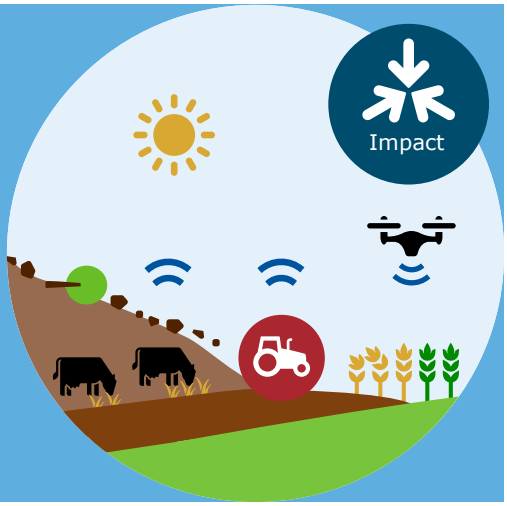
ML-CLIMATE

iMproving cLimate information serviCes for sustainabLe agrIculture by integrating scientific and indigenous forecasts using Machine leArning TEchniques

Emerging DS/AI methods

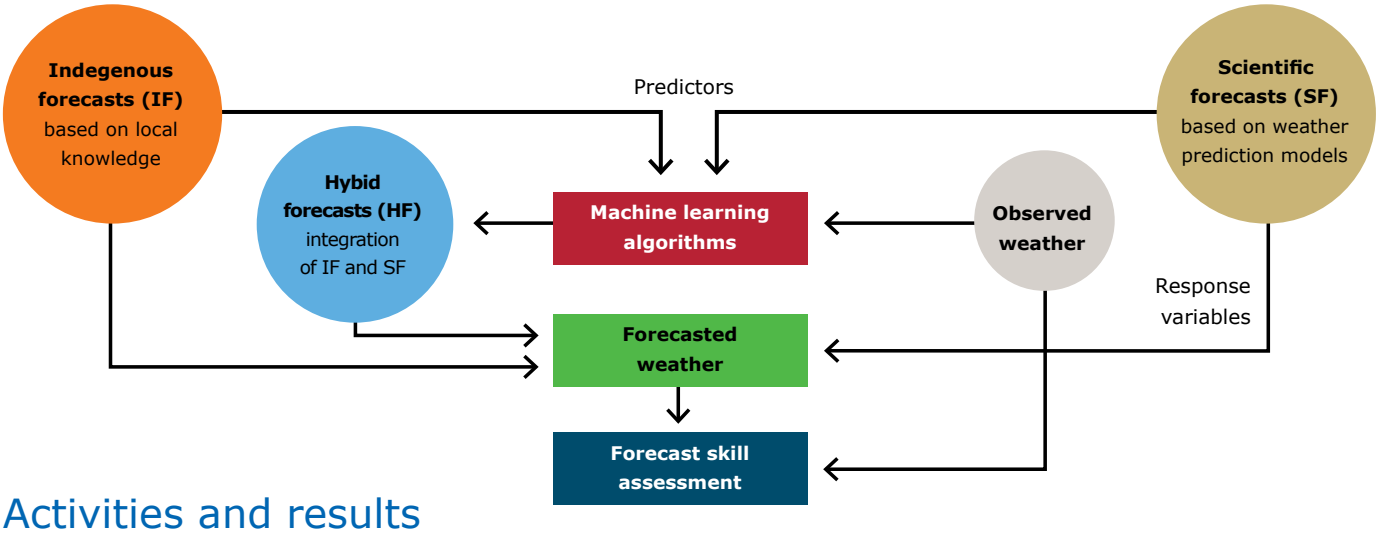
WAGENINGEN
UNIVERSITY & RESEARCH



Data Driven Discoveries in a changing climate (D3C2)

Goal/objective: The objective of the ML-CLIMATE project was to study the potential of machine learning (ML) techniques to improve climate services using hybrid weather forecast (HF) derived from local or indigenous weather forecast knowledge (IF) and scientific weather forecast knowledge (SF) obtained from climate and weather prediction models. The integration of IF with SF was performed by developing different ML techniques, such as random forest, neural network, and log regression to deliver a skilful HF system. The ML algorithms were trained using local ecological forecast indicators that WSG and MAQ students collected on the field in Ghana and Guatemala, the scientific weather forecast from global models as predictors and the observed rainfall data as response variables.
A database was developed to visualize the local weather forecast indicators around the world.

