



From Concept to Prototype: Developing a Pollen Allergy Risk Forecaster for Ukraine

*An Interactive Tool Using R Shiny and Local Climate
Data*

Presenters: G3 team

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Developing Skills to Use Climatic Information and Services for Various Climate-Dependent Branches of
Economy ClimEd 7th Training
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What is Pollinosis?

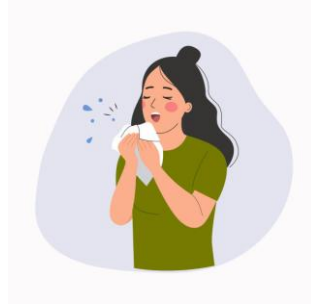
Understanding Seasonal Pollen Allergy

- Pollinosis, widely known as **Hay Fever** or **Seasonal Allergic Rhinitis**, is an allergic condition triggered by breathing in airborne pollen.
- It's an immune system response to pollen from specific trees, grasses, and weeds that are typically harmless to non-allergic individuals.



Common Symptoms

- Frequent Sneezing



- Runny or Blocked Nose (Rhinorrhea / Nasal Congestion)



- Itchy, Red, and Watery Eyes (Allergic Conjunctivitis)



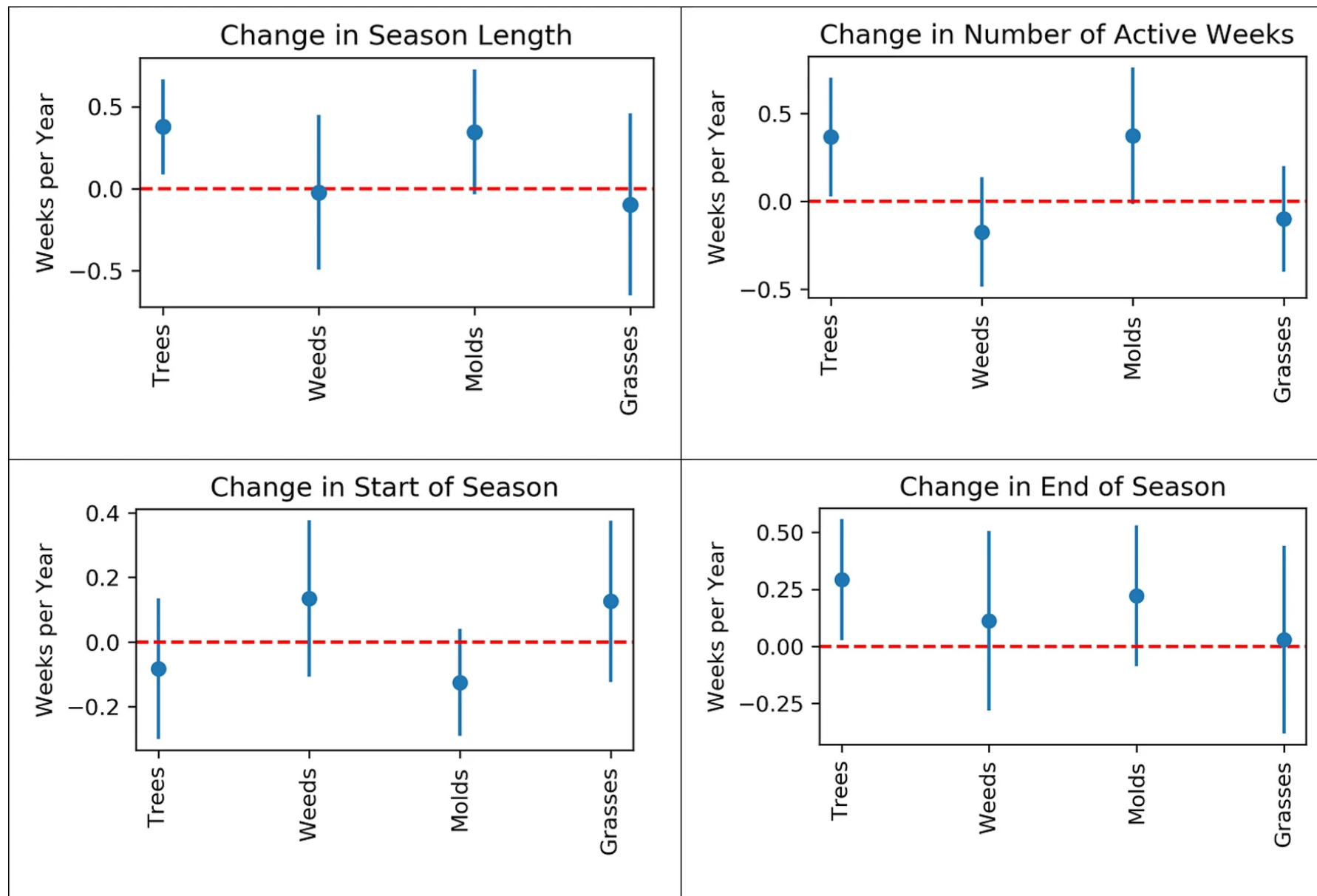
- Itchiness in the Nose, Throat, Roof of Mouth, and Ears



- Fatigue, often due to poor sleep quality

Key Pollen Triggers in Ukraine

- **Early Spring:** Alder, Hazel
- **Spring:** Birch (Major!), Oak, Ash, Pine (less allergenic)
- **Late Spring / Summer:** Grasses (Major!)
- **Late Summer / Autumn:** Ragweed (Major!), Mugwort (Major!), Nettle, Plantain



Paudel, B., Chu, T., Chen, M. et al. Increased duration of pollen and mold exposure are linked to climate change. *Sci Rep* **11**, 12816 (2021). <https://doi.org/10.1038/s41598-021-92178-7>

Why This Topic? Motivation and Relevance

- Allergy sufferers and healthcare providers need timely, localized information to anticipate periods of high pollen exposure risk, allowing for preventative measures.
- Pollen production, release timing, season length, and transport are directly influenced by meteorological factors (temperature, precipitation, wind).
- Observed and projected climate change (e.g., warmer springs, altered rainfall patterns) directly impacts these factors, making pollinosis a key area where climate change affects human health.
- Pollen types, concentrations, and timing vary significantly by region (e.g., the importance of Ragweed in Ukraine vs. Olive pollen in parts of Spain).
- Our team's multidisciplinary background (Pediatrics, Ecology, Agrometeorology, Ag Science) provides the necessary expertise to connect climate data analysis with plant biology and potential health outcomes.

