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

An Interactive Tool Using R Shiny and Local Climate Data

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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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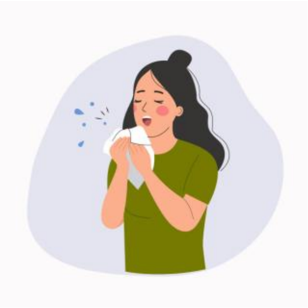
What is Pollinosis?
Understanding Seasonal Pollen Allergy

- 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)

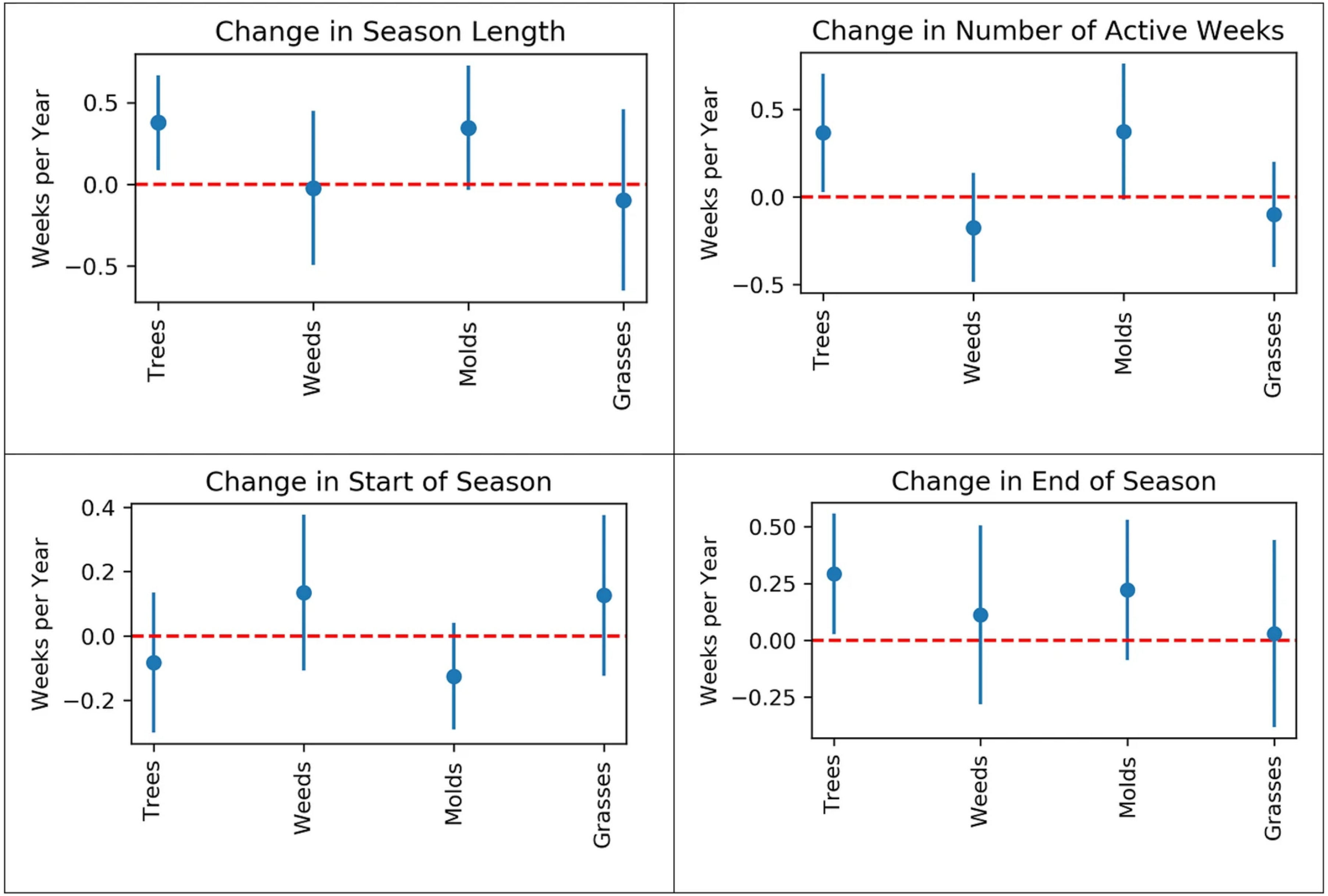
- Itchy, Red, and Watery Eyes (Allergic Conjunctivi

