide a transformative solution beyond seasonal to proactive long run yield loss forecasting at NUTS-3 level in four central EU states. Moreover, deterministic crop models such as WOFOST with basic agroclimatic inputs are not well equipped to understand the complex and non-linear relationships between climatic extremes and crops response towards changing climate scenarios. From this perspective, current research project aims to develop a novel Geo-AI framework for high resolution Yield Loss Risk Forecasting (YLRF) of three main crops (Maize, Wheat, and Barley) at NUTS-3 scale in Central European countries (Czechia, Slovakia, Hungary, and Austria), integrating multisource Earth Observation (EO), and Climate data with crops yield statistics under present and future (CMIP6-SSPs) climate scenarios. This project leads to develop new integrated Agricultural Drought Indices (AgDI) using EO datasets enabling robust monitoring of agricultural droughts across Central Europe. Furthermore, the project will deliver an interactive visualization dashboard and a structured communication, dissemination, and exploitation strategy to support evidence-based decision-making and climate-resilient agricultural policies aligned with EU priorities. Overall, research findings will be instrumental in promoting agricultural sustainability by identifying high-risk areas, guiding climate-resilient crop planning, and informing evidence-based adaptation policies. The developed framework will serve as scalable decision support tool, bridging the gap between innovative methods and policy implementation in support of national and regional agri-environmental planning. Furthermore, the results can support regional and national authorities in aligning agricultural policies with the EU Green Deal, Common Agricultural Policy (CAP) eco-schemes, and long-term climate resilience goals.

<p style="color: dark blue; font-size: 18px;font-weight: bold;">Sustainable Development Goals</p>

Meet the Project

If you had to explain your project to someone outside your field, how would you describe it in three sentences?

My project explores how climate change and extreme events like droughts are reshaping the future of major crops, including wheat, maize, and barley across Central Europe by combining satellite data with next-generation AI models. The outcomes will be detailed geospatial maps at the NUTS-3 level, providing clear and robust visual insights into where and why crop losses occur from past to present, enabling more precise local-level assessment. Application of advanced crop models with AI algorithms will not only anticipate future risks under changing climate scenarios but also provide practical, easy-to-use tools that help farmers, local communities, and policymakers make smarter and climate-resilient decisions.

What fascinates you most about the topic of your research project?

My research project directly connects cutting edge geospatial science with real world agricultural challenges shaped by climate change and European policy priorities. I am particularly interested in linking satellite-based observations with climate data across space and time to generate region specific insights that support climate resilient agriculture. Moreover, application of advanced AI approaches such as transfer learning, enables more reliable and accurate forecasting of future yield loss risks, addressing key limitations of traditional statistical methods. Building new drought indices and spatiotemporal predictions, my project advances towards identifying and forecasting future droughts patterns along with associated Yield Loss Risk at NUTS-3 scale. It directly supports major EU frameworks such as the Green Deal and the Common Agricultural Policy (CAP). What makes this project highly compelling is the ability to translate complex data into actionable insights through high-resolution maps and predictive tools which can guide farmers, support local communities, and inform policy decisions at multiple scales. This integration of science, technology, and real-world impact is what makes the research both meaningful and exciting.

How does your research contribute specifically to achieving the UN Sustainable Development Goals?

My research contributes directly to key United Nations Sustainable Development Goals, particularly **SDG 2 (Zero Hunger), SDG 13 (Climate Action), and SDG 9 (Industry, Innovation and Infrastructure)**, by addressing one of the most urgent challenges facing agriculture that is climate-driven crop loss. By integrating satellite-based Earth Observation data with advanced AI models, the project develops high-resolution drought and yield loss risk forecasts for major crops such as wheat, maize, and barley across Central Europe. This enables early identification of vulnerable regions at the NUTS-3 level, allowing farmers and local authorities to take timely actions such as adjusting sowing dates, selecting drought-tolerant crop varieties, or optimizing irrigation, thereby reducing crop losses and strengthening food security.

From a climate perspective, the project provides actionable insights into how extreme events like droughts are evolving under future CMIP6 scenarios. These insights support evidence-based adaptation strategies, such as regional crop planning in drought-prone areas of Czechia, Hungary, and Slovakia or water resource management in Austria, directly contributing to climate resilience under SDG 13. At the same time, the development of an open Geo-AI platform and interactive dashboards advances SDG 9 by transforming complex geospatial data into accessible, decision-support tools for policymakers and agribusinesses.

Beyond academia, project will directly support local farmers gaining simple, map-based tools for agricultural decision-making. The local communities would benefit from early warning systems, and governments can design more targeted agro-climatic policies.

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