Understanding Local Climate Change with Climate Indices

- Climate change isn't uniform; understanding local trends is crucial for adaptation.
- Standardized climate indices (e.g., from ETCCDI/Climpact) help quantify changes in extremes and means from daily temperature (Tmax, Tmin) and precipitation data.
- Analyzing the *type of data uploaded to our app* using these indices provides objective measures of how the local climate is evolving, forming the basis for assessing impacts.

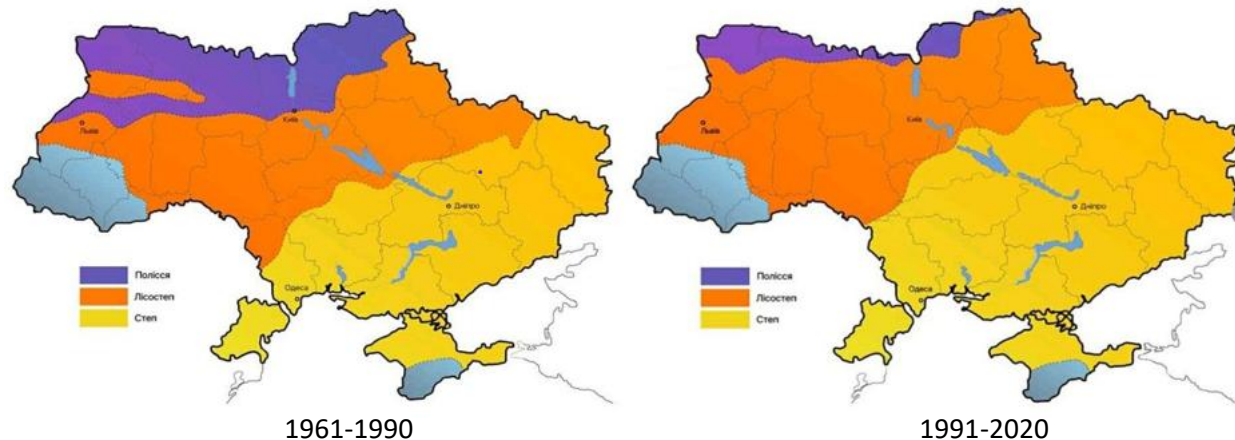
Temperature:

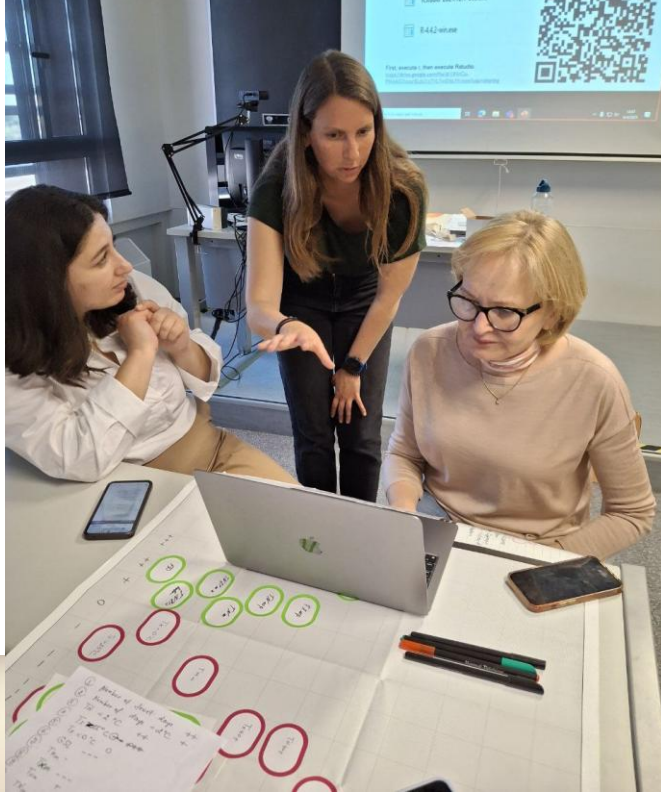
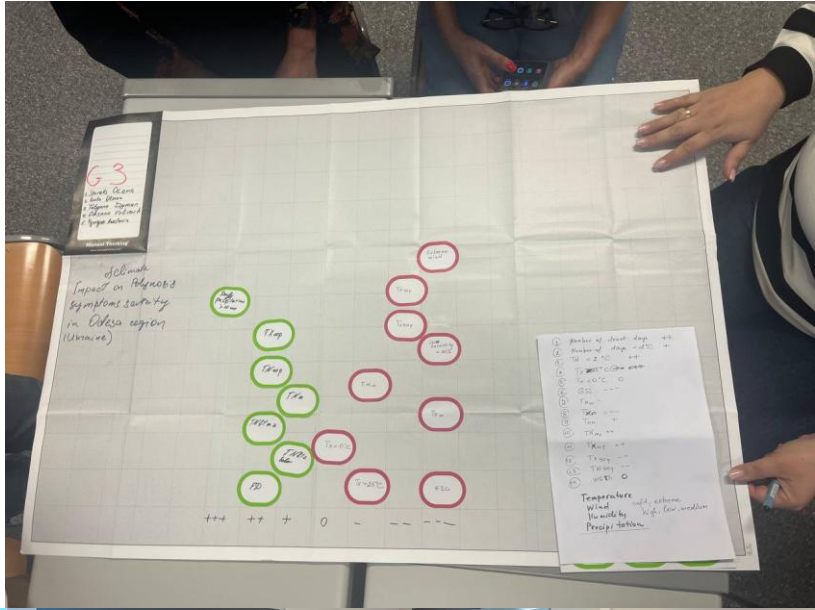
- FD (Frost Days): impact on agriculture, pests.
- SU (Summer Days): heat stress, energy demand.
- GSL (Growing Season Length): longer pollen seasons, changes in agriculture.
- TXx (Max Tmax), TNx (Max Tmin): health impacts.