- Itchiness in the Nose, Throat, Roof of N  l 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-z*

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:

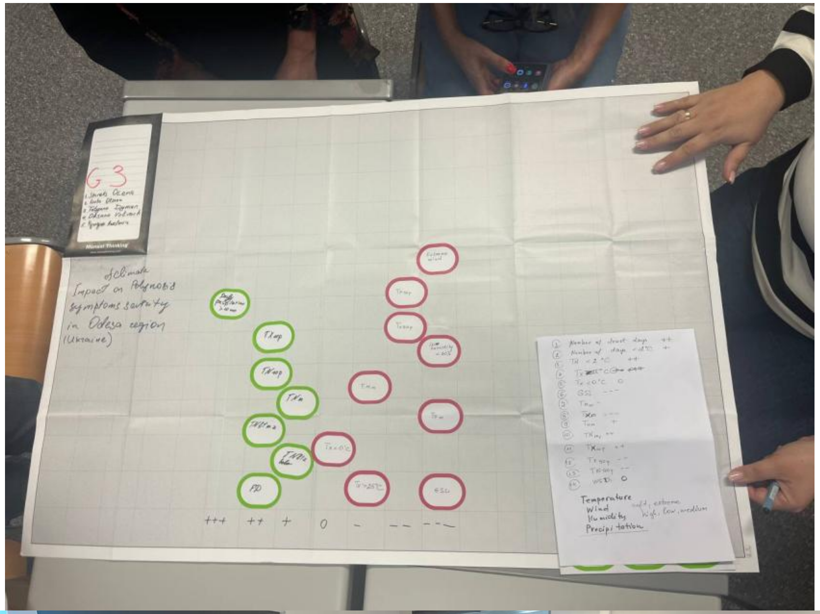
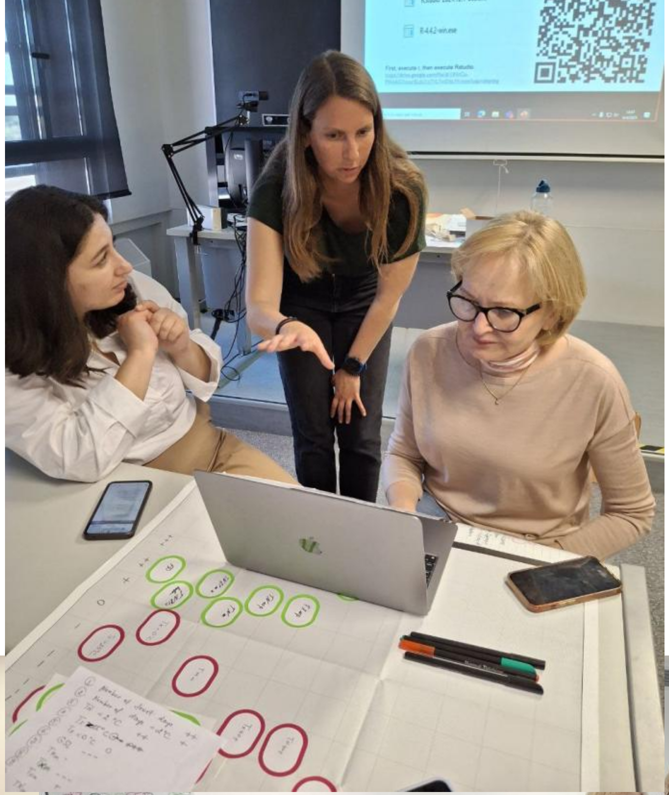
- FD (Frost Days): impact on agriculture, pests.
- SU (Summer Days): heat stress, energy demand.
- GSL (Growing Season Length): longer pollen seasons, changes in agriculture.
- TXx (Max Tmax), TNx (Max Tmin): health impacts.

