A framework to predict start and end of future cropping seasons: potential and limitations

Massimo Tolomio[1], Majid Ali Magham[1], Bernardo Maestrini[2], Gerbert Roerink[3], Ponraj Arumugam[4]

[1] Plant Production Systems, [2] Agrosystems, [3] Earth Observation and Environmental Informatics, [4] Climate Resilience

Background

Farmers adapt start, end and duration of the cropping season to climate change. Crop modelers often use simple rule-based approaches to set the beginning of the cropping season under future climate. But does this represent what happens in practice in the field? How much does the farmers' decision depend on weather and environmental variables? What is their predictive power using a data-driven approach?

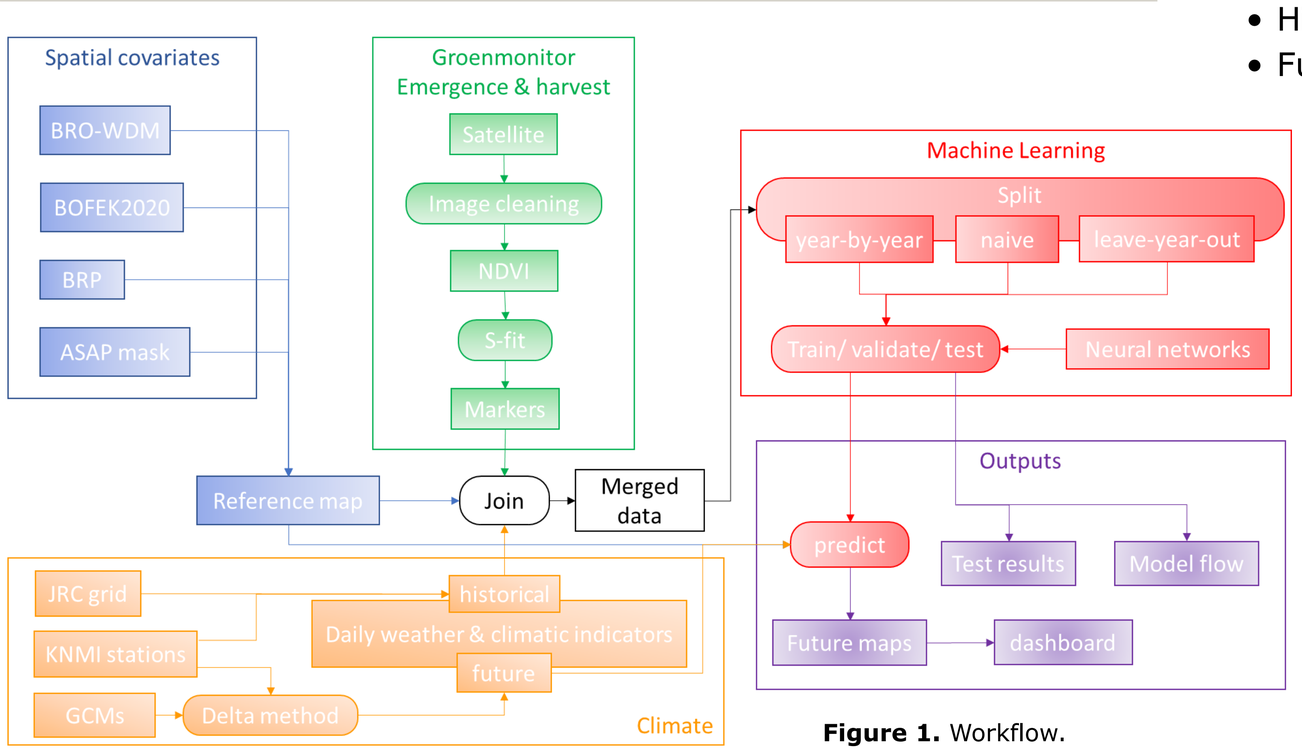

Figure 1. Workflow.