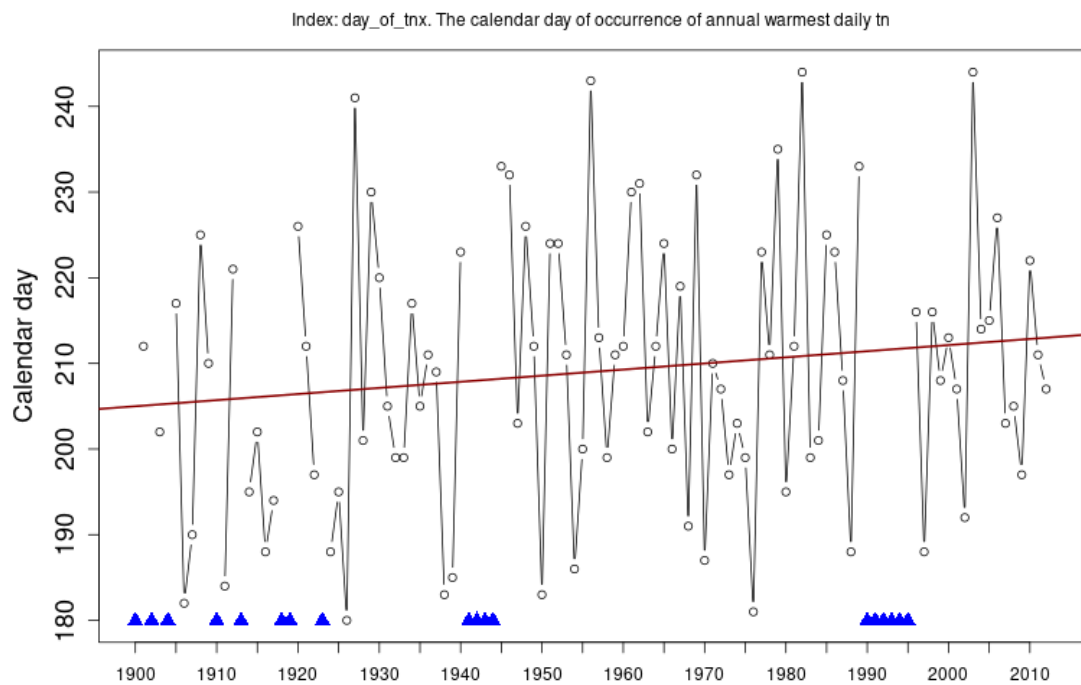
Agroclimatic zoning of the territory of Ukraine in the context of climate change



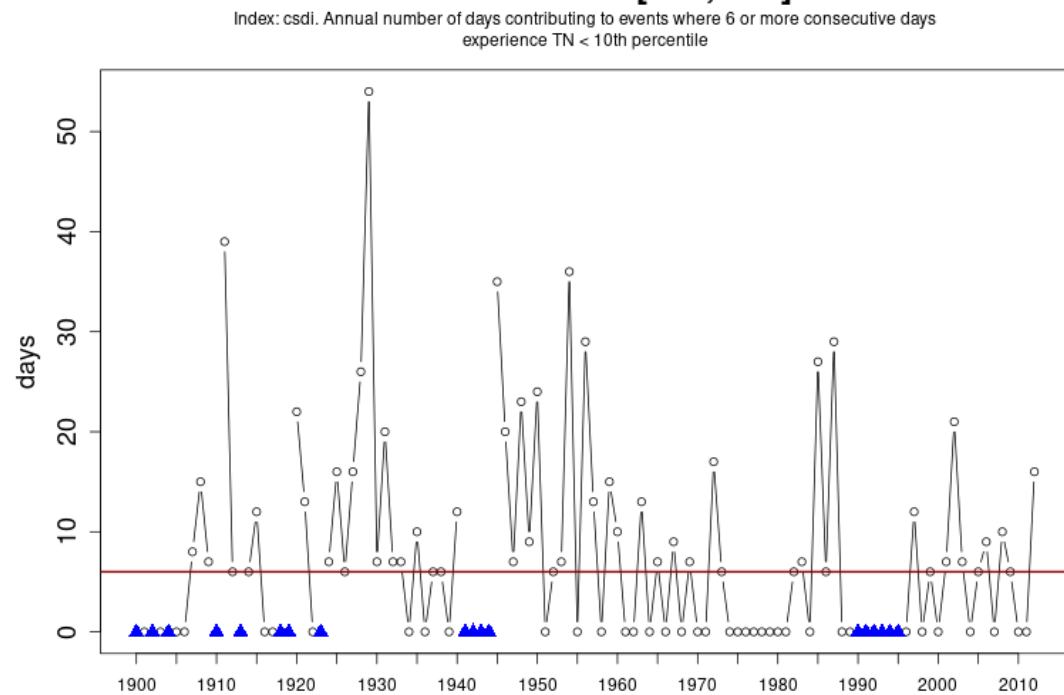
Tetyana Adamenko - Head of the Agrometeorology Department of the Ukrainian Hydrometeorological Center