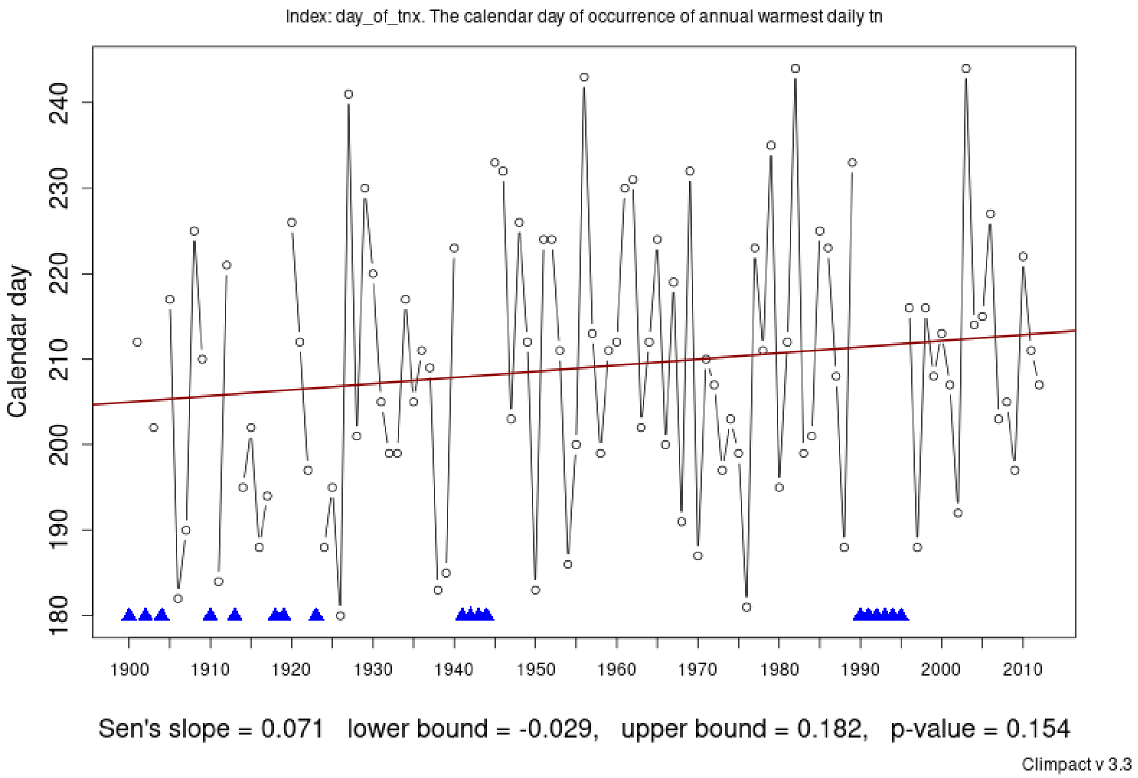
Agroclimatic zoning of the territory of Ukraine in the context of climate change