Methods

Input – spatial covariates

- Topsoil class (BOFEK2020)
- Groundwater class (BRO-WDM)
- BRP (crop and preceding crop)
- ASAP crop mask (base map)

Input – time series

- Historical weather data (KNMI & JRC).
- Future weather from GCMs.

Target – markers

- From Groenmonitor (https://www.groenmonitor.nl/)
- Emergence dates
- Harvest dates

Data-driven model

- Convolutional Neural Networks
- Split data in:
  - Year-by-year (1 model per year)
  - Naive (random split)
  - Leave-year-out (unseen year as test)
- Train and test.
- Predict with future weather.
- Visualize in dashboard.

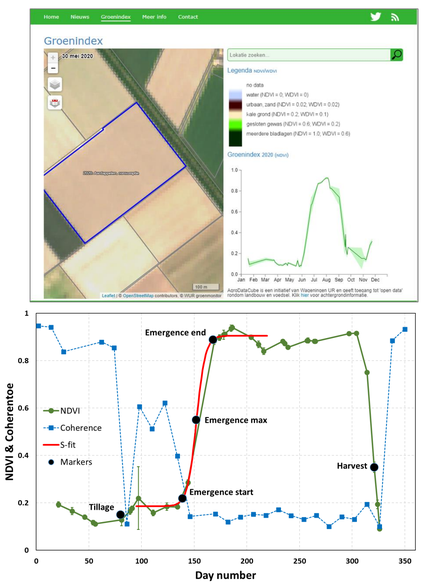

Figure 2. Groenmonitor and S-fit.

Results

Metric	Split	Emergence			Harvest		
		Year-by-Year	Naive	Leave-year-out	Year-by-year	Naive	Leave-year-out
RMSE		7.39	7.36	9.39	21.44	21.73	24.41
R^2		0.29	0.30	-0.16	0.12	0.11	-0.11
MAPE		5.38	5.40	7.27	16.13	16.48	19.12

Table 1. Model performance on the test set.