The conceptual framework of the ML-CLIMATE project:



Activities and results

Within the scope of the ML-CLIMATE project, WSG group collaborated with MAQ to co-develop ML algorithms to deliver a new type of weather forecasting, the 'Hybrid forecasting'. Although the project started in June which was already the rainy season in the localities we were targeting (Ghana and Guatemala), we were able to utilize our network to engage with master students that we sent on the field to document and harness indigenous weather forecast knowledge. At the same time, we utilized already existing datasets from previous years and worked on developing a ML algorithm using Random forest scheme.

What did you achieve? What have you celebrated? Was there an approach that failed, and why?
We have achieved to develop the ML algorithm which is now being implemented in the DROP app, a Wageningen software climate service for small-scale agriculture to provide rainfall forecast. At the same time, we developed

an interactive StoryMap where we visualize more than 1400 local ecological indicators in more than 65 regions around the world. This assists in establishing WUR as global leader in indigenous weather forecasting and the StoryMap links every researcher that wants to work on this topic, with WUR and its on-going research. We increase our visibility and we aim to build on the ML-CLIMATE outcomes to foster research on Hybrid weather forecasting for farm decision-making.
In terms of cross learning between data science/ai and domain knowledge, more and more attention is given in engaging with end-users and harnessing their local knowledge when it comes to weather forecasting for operational decision-making. In this project we showcased what happens where data are scarce, and how harnessing the power of Machine learning integrated with a social perspective can enhance the quality of weather forecast and provide actionable knowledge to people that their livelihoods depend on the success of small-scale agriculture.

What is your outlook with this research?
We have established a strong collaboration between WSG and MAQ groups and many students are interested in Hybrid weather forecasting. We developed a Jupyter Notebook stud case of the work that was performed, and this is now implemented in WUR education to increase awareness on the topic. We are collaborating with the University of Development Studies (UDS) in Ghana that are also interested in the same topic to further expand our research and collaboration.

We intend to write a follow-up proposal for the Open Competition Domain Science – M to acquire funding to continue and expand our activities in more localities.

Deliverables
- Algorithms on hybrid weather forecasting (work in the final stages and will be included in the sharepoint soon)
- Interactive StoryMap https://storymaps.arcgis.com/stories/3ff4a1ad4a314094b02031aec4cdae28)
- A paper is under submission in Scientific Reports journal
- A project website https://www.wur.nl/en/project/ml-climate.htm was developed to highlight the on-going work.

Figure StoryMap of global sources and local ecological indicators on weather forecasting for small-scale farm decision-making.

Lessons learned

We learned that there are multiple possibilities to harness the potential of Machine learning to deliver a hybrid short-term forecast that integrates science with community's perspectives. While doing so, collaboration among the chair groups and local partners was exceptional. Between WSG & MAQ, many common ties were found, and we aim to continue working together in developing a future NWO proposal. We are already collaborating in education by using the case study Jupyter Noterbooks with hand-on exercises that they were developed within the scope of the project. In terms of domain science, the research we perform on the integration of the use of hybrid weather forecasts attracts attention and has been recently featured in the national Dutch media on *NOS Journaal* (https://www.npostart.nl/nos-journaal/24-12-2022/POW_05159166). The predecessor master thesis on integrating local and scientific weather forecast that was co-supervised by Spyros Paparrizos and Arnold Moene and was the main inspiration to develop the ML-CLIMATE project, was awarded the 1e NVBM scriptieprijs in 2022 from the *Nederlandse Vereniging ter Bevordering van de Meteorologie* (https://www.nvbm.nl/nieuws/janina-fraas-winnaar-1e-nvbm-scriptieprijs). An invited article is submitted on NVBM's Meteorologica journal.

Contact

Spyros Paparrizos
Assistant Professor Water & Climate Information Services (project manager)
spyros.paparrizos@wur.nl

Wageningen University & Research
P.O. Box 47
6700 AB Wageningen
The Netherlands
T +31 317 48 07 00
www.wur.eu

Project members
Prof. dr. Fulco Ludwig, *Water Systems and Global Change Group*
Samuel Sutanto, *Water Systems and Global Change Group*
Lisanne Nauta, *Water Systems and Global Change Group*
Imme Benedict, Meteorology and Air Quality
Arnold Moene, *Meteorology and Air Quality*