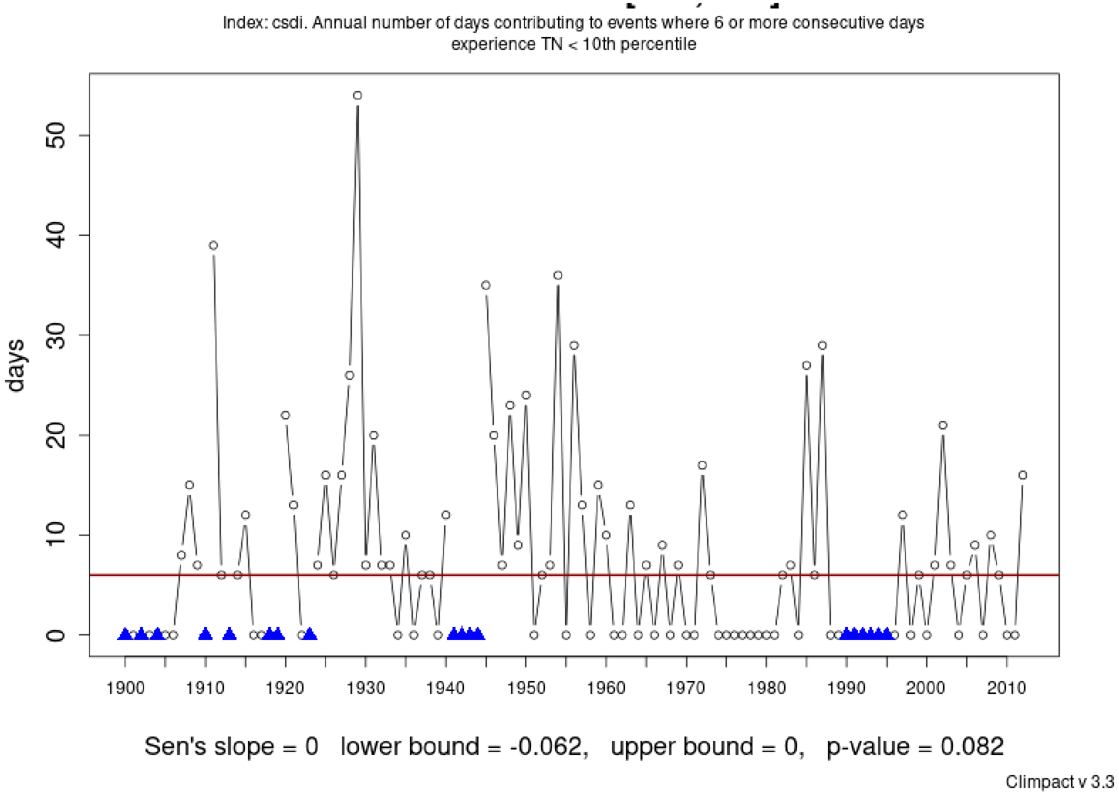
Tetyana Adamenko - Head of the Agrometeorology Department of the Ukrainian Hydrometeorological Center