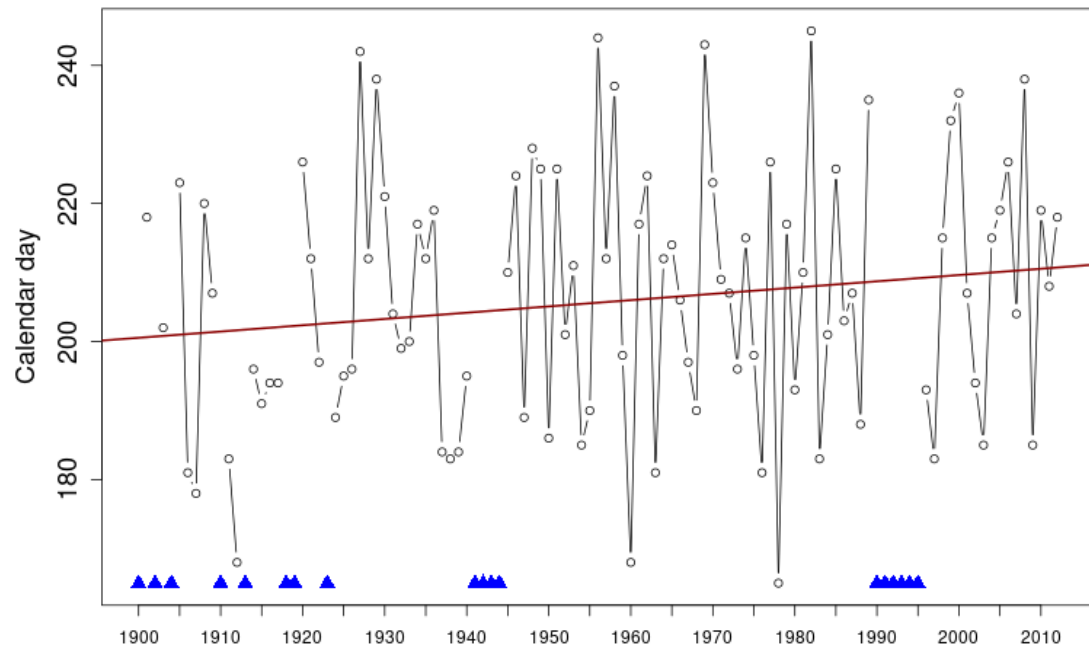


Climpact v 3.3



Climpact v 3.3

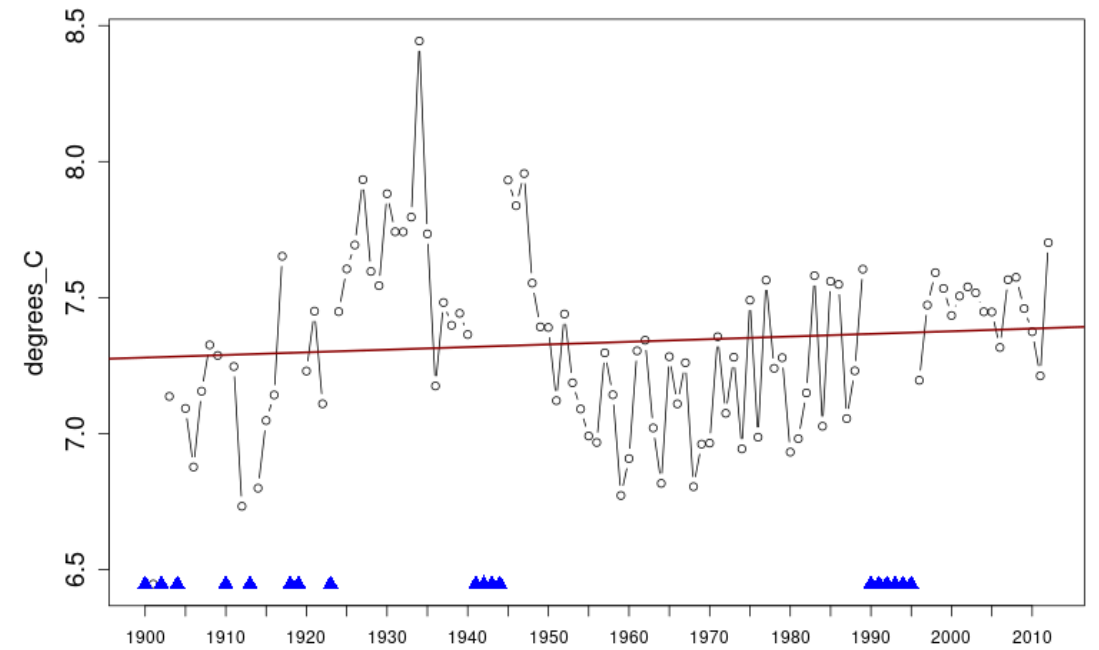
Index: day_of_tx. The calendar day of occurrence of annual warmest daily tx



