AI techniques to evaluate the effectiveness of nature-based solutions in reducing urban heat islands

Emerging DS/AI methods

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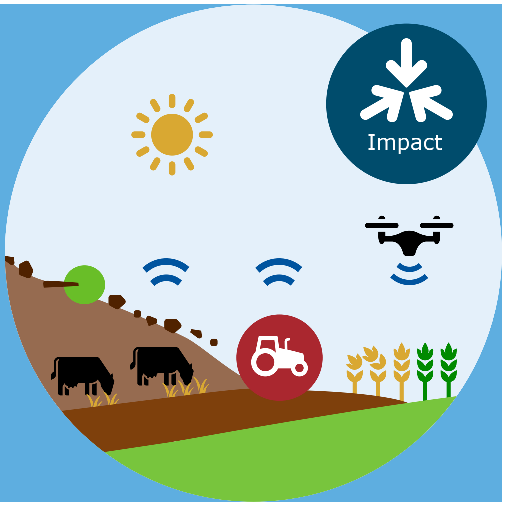
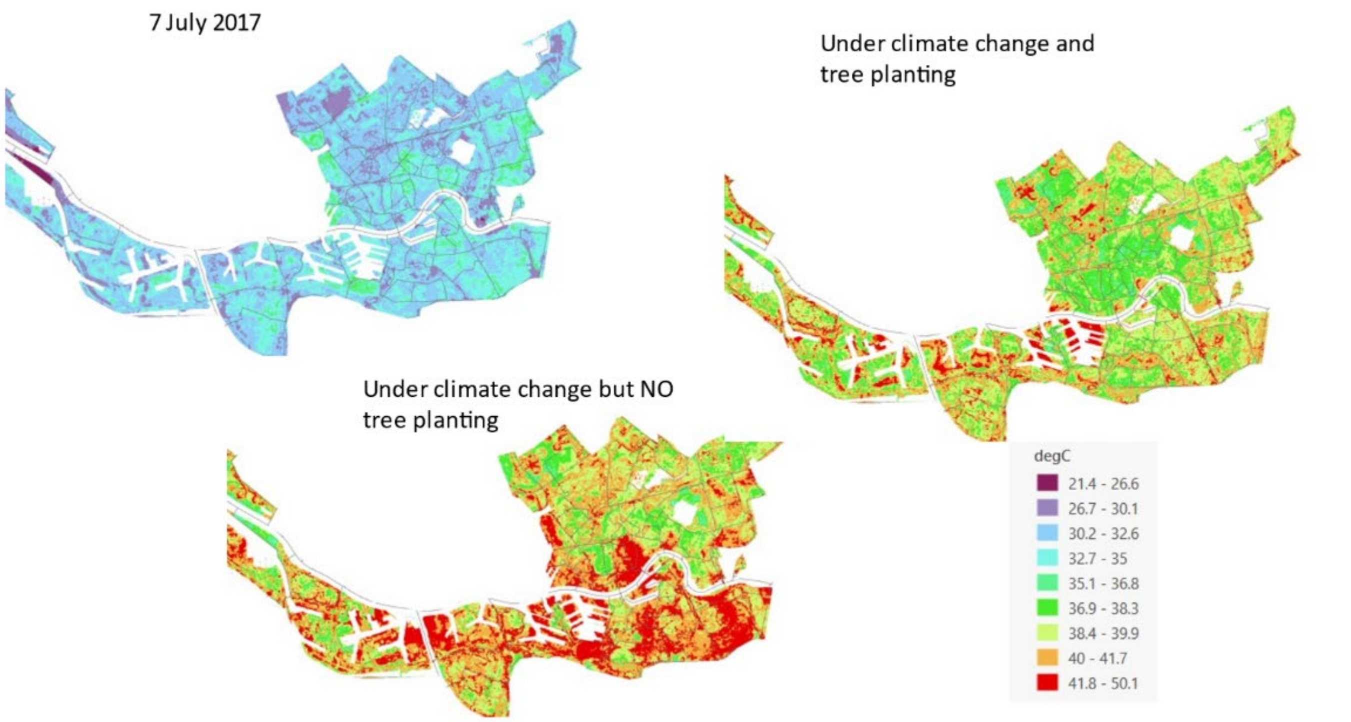


Data Driven Discoveries in a changing climate (D3C2)

Goal: Developing an AI-assisted rapid assessment method for the cooling effect of urban greening efforts, based on open source data.

Modelling the Urban Heat Island effect (UHI) has been done before using a computing power-intensive model (e.g. the model on klimaateffectatlas.nl). We see the potential for a rapid assessment method to calculate current UHI, and to predict the UHI mitigating effectiveness of urban greening plans. This model could be used for local governments to value investments in urban green space expansion, and could also show the local effects of urban greening.

We chose the city of Rotterdam as a case study. This municipality has a large area and, in addition, concrete plans for large scale urban greening in the next ten years. We selected and refined data for surface temperature, vegetation cover index and weather data to train the model. The model is based on the XGBoost (Extreme gradient boosting) algorithm, a machine learning algorithm that uses a gradient boosting framework to create a highly accurate predictive model. The algorithm works by combining multiple decision trees in a process called boosting, where each tree is built based on the errors of the previous tree. The idea is to learn from the mistakes of previous models and gradually improve the accuracy of the final model.



We formulated a scenario where the city doubles its tree coverage in areas where tree canopy cover is below 30% (referring to the 3-30-300 rule by Cecil Konijnendijk). We tested the effect of urban greening for three summer days in the period 2017-2019, and under climate change scenarios.

Reflection

Combining AI modelling with scenarios from real life in a short time span provides difficulties. Even though the used model can be used to handle complex and diverse datasets, the link with real-life policy and the urban planning practice is hard to achieve. Planting trees in urban settings is challenging due to various space claims in the urban fabric. The placement of urban trees for heat mitigation comes down to an accuracy of several meters to achieve heat reduction in buildings or in public space. This level of detail could not be taken into account in our scenarios due to time constraints. It also proved to be difficult to include planned greening efforts in the model, since even the largest additions of urban parks do not come close to reaching the preferred 30% tree canopy cover.

We initially aimed for including amateur weather data in the model to increase accuracy on a city scale. Due to the available data lacking in quality, this turned out to be unfeasible. The created model can be fine-tuned to get rid of anomalies (tree planting increasing land surface temperature?!).

The discussions in the team, where domain knowledge on urban green, soil and water, meteorology and machine learning was combined, proved to be very useful. We gained insights on the added value of AI methods, seeing that large parts of urban climate adaptation mechanisms have been extensively modelled in the Netherlands.

The use of AI combined with open-source remote sensing data has potential to model low-data areas. We also learned that depending on the scarce colleagues with sufficient knowledge on machine learning and AI is a bottleneck in applying these techniques in WUR projects.

Lessons learned
- Machine learning can be used to rapidly assess some climate change impacts on large areas without the need of supercomputers.
- The collaboration of data scientists with domain experts, and between WU and WR teams is essential to be able to model the mechanisms of climate change adaptation.
- Within the given timespan, it proved impossible to combine amateur weather data and spatial greening plans into the model.
- The limited number of AI and Machine learning experts proves to be a bottleneck in working on the nexus of data science and domain knowledge.

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