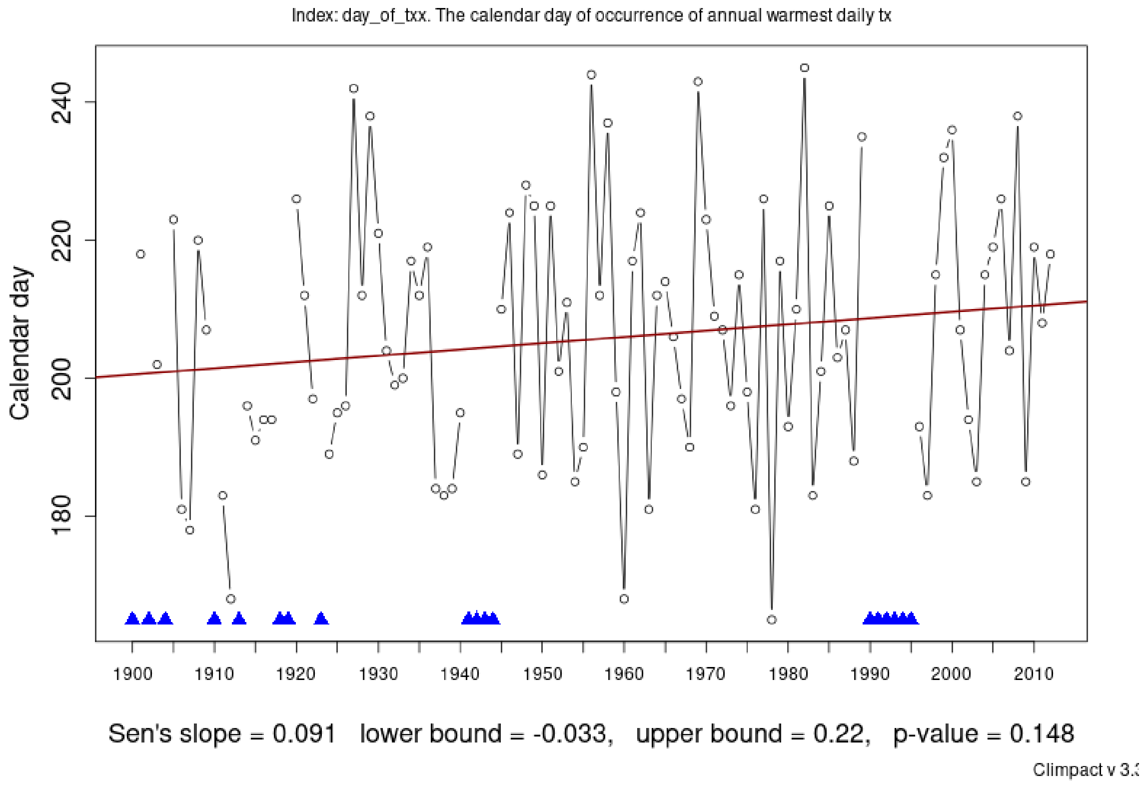
1961-1990

1991-2020

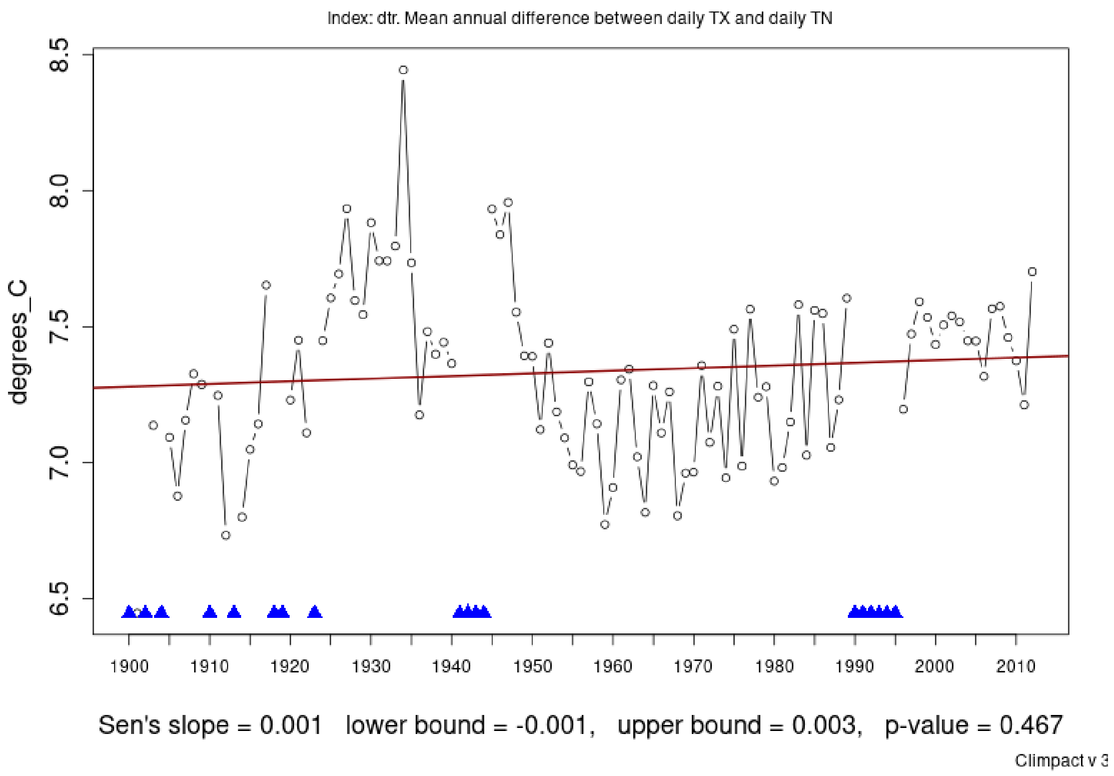





Index: day_of_tnx. The calendar day of occurrence of annual warmest daily tn
Calendar day
180
190
200
210
220
230
240
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
Sen's slope = 0.071   lower bound = -0.029,   upper bound = 0.182,   p-value = 0.154
