RAGWEED POLLEN FORECAST IN THE PANNONIAN BIOGEOGRAPHICAL REGION: LESSONS LEARNED

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Ragweed (*Ambrosia artemisiifolia*)

First appeared in Hungary in 1920

and it has found an optimal habitat in the PBR

Illustration: Zsuzsanna Abonyi

1980

For many decades the population was unaware of the allergic burden of ragweed pollen

Nowadays

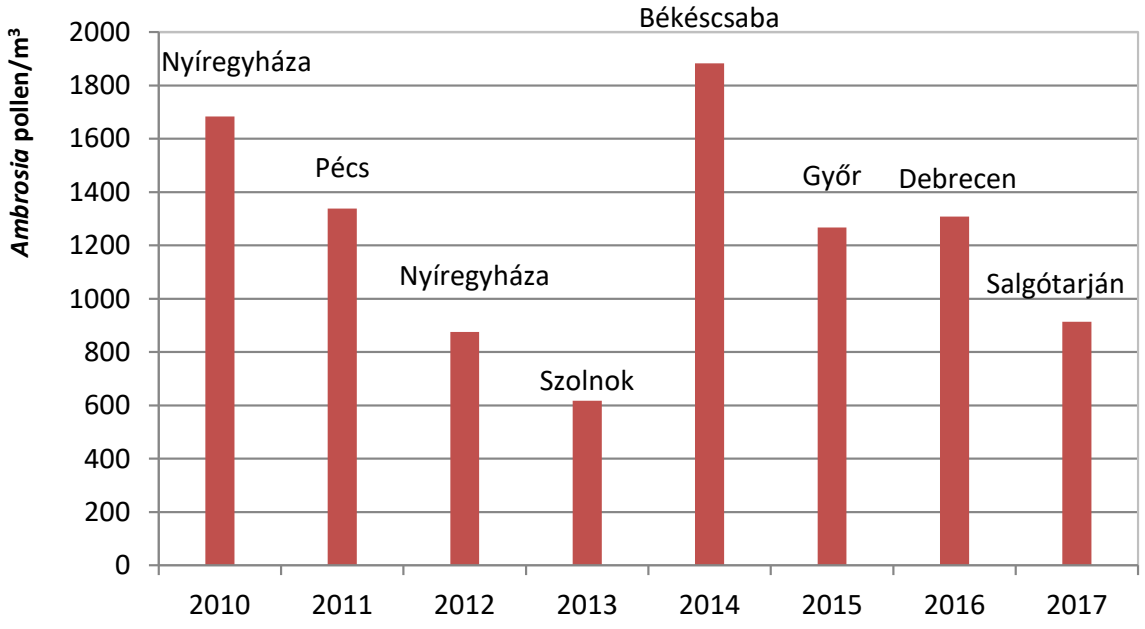
-common ragweed is a major concern of public health and agriculture in the Pannonian Biogeographical Region (PBR).

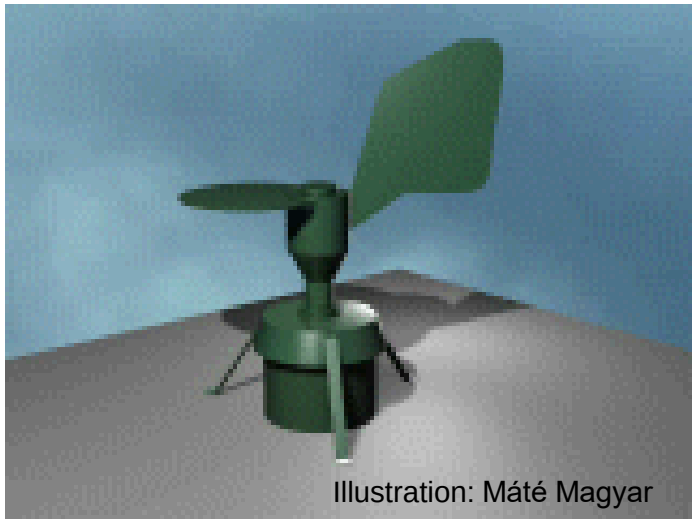
-ragweed pollen affects approximately 15-20% of the population
-5 million hectares (~85%) of the Hungarian agricultural area are endangered by ragweed. Around 0.7 million hectares are strongly infected by ragweed. It is 7.5 % of the total Hungarian territory.

-The estimated value of the yield loss, the cost of control and the health expenses sum up a total of 500 million Euro yearly.


Photo: Gergely Mányoki

Highest levels of *Ambrosia* pollen concentrations in Hungary



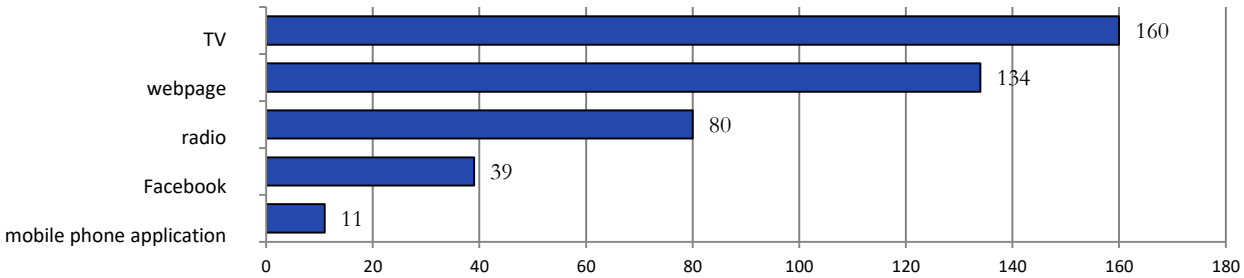


Methods:

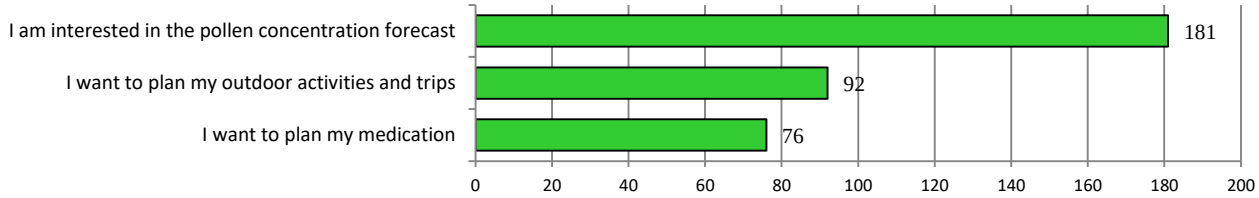
-pollen montoring with 7-day Hirst type pollen trap
-started more than 30 years ago in Hungary. Since then, the Seasonal Pollen Index of this plant show an increasing tendency.

93% of the allergic patients (263) regularly follows pollen information in Hungary.

- How do you follow pollen information?



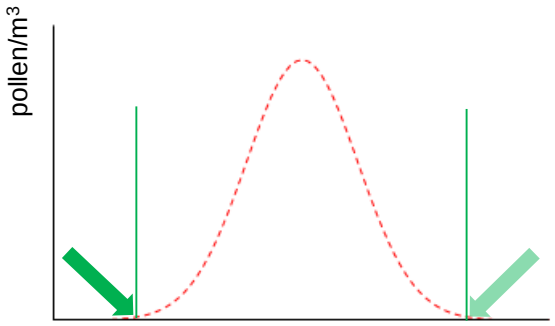
- Why are you following pollen information?