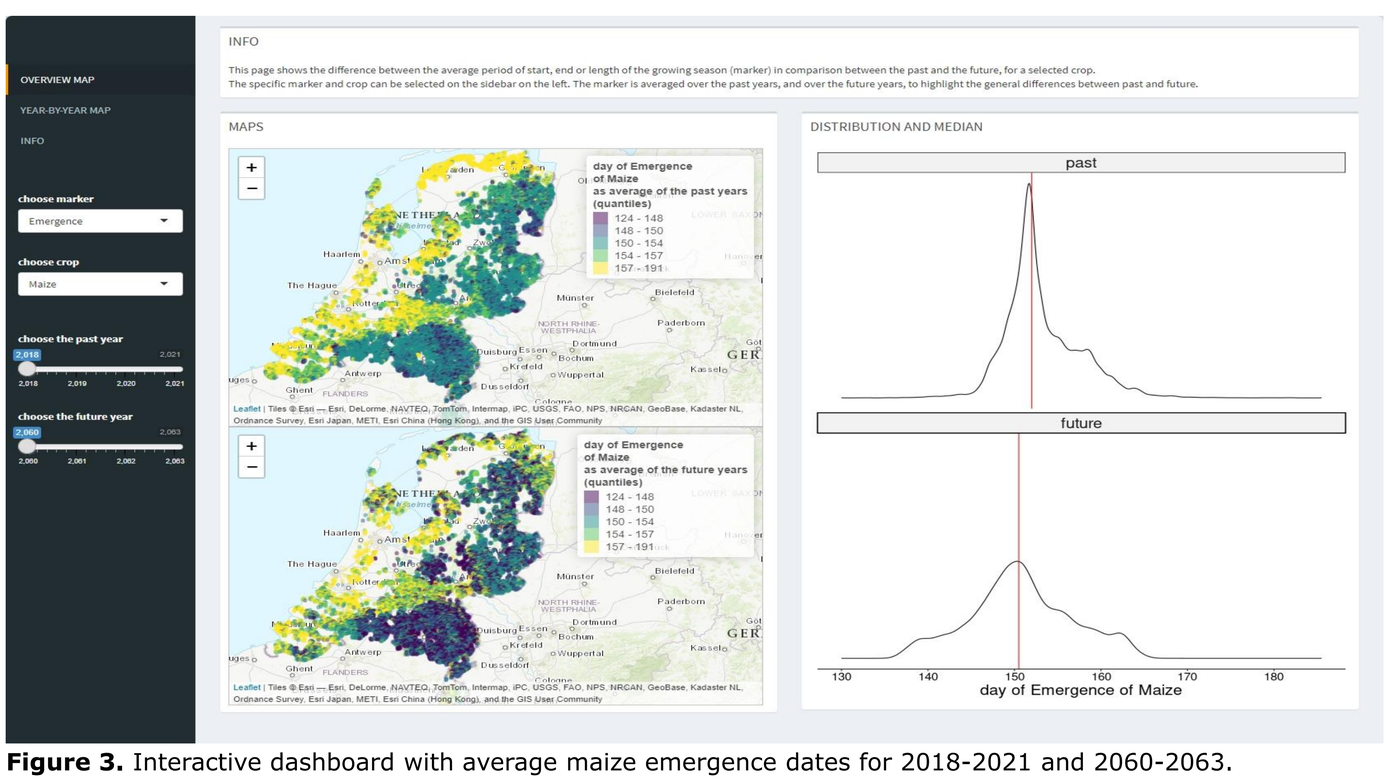

Figure 3. Interactive dashboard with average maize emergence dates for 2018-2021 and 2060-2063.

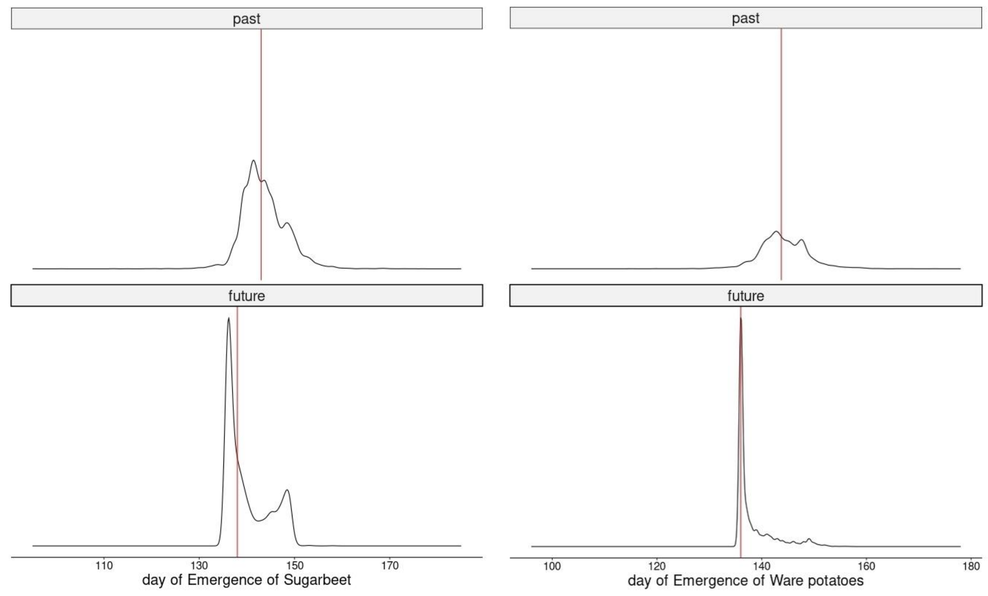

Figure 4. distribution of average emergence dates for sugar beet and ware potatoes for 2018-2021 and 2060-2063.

Conclusions

- System can be improved with more years, as they become available. "Year effect" matters.
- Low explanatory power, but in line with other studies.
- Neural networks don't perform well outside the range of the training data.
- Accurate predictions in the far future are likely not feasible.

Wageningen University & Research
P.O. Box 123, 6700 AB Wageningen
Contact: massimo.tolomio@wur.nl
M +31 (0)6 42 81 30 42