Sen's slope = 0.091 lower bound = -0.033, upper bound = 0.22, p-value = 0.148

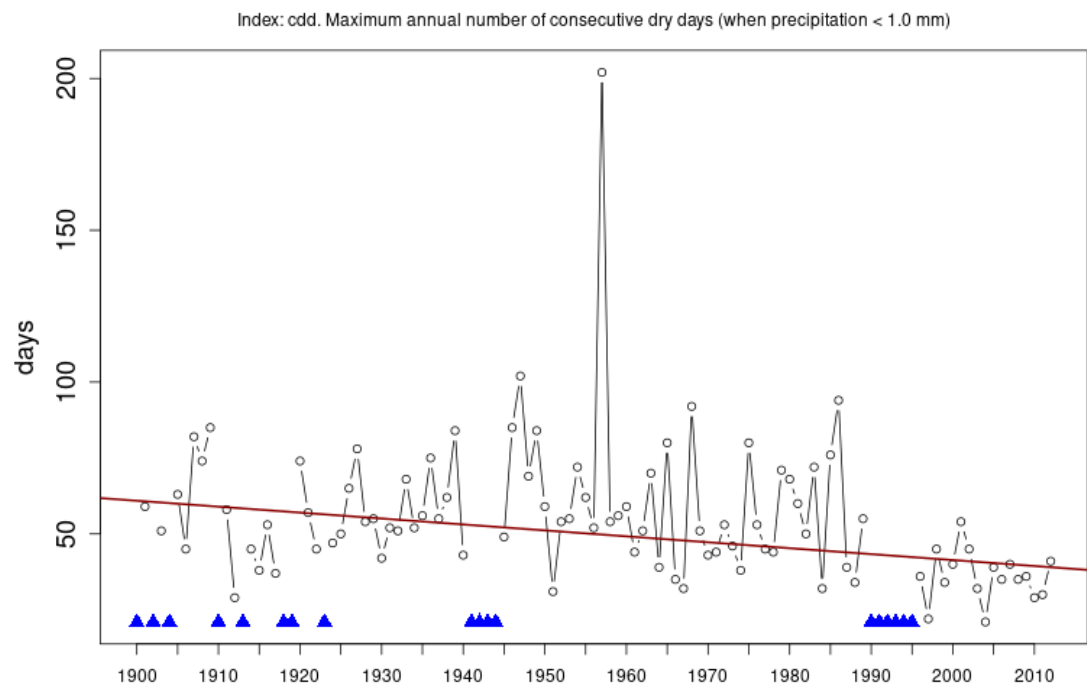
Climpact v 3.1

Index: dtr. Mean annual difference between daily TX and daily TN



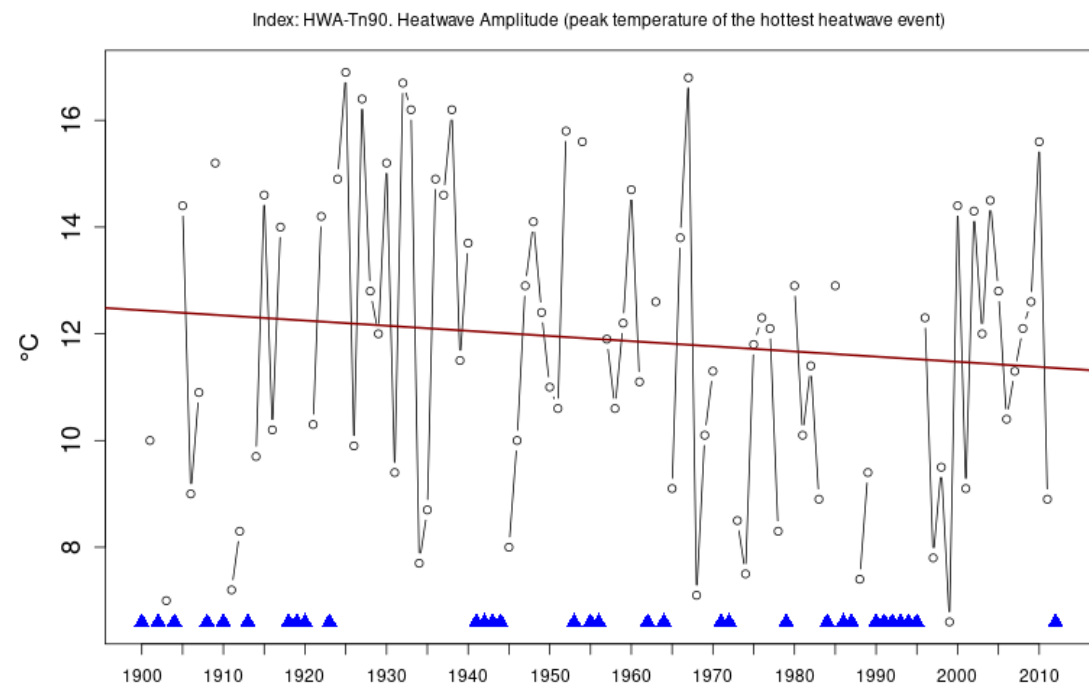
Sen's slope = 0.001 lower bound = -0.001, upper bound = 0.003, p-value = 0.467

Climpact v 3



Sen's slope = -0.195 lower bound = -0.29, upper bound = -0.1, p-value = 0

Climpact v 3.0



Sen's slope = -0.01 lower bound = -0.031, upper bound = 0.013, p-value = 0.38

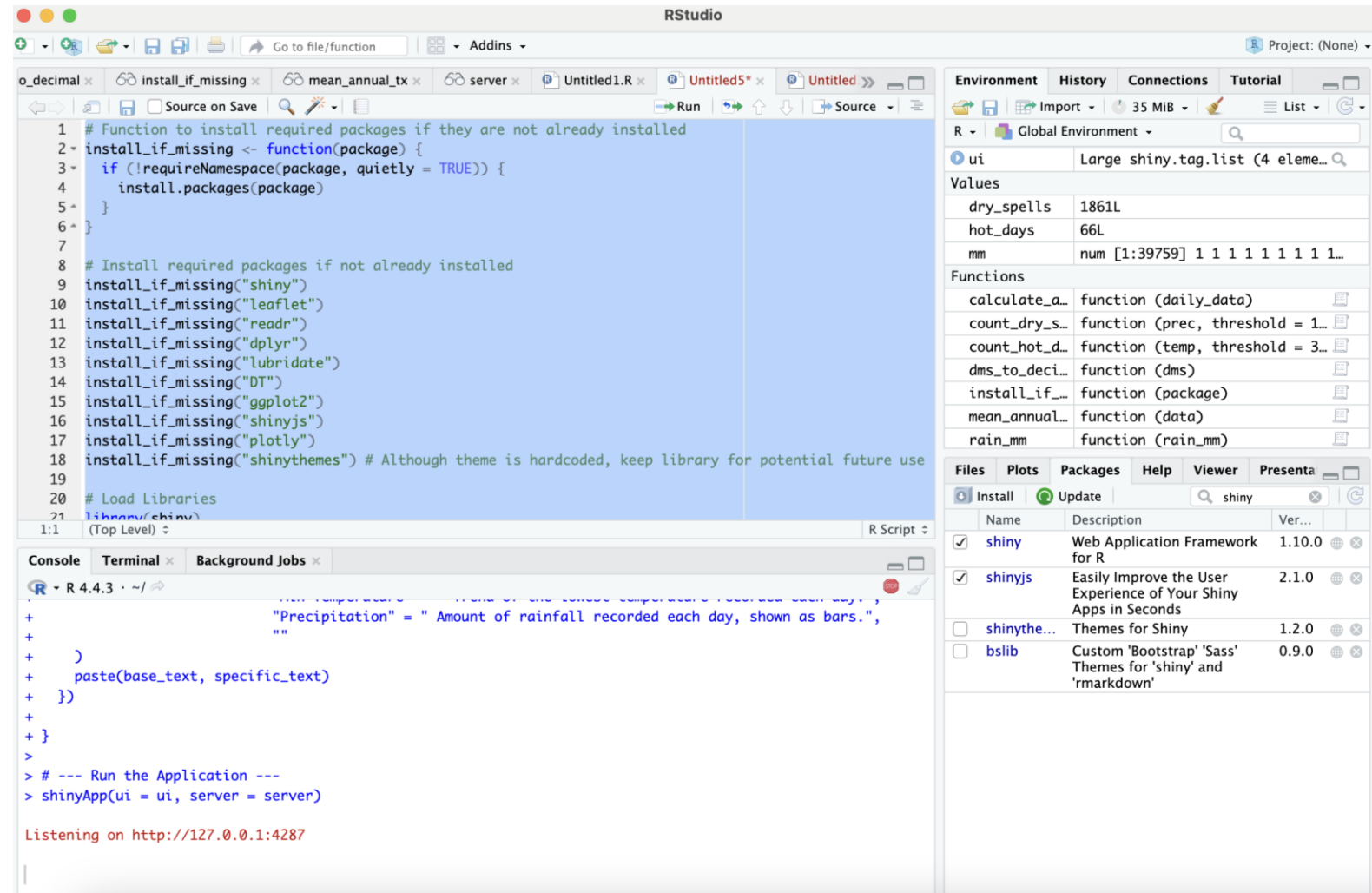
Climpact v 3.0

Linking Climate Change to Sectoral Needs: The Case of Pollen Allergies

- Allergy sufferers and healthcare providers need timely, localized information to anticipate periods of high pollen exposure risk, allowing for preventative measures.
- **Goal:** To translate relevant climate parameters into a practical indicator of risk for a specific sector.
- Climate conditions directly influence pollen production, release, and transport (temperature, rain, wind).
- Climate *change* can alter pollen seasons' length, timing, and intensity, potentially increasing the burden on allergy sufferers.

Building an Interactive Tool: The Shiny App Architecture

- **ui.R (User Interface):** Defines the layout and appearance.
- **server.R (Server Logic):** Contains instructions for processing data and rendering outputs.