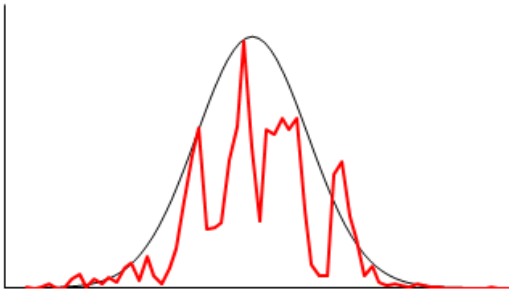
Szigeti, T.; Magyar D. (2019) Do people know enough about pollen information in Hungary? CEJOEM

Types of ragwed pollen forecast

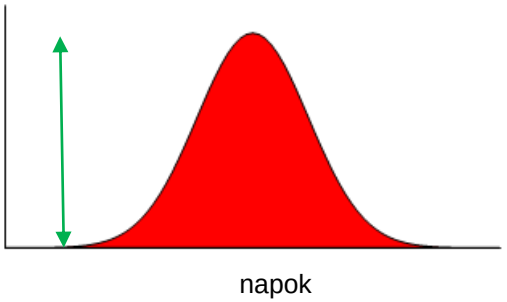
The start of the season
The end of the season



The pollen concentration of the next 2-3 days



The strength of the forecast



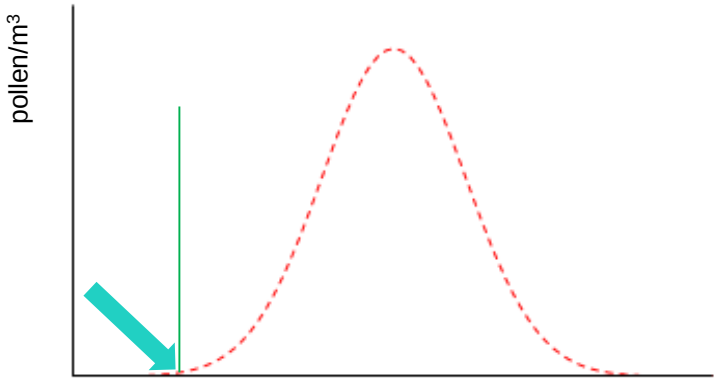
When does the pollen season start?

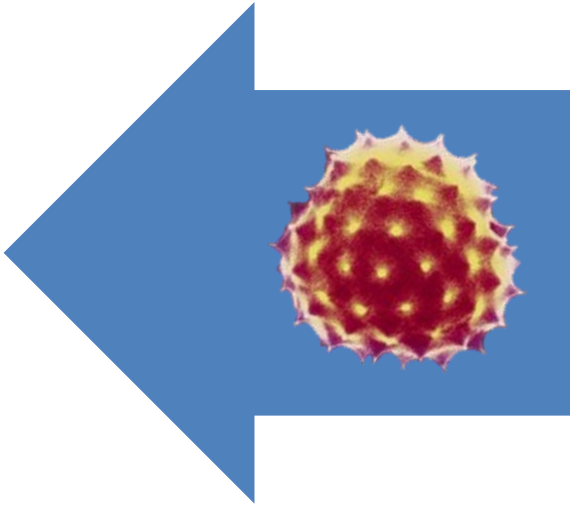
When will it end?

What can I expect in the coming days?

Will the pollen season be strong?

Forecasting the start of the pollen season

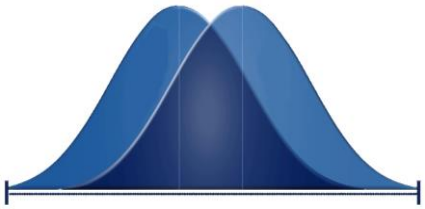




Why do we need it?

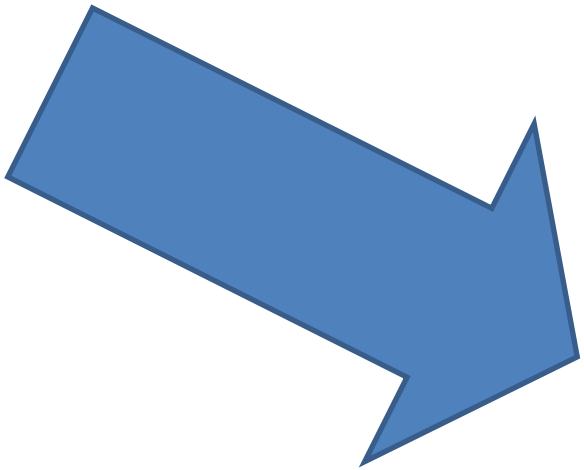
Informing paients to take preventive measures, visit doctors. etc. (in middle July).

Allergic patients and doctors need information about the onset of the season in order to start the intake of preventive medication two weeks ahead of the appearance of symptoms (10 pollen/m^3/day).



The positioning of the ragweed season to the start date is important for the calculation of a reliable forecast for the first weeks.

Ragweed season start
15 different definitions



EAACI
EUROPEAN academy OF ALLERGY AND CLINICAL IMMUNOLOGY

Pfaar et al. 2017

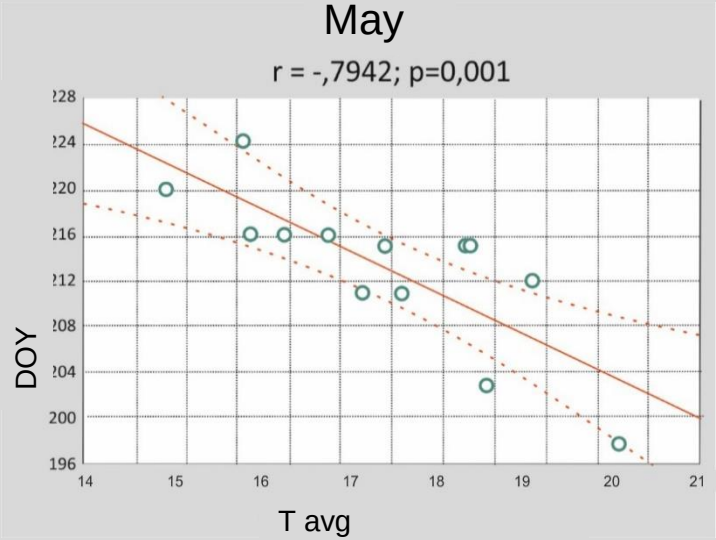
„ragweed pollen season starts on the first day of 5 days (out of seven consecutive days) with each of these 5 days ≥3 pollen/m^3 and with a sum of these 5 days of ≥ 30 pollen/m^3 and ends on the last days fulfilling the same requirements”

