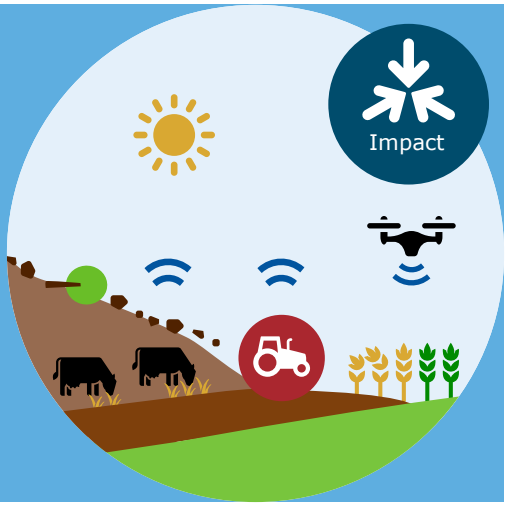
Predicting drought and heatwave effects

Novel algorithms for predicting future compound impacts

Emerging DS/AI methods



WAGENINGEN
UNIVERSITY & RESEARCH

Data Driven Discoveries in a changing climate (D3C2)

Objective: To develop algorithms for predicting the effects of drought and heatwaves, including compound effects.

Activities

In this project, we developed algorithms for predicting future drought and heatwave effects. This included the compound effects of both events. With a machine learning approach, we studied future drought and heatwave impacts under different shared socioeconomic pathway scenarios, which was never done before. To define drought hazard, we used the standardised 'soil moisture index'. Heatwaves were defined as an event during which both daily maximum and minimum air temperatures exceeded the corresponding climatological 90th percentile for three days or longer. By combining hazard indices, we quantified historical compound drought and heatwave effects. These included time series of reported impacts collected by ESC students, used as predictors and response variables and to train the algorithms.

Within the project, the ESC group collaborated with the CR group to develop machine learning algorithms that can predict the future (compound) drought and heatwave impacts.

Achievement

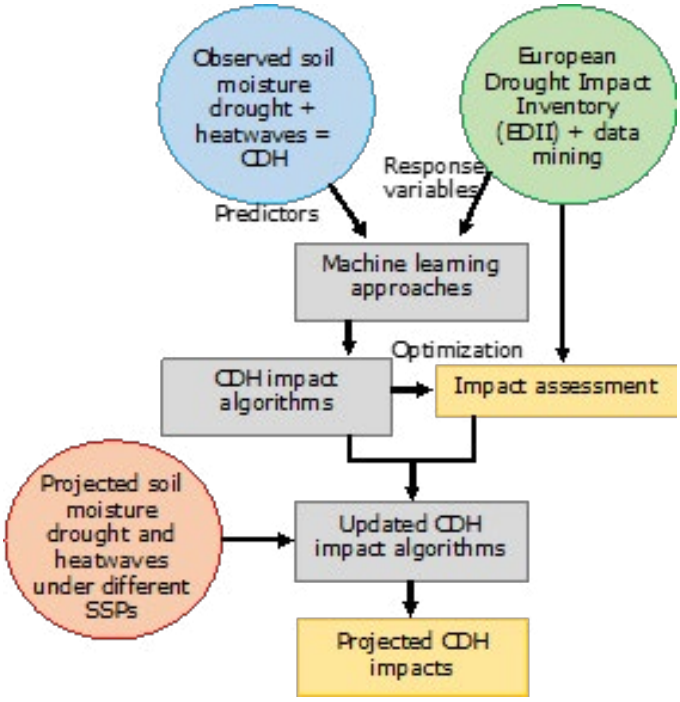
Our findings reveal that western Europe will experience higher compound and cascading events and southern Europe is anticipated to have longer-lasting of events of this kind. Moreover, we also developed machine learning algorithms to predict future drought impacts on economic, non-economic, and ecosystem sectors, as well as heatwave impact on human health and loss. Our models indicate that the occurrence of drought impacts will be longer by two months for economic and ecosystem sectors, and one month for non-economic sector. The impact of heatwave on human will increase quadruple under the highest scenario (SSP5-8.5). The findings from this project will increase the visibility of WUR in leading the multi-hazard impact prediction research. This research will also help us to foster develop a multi-hazard early warning system that predicts not only hazards but also their impacts.

In term of cross learning between data science/AI and natural hazard domain, we have demonstrated that the machine learning models/AI can assist scientists working in the field of natural hazard to predict the impacts of hazards. This is still missing in the prediction of hazards. Many studies only predict the occurrence of natural hazards and ignoring their impacts. Information on the impacts of hazards is crucial for climate adaptation, as these impacts are the ones that we want to prepare for. This project showcased how ML/AI knowledge can be utilised to fill the gap in predicting the impacts of natural hazards.

Outlook

We have established a strong collaboration between ESC and CR groups, and we are looking forward to expanding our collaboration for another project. The method used in this research will be used as a basis for our newly NWO funded project, LODESTAR. We also intend to write follow-up NWO-M and Horizon EU proposals.

The conceptual framework of the project:



Deliverables

- machine learning algorithms for predicting future compound drought and heatwave impacts available in an open-source repository (in the final stage and will be available at WUR GitHub);
- an interactive story map consisting of updated impact databases for Europe aimed at professionals and climate adaptation planners (will be online soon at ESC website);
- presentation at the thematic IAHS conference;
- a scientific documentation (paper) on the development of compound drought and heatwave impact algorithms, using the machine learning technique (the paper 'Compound and cascading drought and heatwave impacts in Europe under global warming' will be submitted soon).

Lessons learned

We have learned that prediction of drought and heatwaves including the compound events is possible with the use of ML model. However, the performance of the ML is strongly influenced by the amount of impact data, which is the main issue for Europe. Therefore, we developed the ML models only for Germany. While doing so, collaboration between ESC and CR groups on climate related topic is deepened. We aim to continue working together in developing a future NWO/Horizon EU proposal.

Finally, we would like to emphasise that a wildcard is still needed to facilitate the publication fee of the findings. A paper usually will be submitted after all analyses were done, which is in the end of the project. Also, it can be used for dissemination.

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