Climpact v 3.3

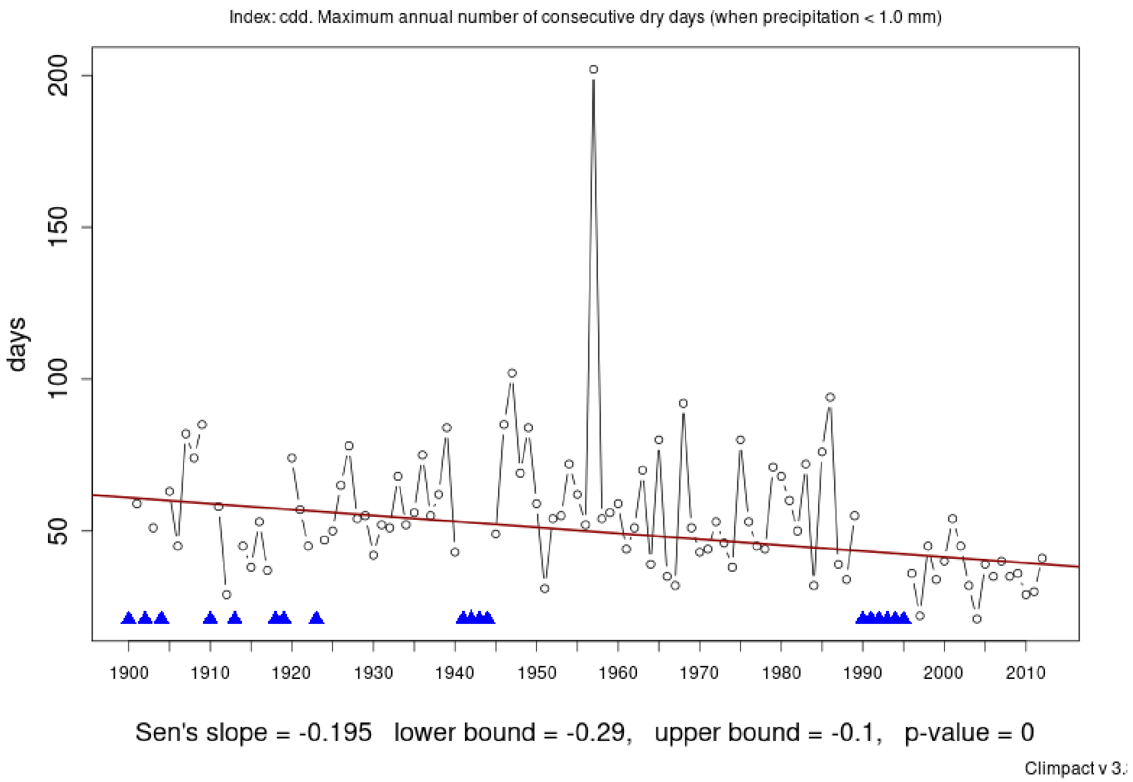

Index: csdi. Annual number of days contributing to events where 6 or more consecutive days experience TN < 10th percentile
days
0
10
20
30
40
50
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
Sen's slope = 0   lower bound = -0.062,   upper bound = 0,   p-value = 0.082
Climpact v 3.3