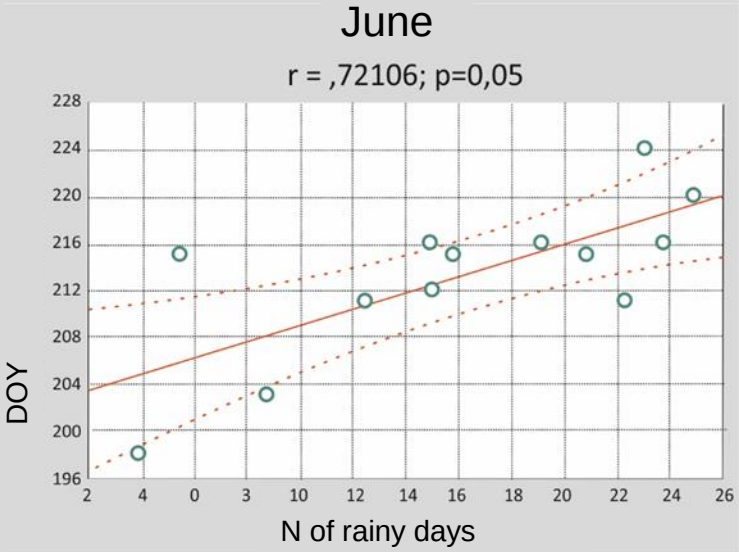
Several attempts have been made to predict the start of the ragweed season

(including COPERNICUS and EFOP1.8.0.projects):

- Testing already existing models
- New, temporal pattern method
- Phenological observations

Correlation analysis on 13 yrs data





Predicted: 29 July 2022
Actual: 28 July 2022

Bátki et al. 2013

Temporal pattern method

Delay in the start of the pollen season in each monitoring stations

Leelőssy Á, Magyar D. és mtsaik 2020

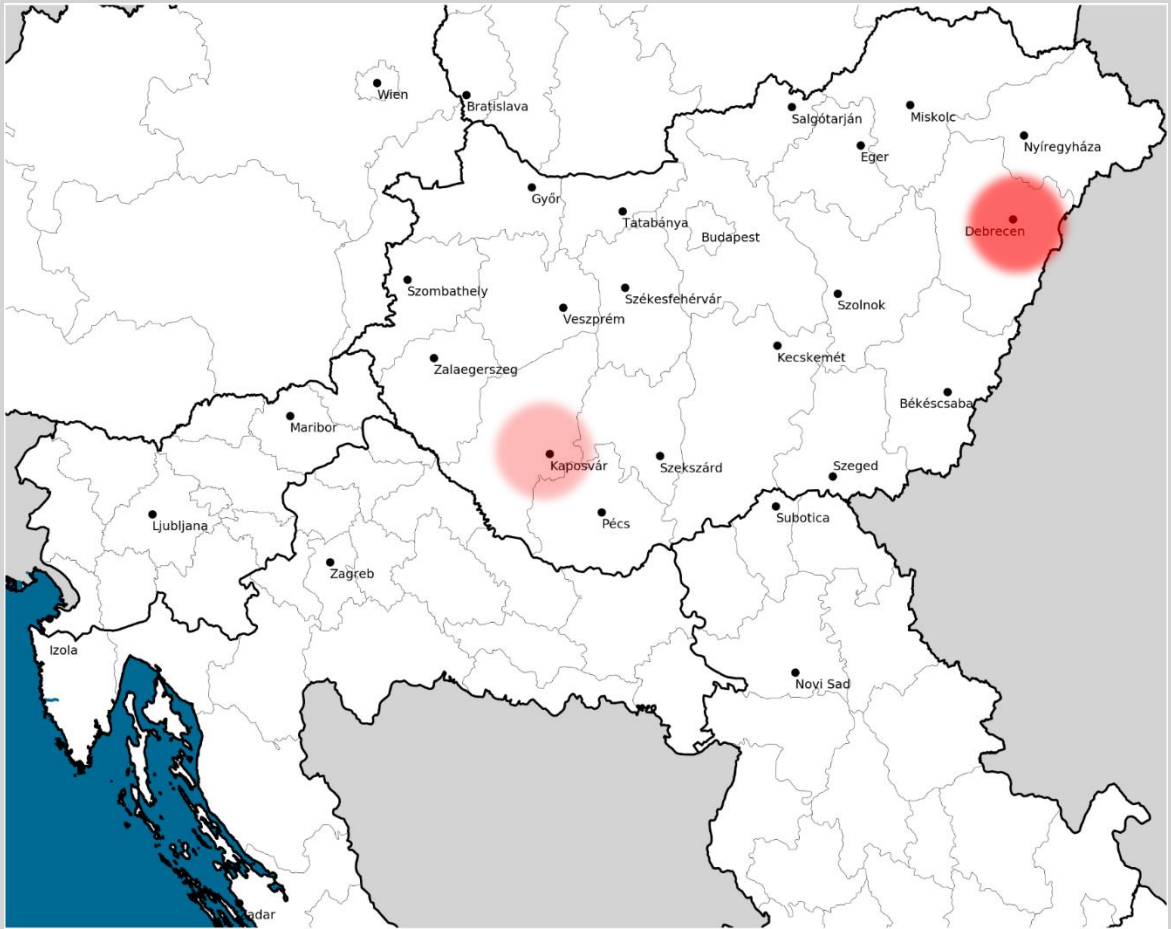
The analyses show that

The time difference between the start of the season of any two stations varies in 2-3 weeks.

the earliest start of the season was 9 times in Hungary in the PBR in the last 10 years

4 times in Debrecen and twice in Kaposvár.