The screenshot shows the RStudio interface with the following components:

- Main Editor:** Displays the `server.R` file with the following R code:

```
1 # Function to install required packages if they are not already installed
2 install_if_missing <- function(package) {
3   if (!requireNamespace(package, quietly = TRUE)) {
4     install.packages(package)
5   }
6 }
7
8 # Install required packages if not already installed
9 install_if_missing("shiny")
10 install_if_missing("leaflet")
11 install_if_missing("readr")
12 install_if_missing("dplyr")
13 install_if_missing("lubridate")
14 install_if_missing("DT")
15 install_if_missing("ggplot2")
16 install_if_missing("shinyjs")
17 install_if_missing("plotly")
18 install_if_missing("shinythemes") # Although theme is hardcoded, keep library for potential future use
19
20 # Load Libraries
21 library(shiny)
```

The console shows the command to run the application:

```
> # --- Run the Application ---
> shinyApp(ui = ui, server = server)

Listening on http://127.0.0.1:4287
```

- Environment Pane:** Shows the loaded packages and their versions:

Name	Description	Ver...
shiny	Web Application Framework for R	1.10.0
shinyjs	Easily Improve the User Experience of Your Shiny Apps in Seconds	2.1.0
shinythemes	Themes for Shiny	1.2.0
bslib	Custom 'Bootstrap' 'Sass' Themes for 'shiny' and 'rmarkdown'	0.9.0

Using the App: Data Input to Insight

http://127.0.0.1:4287

Open in Browser

Publish

Odesa Region Pollen Allergy Risk Forecaster

Data Upload

1. Upload Stations Metadata (.csv/.txt)

Browse...No file selected

2. Upload Climate Data Files (.csv/.txt)

Browse...No file selected

Climate filenames should match station IDs (without extension). E.g., 'StationA.txt' for station 'StationA'.
Columns expected: year month day precipitation tmax tmin (space-separated).

Status

☒ Enable Dark Mode

Stations Map

Station Metadata

Pollen Allergy Risk Forecast

Daily Climate Evolution

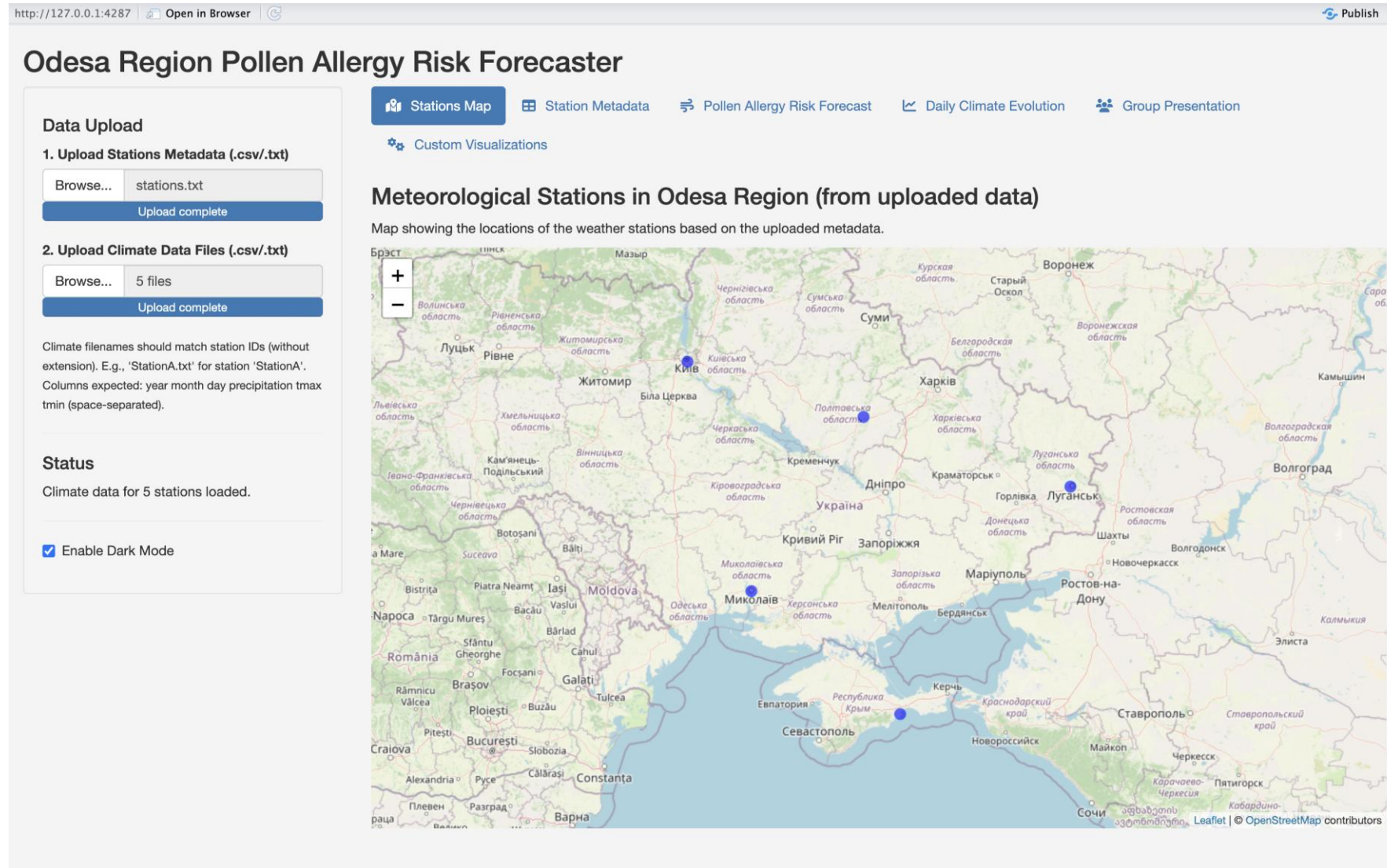
Group Presentation

Custom Visualizations

Meteorological Stations in Odesa Region (from uploaded data)

Map showing the locations of the weather stations based on the uploaded metadata.

Using the App: Data Input to Insight



Using the App: Data Input to Insight

http://127.0.0.1:4287

Open in Browser

Publish

Odesa Region Pollen Allergy Risk Forecaster

Data Upload

1. Upload Stations Metadata (.csv/.txt)

Browse...

stations.txt

Upload complete

2. Upload Climate Data Files (.csv/.txt)

Browse...

5 files

Upload complete

Climate filenames should match station IDs (without extension). E.g., 'StationA.txt' for station 'StationA'. Columns expected: year month day precipitation tmax tmin (space-separated).

Status

Climate data for 5 stations loaded.