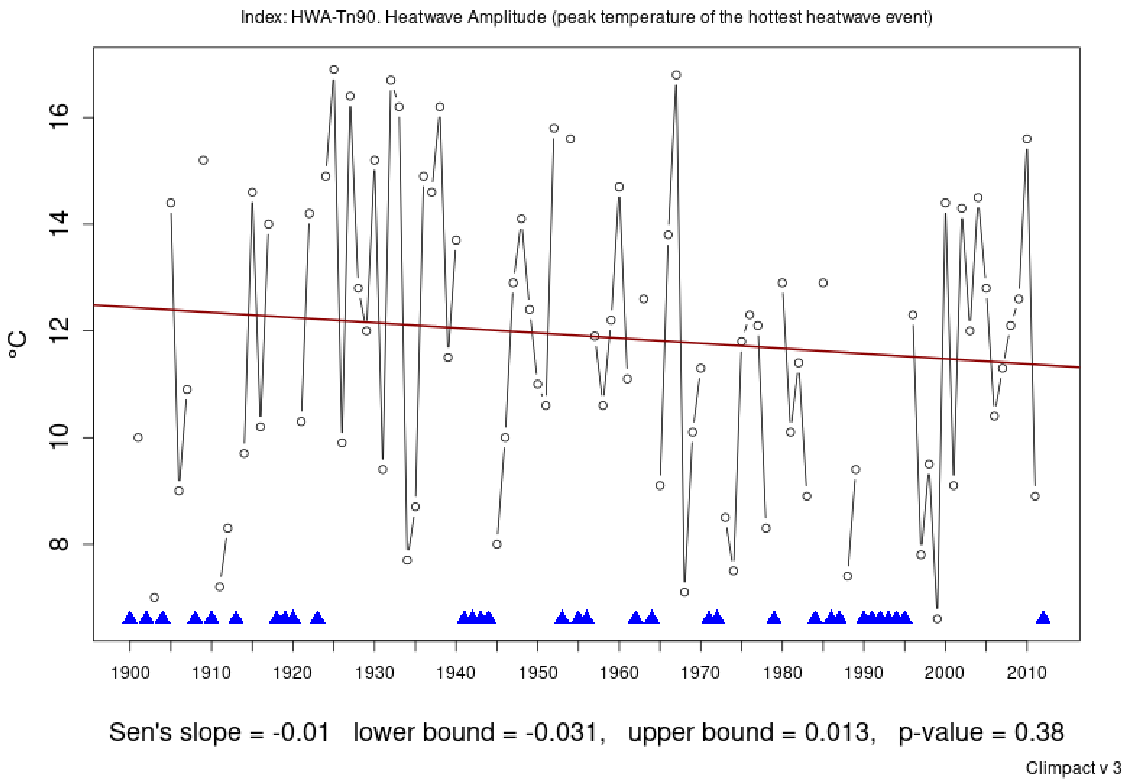


Index: day_of_txx. The calendar day of occurrence of annual warmest daily tx
Calendar day
180
200
220
240
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
Sen's slope = 0.091 lower bound = -0.033, upper bound = 0.22, p-value = 0.148



Index: dtr. Mean annual difference between daily TX and daily TN
degrees_C
6.5
7.0
7.5
8.0
8.5
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
Sen's slope = 0.001 lower bound = -0.001, upper bound = 0.003, p-value = 0.467


Index: cdd. Maximum annual number of consecutive dry days (when precipitation < 1.0 mm)
days
Sen's slope = -0.195 lower bound = -0.29, upper bound = -0.1, p-value = 0
Climpact v 3.