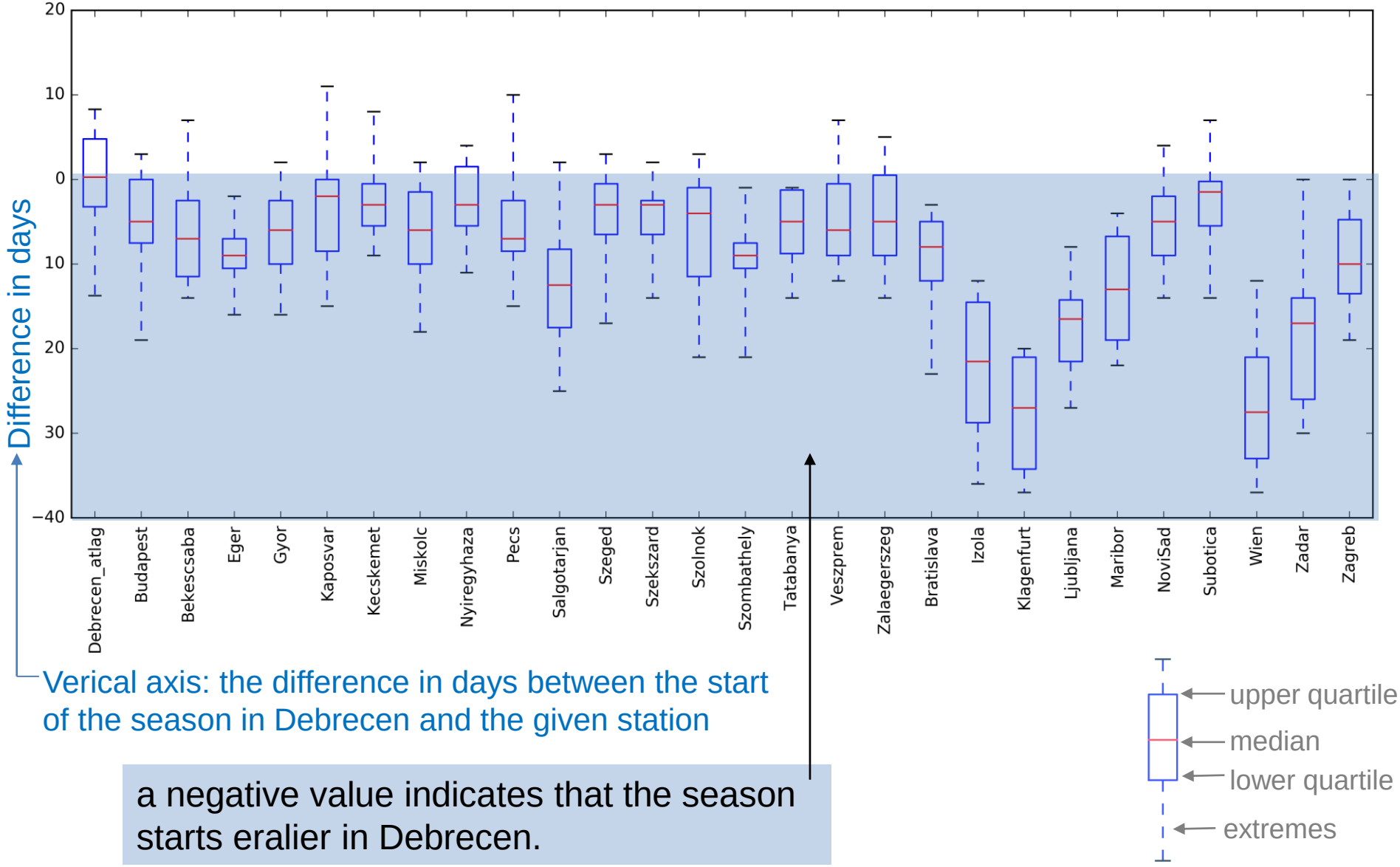
Leelőssy et al. 2021



LESSON LEARNED:

the date of the start of the ragweed pollen season does not increase according to latitude from south to north.

Differences in the start of the ragweed pollen seasons in Debrecen compared to other stations, 2009-2018

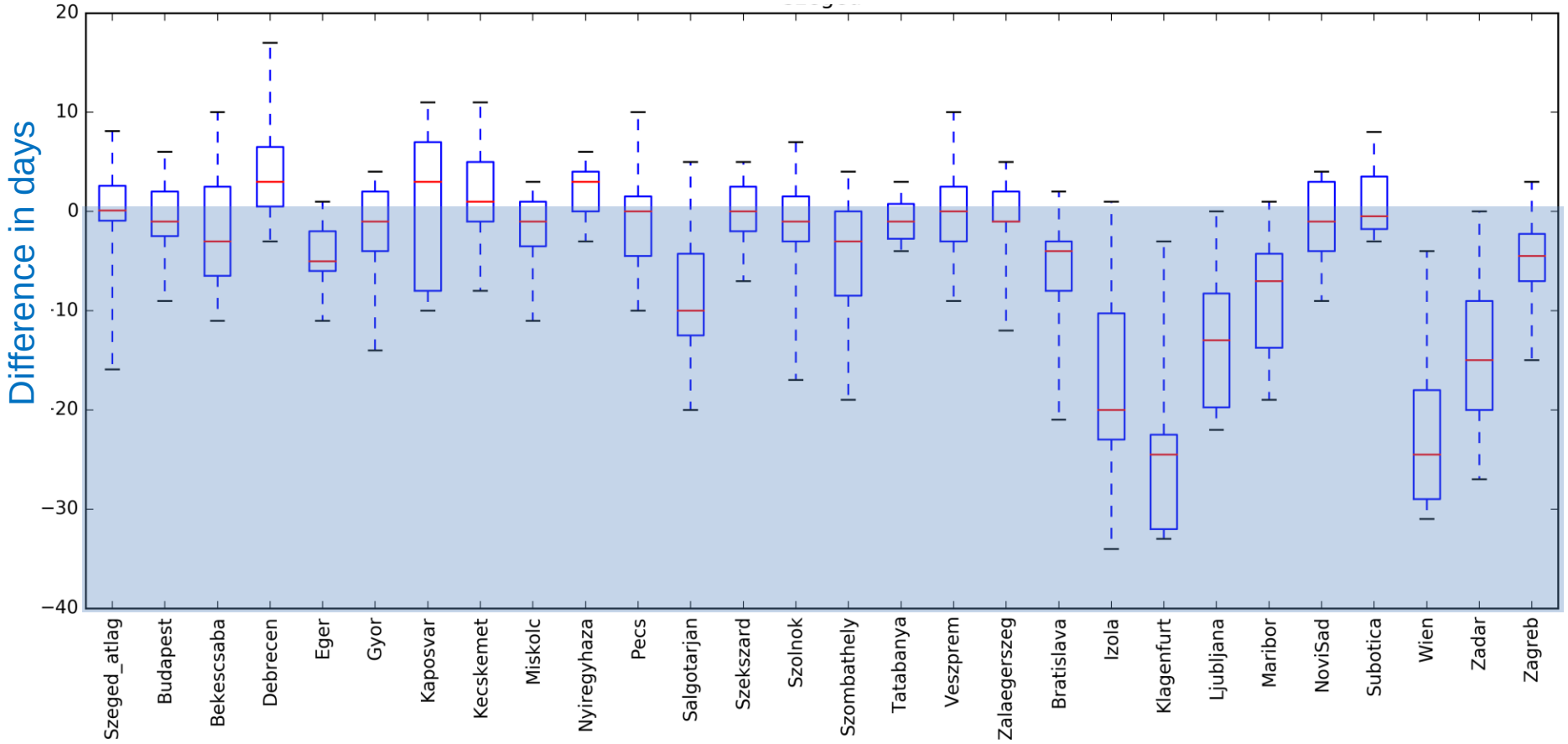


Verical axis: the difference in days between the start of the season in Debrecen and the given station

a negative value indicates that the season starts eralier in Debrecen.

Leelőssy et al. 2021

Szeged (the southern station in Hungary)

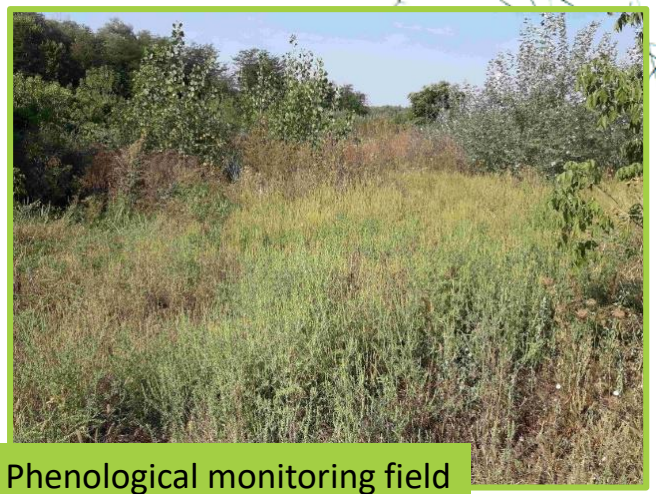


collaboration of two national networks to enable a precise prediction of pollen seasons' start

pollen data (daily)

phenological data
2 (1) weekly

Pollen monitoring station, Pécs (Photo: D. Magyar



Phenological monitoring field Kiszombor -Makó (S. Görbe) (Photo: E. Simon-Csete)

Most of the dates for the start of the season fall within the same five-day period, between 27-31 July.