☒ Enable Dark Mode

Stations Map

Station Metadata

Pollen Allergy Risk Forecast

Daily Climate Evolution

Group Presentation

Custom Visualizations

Forecast Settings

Select Station for Forecast

000251

Select Date Range

2012-01-01 to 2012-12-31

Risk Calculation Note

Disclaimer: The risk level ('Low', 'Moderate', 'High') is calculated using a **simplified placeholder model** based only on daily maximum temperature, minimum temperature, and precipitation.

It serves as an example and **does not incorporate actual pollen counts or complex meteorological factors** known to influence allergy symptoms (like wind, humidity, specific pollen types). Real-world predictions require more sophisticated data and models.

Pollen Allergy Risk Forecast - Odesa Region

Predicted allergy risk based on simplified climate analysis for the selected station and date range.

Forecast for Station: 000251

Predicted Allergy Risk Over Time for 000251

Date	Predicted Risk Level
2012-01-01	Low
2012-01-02	Low
2012-01-03	Moderate
2012-01-04	Low
2012-01-05	Low
2012-01-06	Low
2012-01-07	Low
2012-01-08	Low
2012-01-09	Low
2012-01-10	Low
2012-01-11	Low
2012-01-12	Low
2012-01-13	Low
2012-01-14	Low
2012-01-15	Low
2012-01-16	Low
2012-01-17	Low
2012-01-18	Low
2012-01-19	Low
2012-01-20	Low
2012-01-21	Low
2012-01-22	Low
2012-01-23	Low
2012-01-24	Low
2012-01-25	Low
2012-01-26	Low
2012-01-27	Low
2012-01-28	Low
2012-01-29	Low
2012-01-30	Low
2012-01-31	Low
2012-02-01	Low
2012-02-02	Low
2012-02-03	Low
2012-02-04	Low
2012-02-05	Low
2012-02-06	Low
2012-02-07	Low
2012-02-08	Low
2012-02-09	Low
2012-02-10	Low
2012-02-11	Low
2012-02-12	Low
2012-02-13	Low
2012-02-14	Low
2012-02-15	Low
2012-02-16	Low
2012-02-17	Low
2012-02-18	Low
2012-02-19	Low
2012-02-20	Low
2012-02-21	Low
2012-02-22	Low
2012-02-23	Low
2012-02-24	Low
2012-02-25	Low
2012-02-26	Low
2012-02-27	Low
2012-02-28	Low
2012-02-29	Low
2012-03-01	Low
2012-03-02	Low
2012-03-03	Low
2012-03-04	Low
2012-03-05	Low
2012-03-06	Low
2012-03-07	Low
2012-03-08	Low
2012-03-09	Low
2012-03-10	Low
2012-03-11	Low
2012-03-12	Low
2012-03-13	Low
2012-03-14	Low
2012-03-15	Low
2012-03-16	Low
2012-03-17	Low
2012-03-18	Low
2012-03-19	Low
2012-03-20	Low
2012-03-21	Low
2012-03-22	Low
2012-03-23	Low
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2012-03-25	Low
2012-03-26	Low
2012-03-27	Low
2012-03-28	Low
2012-03-29	Low
2012-03-30	Low
2012-03-31	Low
2012-04-01	Low
2012-04-02	Low
2012-04-03	Low
2012-04-04	Low
2012-04-05	Low
2012-04-06	Low
2012-04-07	Low
2012-04-08	Low
2012-04-09	Low
2012-04-10	Low
2012-04-11	Low
2012-04-12	Low
2012-04-13	Low
2012-04-14	Low
2012-04-15	Low
2012-04-16	Low
2012-04-17	Low
2012-04-18	Low
2012-04-19	Low
2012-04-20	Low
2012-04-21	Low
2012-04-22	Low
2012-04-23	Low
2012-04-24	Low
2012-04-25	Low
2012-04-26	Low
2012-04-27	Low
2012-04-28	Low
2012-04-29	Low
2012-04-30	Low
2012-05-01	Low
2012-05-02	Low
2012-05-03	Low
2012-05-04	Low
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2012-05-09	Low
2012-05-10	Low
2012-05-11	Low
2012-05-12	Low
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2012-05-15	Low
2012-05-16	Low
2012-05-17	Low
2012-05-18	Low
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2012-05-20	Low
2012-05-21	Low
2012-05-22	Low
2012-05-23	Low
2012-05-24	Low
2012-05-25	Low
2012-05-26	Low
2012-05-27	Low
2012-05-28	Low
2012-05-29	Low
2012-05-30	Low
2012-05-31	Low
2012-06-01	Low
2012-06-02	Low
2012-06-03	Low
2012-06-04	Low
2012-06-05	Low
2012-06-06	Low
2012-06-07	Low
2012-06-08	Low
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2012-06-10	Low
2012-06-11	Low
2012-06-12	Low
2012-06-13	Low
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2012-06-21	Low
2012-06-22	Low
2012-06-23	Low
2012-06-24	Low
2012-06-25	Low
2012-06-26	Low
2012-06-27	Low
2012-06-28	Low
2012-06-29	Low
2012-06-30	Low
2012-07-01	Low
2012-07-02	Low
2012-07-03	Low
2012-07-04	Low
2012-07-05	Low
2012-07-06	Low
2012-07-07	Low
2012-07-08	Low
2012-07-09	Low
2012-07-10	Low
2012-07-11	Low
2012-07-12	Low
2012-07-13	Low
2012-07-14	Low
2012-07-15	Low
2012-07-16	Low
2012-07-17	Low
2012-07-18	Low
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2012-07-22	Low
2012-07-23	Low
2012-07-24	Low
2012-07-25	Low
2012-07-26	Low
2012-07-27	Low
2012-07-28	Low
2012-07-29	Low
2012-07-30	Low
2012-07-31	Low
2012-08-01	Low
2012-08-02	Low
2012-08-03	Low
2012-08-04	Low
2012-08-05	Low
2012-08-06	Low
2012-08-07	Low
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2012-08-10	Low
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2012-08-13	Low
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2012-08-22	Low
2012-08-23	Low
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2012-08-27	Low
2012-08-28	Low
2012-08-29	Low
2012-08-30	Low
2012-08-31	Low
2012-09-01	Low
2012-09-02	Low
2012-09-03	Low
2012-09-04	Low
2012-09-05	Low
2012-09-06	Low
2012-09-07	Low
2012-09-08	Low
2012-09-09	Low
2012-09-10	Low
2012-09-11	Low
2012-09-12	Low
2012-09-13	Low
2012-09-14	Low
2012-09-15	Low
2012-09-16	Low
2012-09-17	Low
2012-09-18	Low
2012-09-19	Low
2012-09-20	Low
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2012-09-22	Low
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2012-09-24	Low
2012-09-25	Low
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2012-09-27	Low
2012-09-28	Low
2012-09-29	Low
2012-09-30	Low
2012-10-01	Low
2012-10-02	Low
2012-10-03	Low
2012-10-04	Low
2012-10-05	Low
2012-10-06	Low
2012-10-07	Low
2012-10-08	Low
2012-10-09	Low
2012-10-10	Low
2012-10-11	Low
2012-10-12	Low
2012-10-13	Low
2012-10-14	Low
2012-10-15	Low
2012-10-16	Low
2012-10-17	Low
2012-10-18	Low
2012-10-19	Low
2012-10-20	Low
2012-10-21	Low
2012-10-22	Low
2012-10-23	Low
2012-10-24	Low
2012-10-25	Low
2012-10-26	Low
2012-10-27	Low
2012-10-28	Low
2012-10-29	Low
2012-10-30	Low
2012-10-31	Low
2012-11-01	Low
2012-11-02	Low
2012-11-03	Low
2012-11-04	Low
2012-11-05	Low
2012-11-06	Low
2012-11-07	Low
2012-11-08	Low
2012-11-09	Low
2012-11-10	Low
2012-11-11	Low
2012-11-12	Low
2012-11-13	Low
2012-11-14	Low
2012-11-15	Low
2012-11-16	Low
2012-11-17	Low
2012-11-18	Low
2012-11-19	Low
2012-11-20	Low
2012-11-21	Low
2012-11-22	Low
2012-11-23	Low
2012-11-24	Low
2012-11-25	Low
2012-11-26	Low
2012-11-27	Low
2012-11-28	Low
2012-11-29	Low
2012-11-30	Low
2012-12-01	Low
2012-12-02	Low
2012-12-03	Low
2012-12-04	Low
2012-12-05	Low
2012-12-06	Low
2012-12-07	Low
2012-12-08	Low
2012-12-09	Low
2012-12-10	Low
2012-12-11	Low
2012-12-12	Low
2012-12-13	Low
2012-12-14	Low
2012-12-15	Low
2012-12-16	Low
2012-12-17	Low
2012-12-18	Low
2012-12-19	Low
2012-12-20	Low
2012-12-21	Low
2012-12-22	Low
2012-12-23	Low
2012-12-24	Low
2012-12-25	Low
2012-12-26	Low
2012-12-27	Low
2012-12-28	Low
2012-12-29	Low
2012-12-30	Low
2012-12-31	Low
2013-01-01	Low