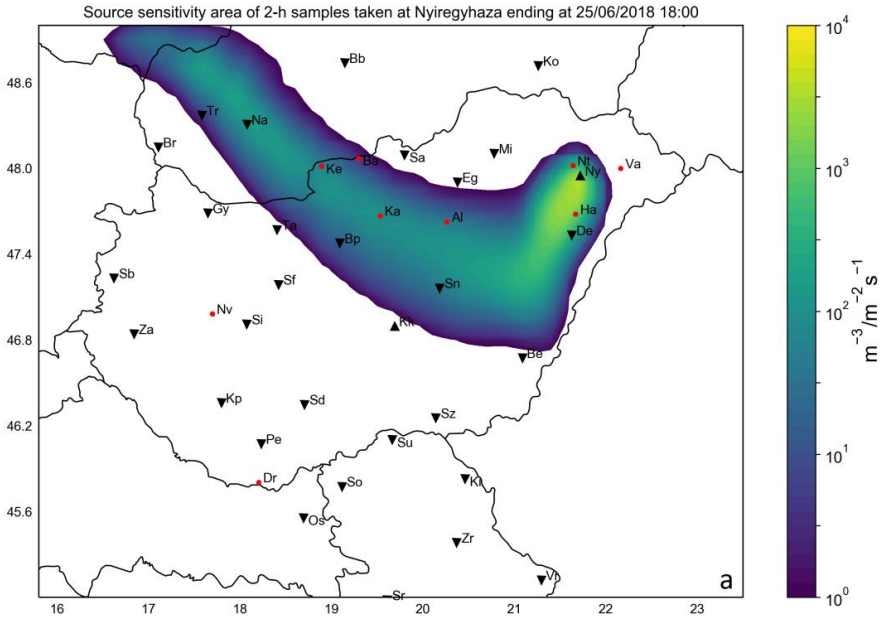
however anomalies were also detected…

Leelőssy et al. 2021

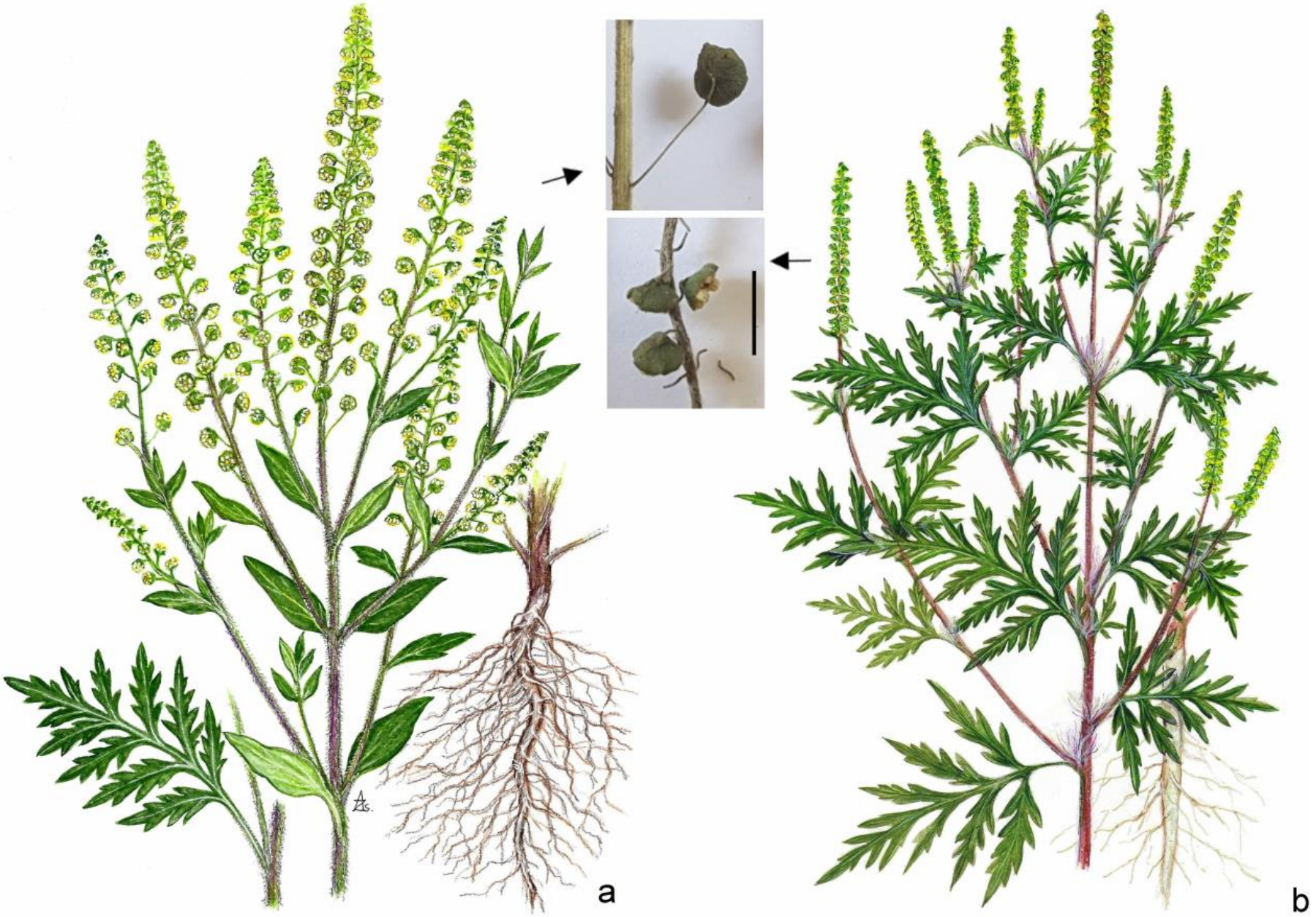
Extremely early peaks of pollen concentrations were observed at several air monitoring stations in Hungary in June 2017 and 2018, **one month before the usual onset.**

During the nationwide field surveys, **early blooming ragweed plants** were found, mostly in North-East Hungary.

These field observations matched with the **local source** areas identified by trajectory analyses.



Magyar D, Leelőssy Á, Novák R et al. 2022 *Int.J. Biometeorol*.



rare, early flowering morphotype

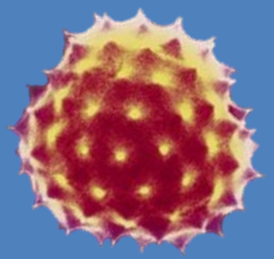
common morphotype

drawings: Z. Abonyi, photo: D. Magyar, collected by: M. Nagy

early flowering was developed as a result of herbicide-induced stress

Collected by: C. Doma; photo, drawing: D. Magyar

Short terms (2-3 days) pollen forecast



During the main season the short-term (i.e. 3 days) ragweed pollen forecast is crucial –this information can be achieved by different methods.

Calendar-based method
Forecast models

- observaton-based: Neural Network (Csépe et al.
- Source based:… (Leelőssy et al. …

Calendar-based method

Averages and 10-90th percentiles of ragweed pollen levels for 15 years

- moving average used to smooth the graph.
- the values at the start and end of the modelled season become too high and the peak period too low.
- Modification: adjusted accordig the weather: 90th percentile is chosen if there is hot, dry and windy weather (optimal for pollen release)
- 10th percentile: in rainly weather.
- **It is useful in the first 3 weeks of the season.**

Springer Link

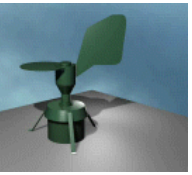
Original Paper | Open Access | Published: 09 November 2019

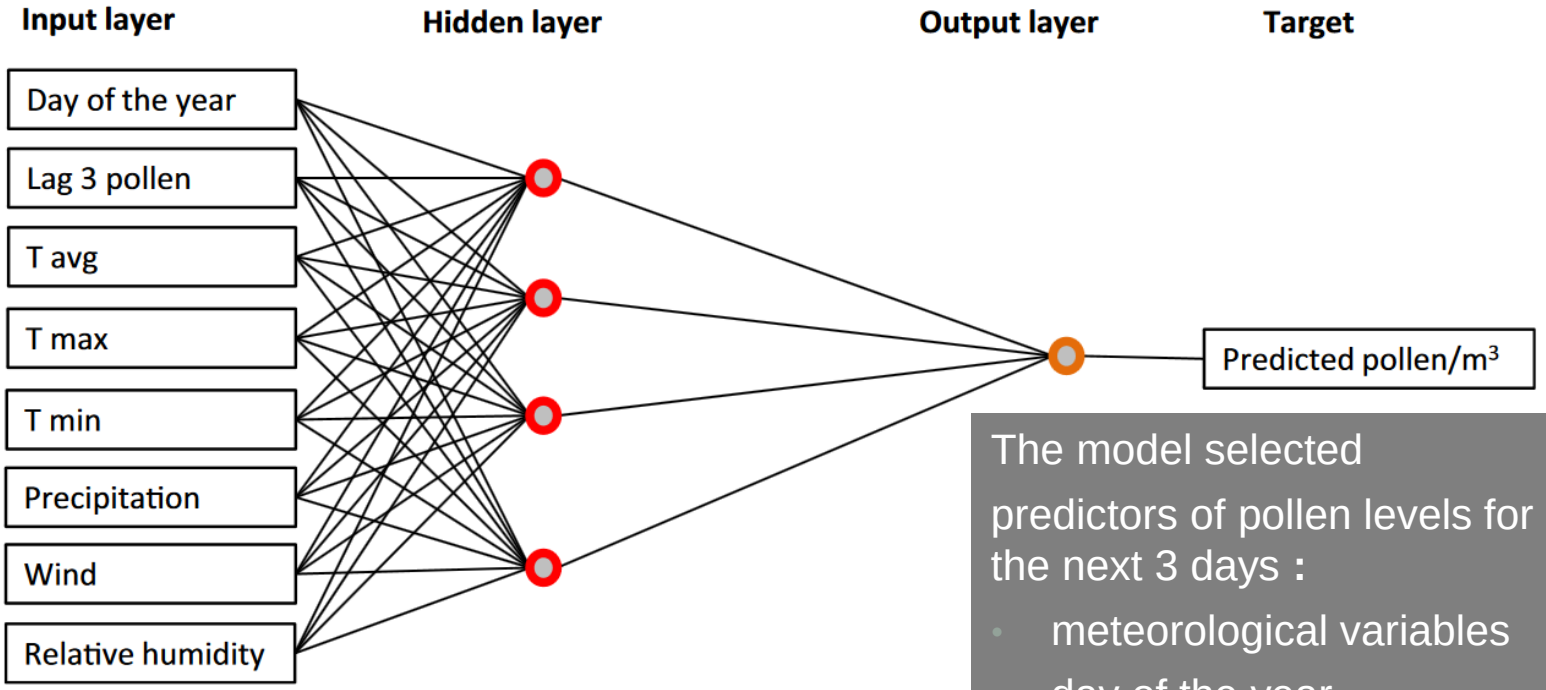
The application of a neural network-based ragweed pollen forecast by the Ragweed Pollen Alarm System in the Pannonian biogeographical region

Z. Csépe, Á. Leelőssy, [...] D. Magyar

Aerobiologia **36**, 131–140(2020) | Cite this article

10-year long pollen dataset were selected for training a multilayer perceptron model

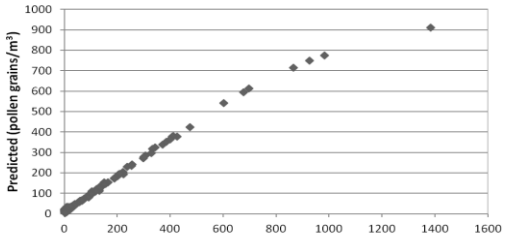
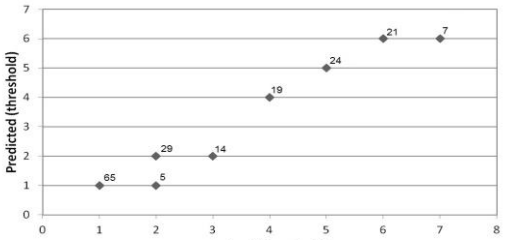
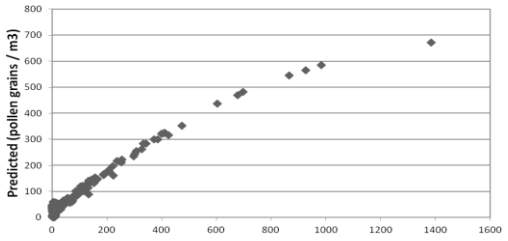
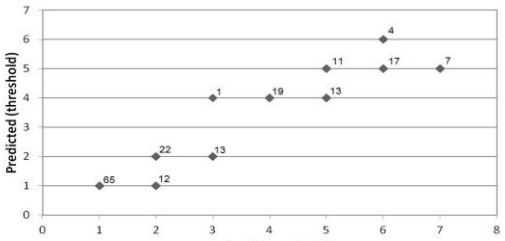
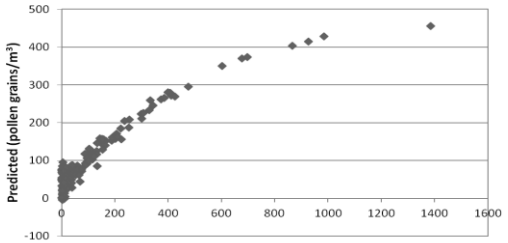
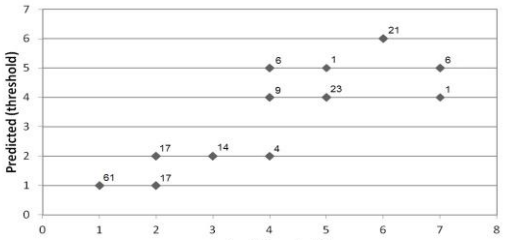
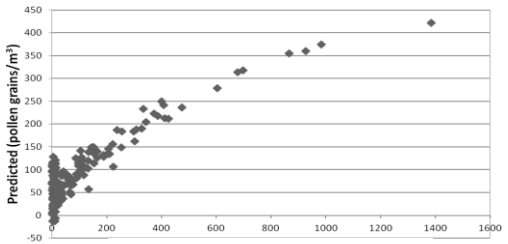
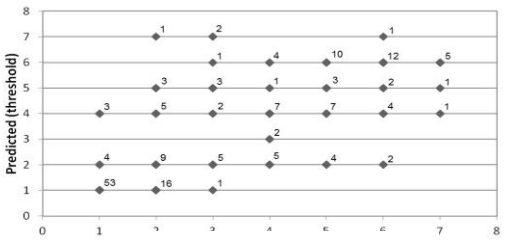




The model selected predictors of pollen levels for the next 3 days :