Forecast Data Table

Show 10 entries Search:

Date	Max Temp (°C)	Min Temp (°C)	Precipitation (mm)	Predicted Risk
2012-01-01	5.9	1.6	0.4	Low
2012-01-02	4.2	-1.5	0.0	Low
2012-01-03	10.2	3.0	0.0	Moderate

Using the App: Data Input to Insight

http://127.0.0.1:4287

Open in Browser

Publish

Odesa Region Pollen Allergy Risk Forecaster

Data Upload

1. Upload Stations Metadata (.csv/.txt)

Browse...

stations.txt

Upload complete

2. Upload Climate Data Files (.csv/.txt)

Browse...

5 files

Upload complete

Climate filenames should match station IDs (without extension). E.g., 'StationA.txt' for station 'StationA'. Columns expected: year month day precipitation tmax tmin (space-separated).

Status

Climate data for 5 stations loaded.

☒ Enable Dark Mode

Stations Map

Station Metadata

Pollen Allergy Risk Forecast

Daily Climate Evolution

Group Presentation

Custom Visualizations

Forecast Settings

Select Station for Forecast

000251

Select Date Range

2012-05-01 to 2012-08-31

Risk Calculation Note

Disclaimer: The risk level ('Low', 'Moderate', 'High') is calculated using a **simplified placeholder model** based only on daily maximum temperature, minimum temperature, and precipitation.

It serves as an example and **does not incorporate actual pollen counts or complex meteorological factors** known to influence allergy symptoms (like wind, humidity, specific pollen types). Real-world predictions require more sophisticated data and models.

Pollen Allergy Risk Forecast - Odesa Region

Predicted allergy risk based on simplified climate analysis for the selected station and date range.

Forecast for Station: 000251

Predicted Allergy Risk Over Time for 000251

Predicted Risk Level

High

Moderate

Low

May

Jun

Jul

Aug

Sep

Date

Risk Level

Low

Moderate

High

Forecast Data Table

Show 10 entries

Search:

Date	Max Temp (°C)	Min Temp (°C)	Precipitation (mm)	Predicted Risk
2012-05-01		27.9	17.9	0.0 High
2012-05-02		28.9	14.4	0.0 High
2012-05-03		26.7	13.3	0.0 High

Using the App: Data Input to Insight

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Climate filenames should match station IDs (without extension). E.g., 'StationA.txt' for station 'StationA'. Columns expected: year month day precipitation tmax tmin (space-separated).

Status

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☒ Enable Dark Mode

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Forecast Settings

Select Station for Forecast

000251

Select Date Range

2011-12-01 to 2012-03-31

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Pollen Allergy Risk Forecast - Odesa Region

Predicted allergy risk based on simplified climate analysis for the selected station and date range.

Forecast for Station: 000251

Predicted Allergy Risk Over Time for 000251

Predicted Risk Level

High

Moderate

Low

Dec

Jan

Feb

Mar

Apr

Date

Risk Level

Low

Moderate

Forecast Data Table

Show 10 entries

Search:

Date	Max Temp (°C)	Min Temp (°C)	Precipitation (mm)	Predicted Risk
2011-12-01		10.9	0.6	0.0 Moderate
2011-12-02		7.9	1.4	4.0 Low
2011-12-03		9.4	0.6	0.0 Low

Conclusion

- Demonstrated the importance of analyzing local climate data using standardized approaches (like climate indices).
- Showcased how specific sectoral needs (e.g., pollen allergy risk) can be defined and potentially addressed using functions based on climate data.
- Presented a Shiny application structure that effectively handles data input, processing, and interactive visualization (maps, plots, tables).
- Illustrated the workflow for using the app to explore climate data and its conceptual link to a sectoral risk indicator.
- **Key Takeaway:** R Shiny provides a powerful framework for building tailored tools that bridge the gap between raw climate data and actionable insights for specific regional needs, even if initial functions (like our risk assessment) are conceptual placeholders requiring further development (e.g., adding pollen data).

Thank You!