- meteorological variables
- day of the year
- 3 -day Lag pollen data

Effect of 1 to 7-day Lag pollen concentration data on forecasted

	concentrations	categories
Lag1		
Lag3		
Lag5		
Lag7		

LESSON LEARNED

Lag3 pollen data give acceptable forecast results

Sending pollen data to the center for calculations 2 times a week is practicable

Source-based model

1. Emission model
   - Abundance map (Skjøth et al. 2019)
   - Seasonal phenology (based on the 2009-2016 mean pollen observations)
   - Diurnal cycle (Prank-Martin)
   - Wind speed and precipitation (GFS)

   → Provides dimensionless (relative) spatio-temporal emission pattern
2. Dispersion model
   - Lagrangian dispersion model (RAPTOR) powered by GFS meteorology
   - 0.25° spatial and 1 h temporal resolution

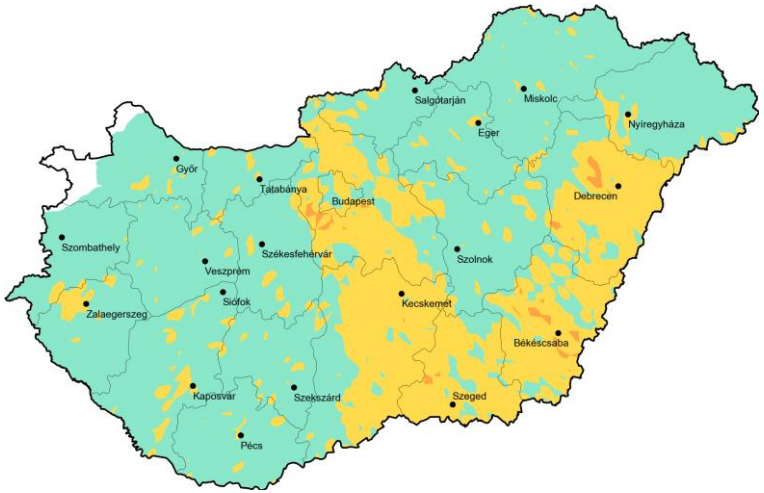
   → Provides dimensionless (relative) spatio-temporal concentration pattern
3. Calibration
   - Bias-correcting the prediction with the latest available observations

   → Quantifies (gives dimension to) the dispersion model result
4. Fine-resolution spatial weighting
   - Introduce variability in grid cells by weighting with fine-resolution abundance map

Leelőssy 2018

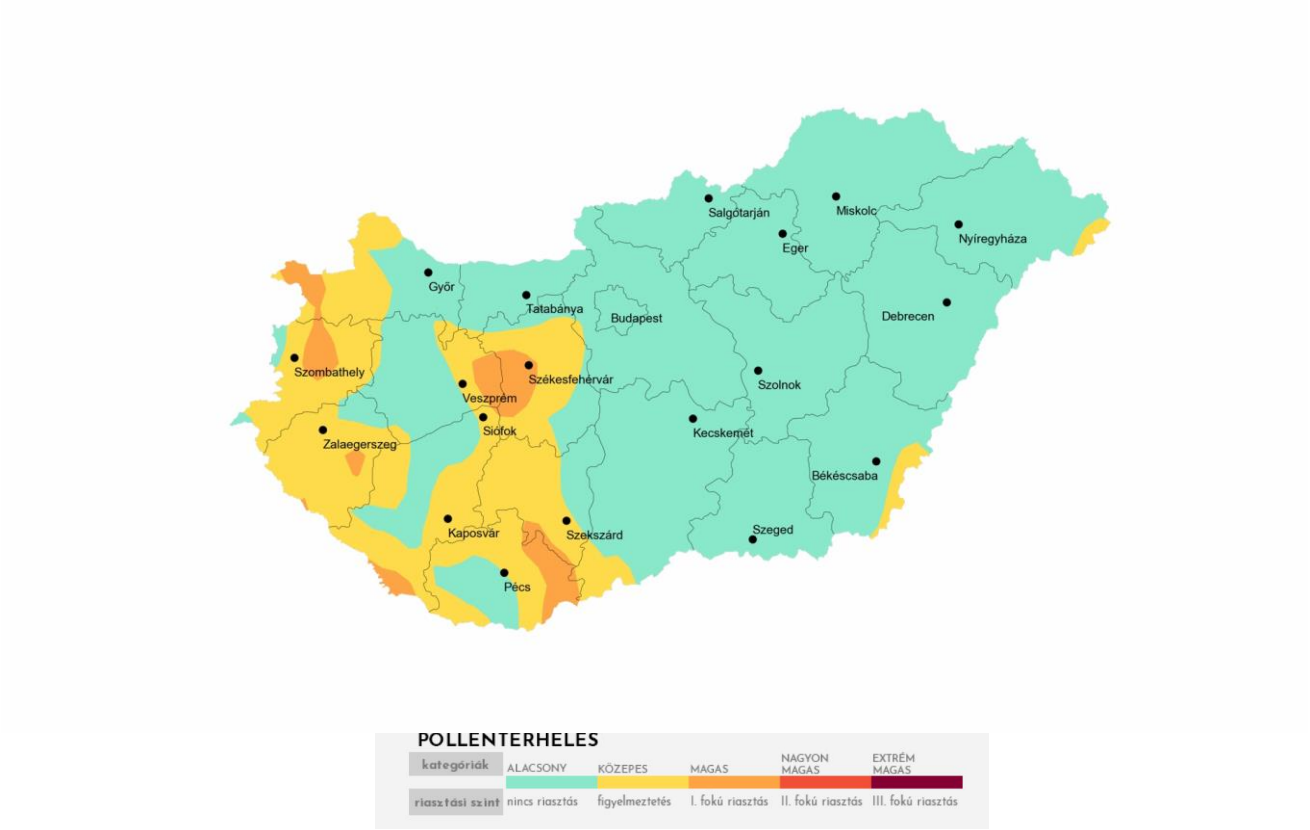
source-based model

forecast on the map

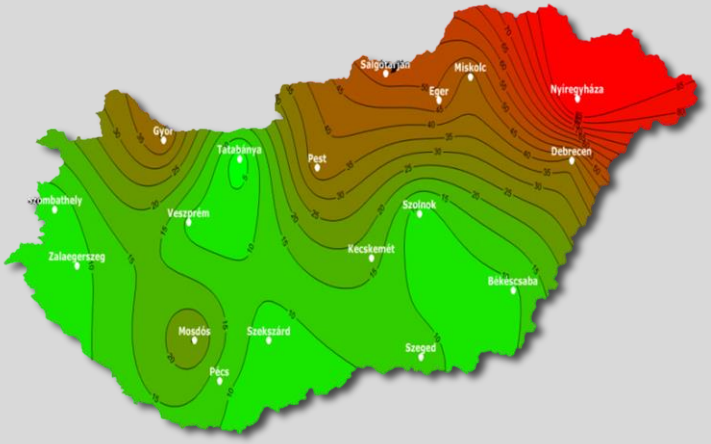


source-based model

hourly forecast



Interpolation errors occur due to missing data (monitoring stations) along the Hungarian bounder.



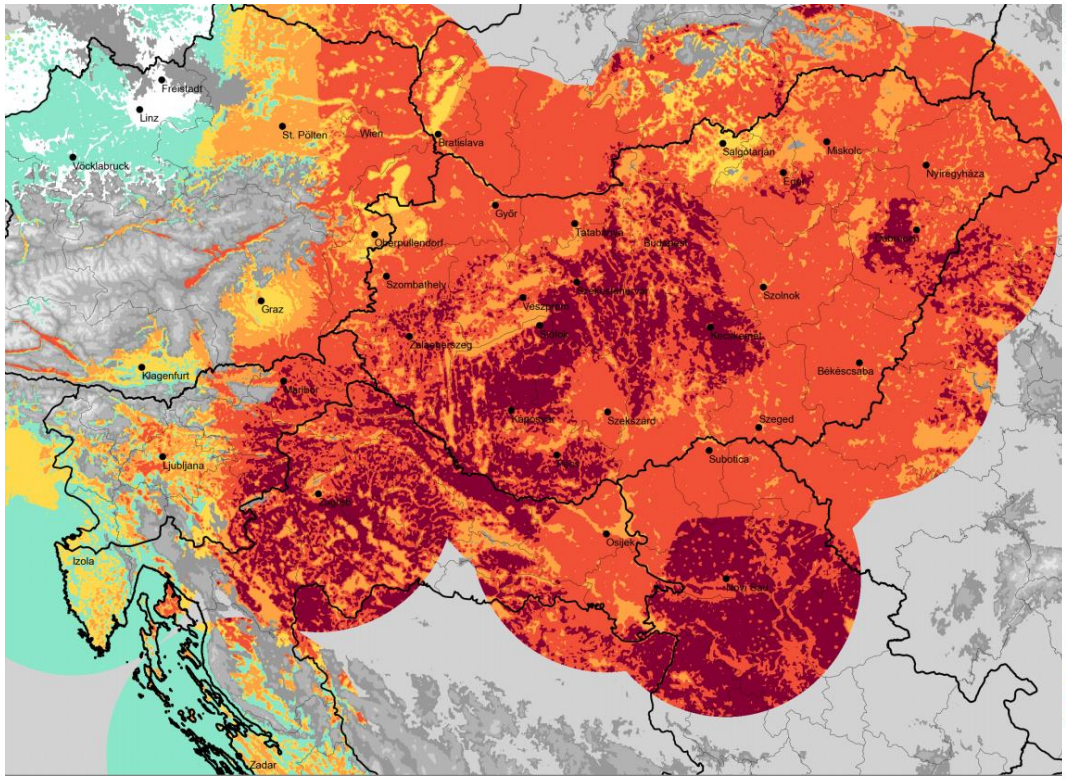
Root Mean Square Error of the interpolation

LESSON LEARNED:
Pollen do not respect borders.

This can be corrected by adding measurement data beyond the boundary.

Ragweed Pollen Alarm System

https://www.oki.hu/projektek/r-pas



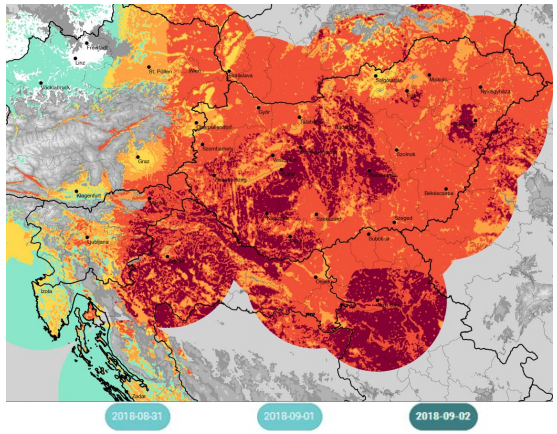
Nemzetközi Parlagfű Pollen Riasztási Rendszer

Ragweed Pollen Alarm System (R-PAS)

A Nemzetközi Parlagfű Pollen Riasztási Rendszer egyetemek, állami intézetek és kutatóközpontok együttműködésével jött létre annak érdekében, hogy az Európában a parlagfű által egyik legjobban fertőzött területen, a Pannon biogeográfiai régióban polleninformációt szolgáltasson különböző célcsoportok (lakosság, döntéshozók) számára. Az együttműködés az Országos Közegészségügyi Intézet kezdeményezésével alakult 2014-ben. Az ideális érési kezdődően a napi parlagfű pollenkoncentráció előrejelzése készítése térképeken érhető el. Az egyszerű és informatív kockázatkommunikáció érdekében a térképeken a tűrési küszöbértékeknek megfelelő kategóriák kerülnek feltüntetésre. A térképek hetente kétszer (kedden és pénteken) frissülnek.

R-PAS is a joint collaboration among universities, public institutes and research centers to supply pollen information for different target groups (i.e. public, stakeholders) in the Pannonian biogeographical region, the hot spot of ragweed infestation in Europe. R-PAS was initiated by the National Public Health Institute in 2014. Recently, R-PAS provides daily ragweed pollen concentration forecast on a high resolution map. Categories based on symptom threshold values are depicted on the maps, in order to achieve a clear, simple and informative way of risk communication. The forecast maps are generated twice a week (Tuesday and Friday).

Aktuális előrejelzés / Recent forecast maps



nincs adat
nincs pollen a levegőben
alacsony
közepes
magas
nagyon magas
extrém magas

"figyelmeztetés"
"I. fokú riasztás"
"II. fokú riasztás"
"III. fokú riasztás"

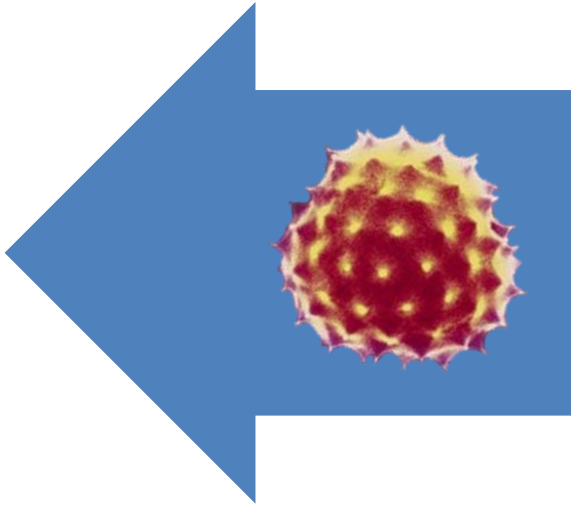
no data
no pollen in the air
low
moderate
high
very high
extremely high

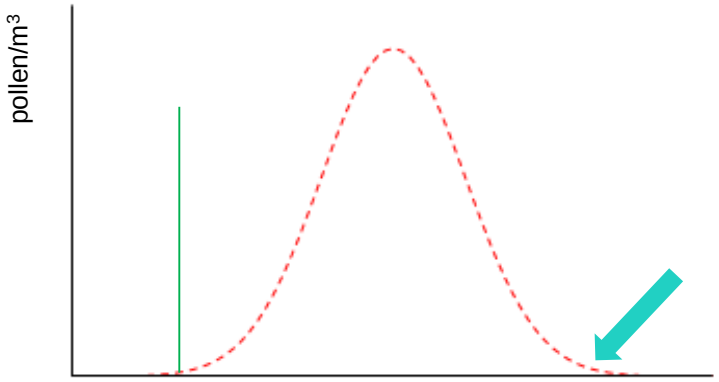
'alert level'
'I. stage alarm'
'II. stage alarm'
'III. stage alarm'

Partnerek / Partners

Kapcsolat / Contact

Forecasting the end of the pollen season





Further research is needed to forecast the end of the ragweed season, using a different approach due to the re-aerosolization of pollen grains.

Early ending of ragweed flowering

Unknown factor

candy-cane shaped


Thank you for your attention
Dr. Magyar Donát