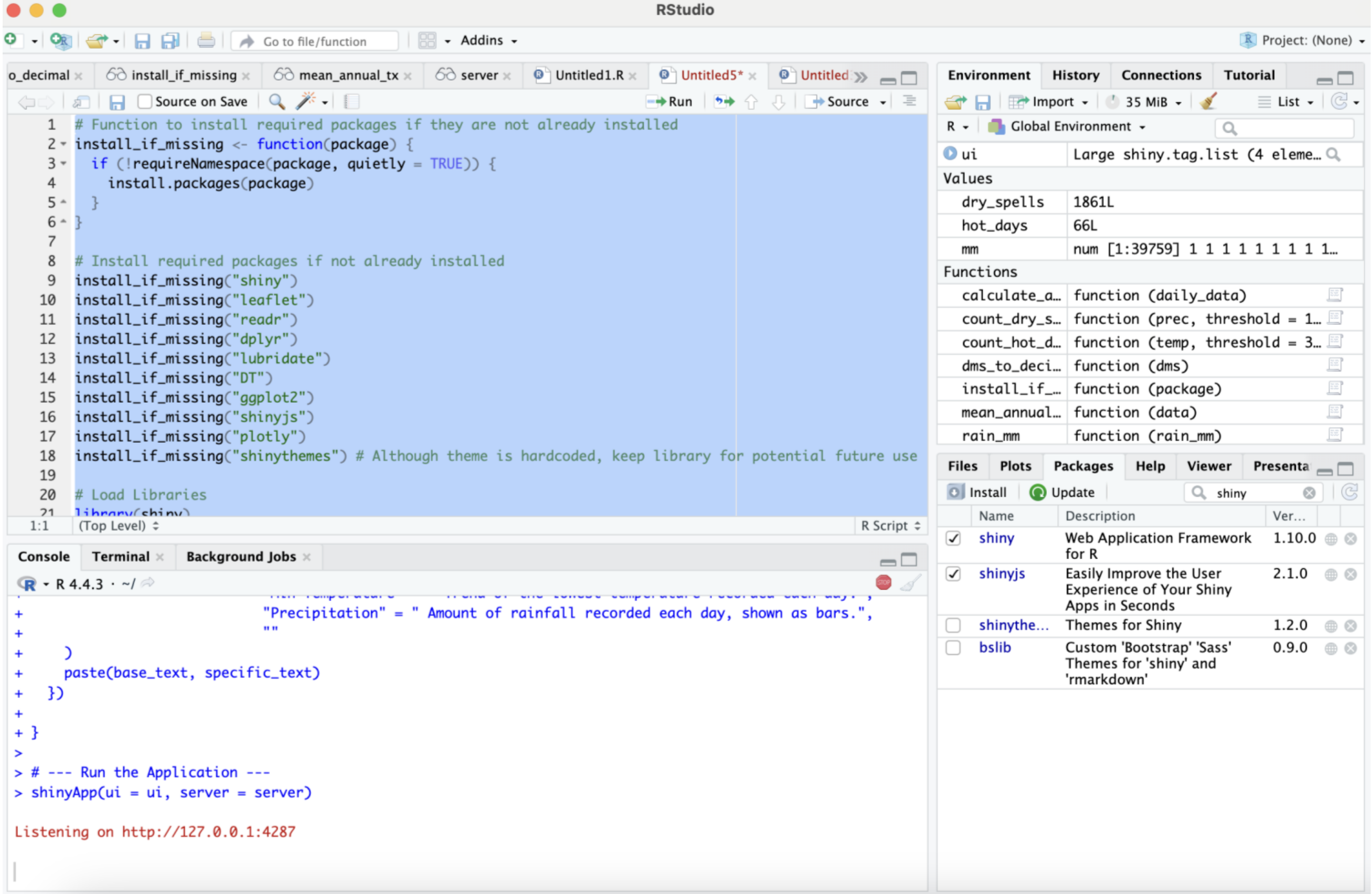

Index: HWA-Tn90. Heatwave Amplitude (peak temperature of the hottest heatwave event)
°C
Sen's slope = -0.01 lower bound = -0.031, upper bound = 0.013, p-value = 0.38
Climpact v 3

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

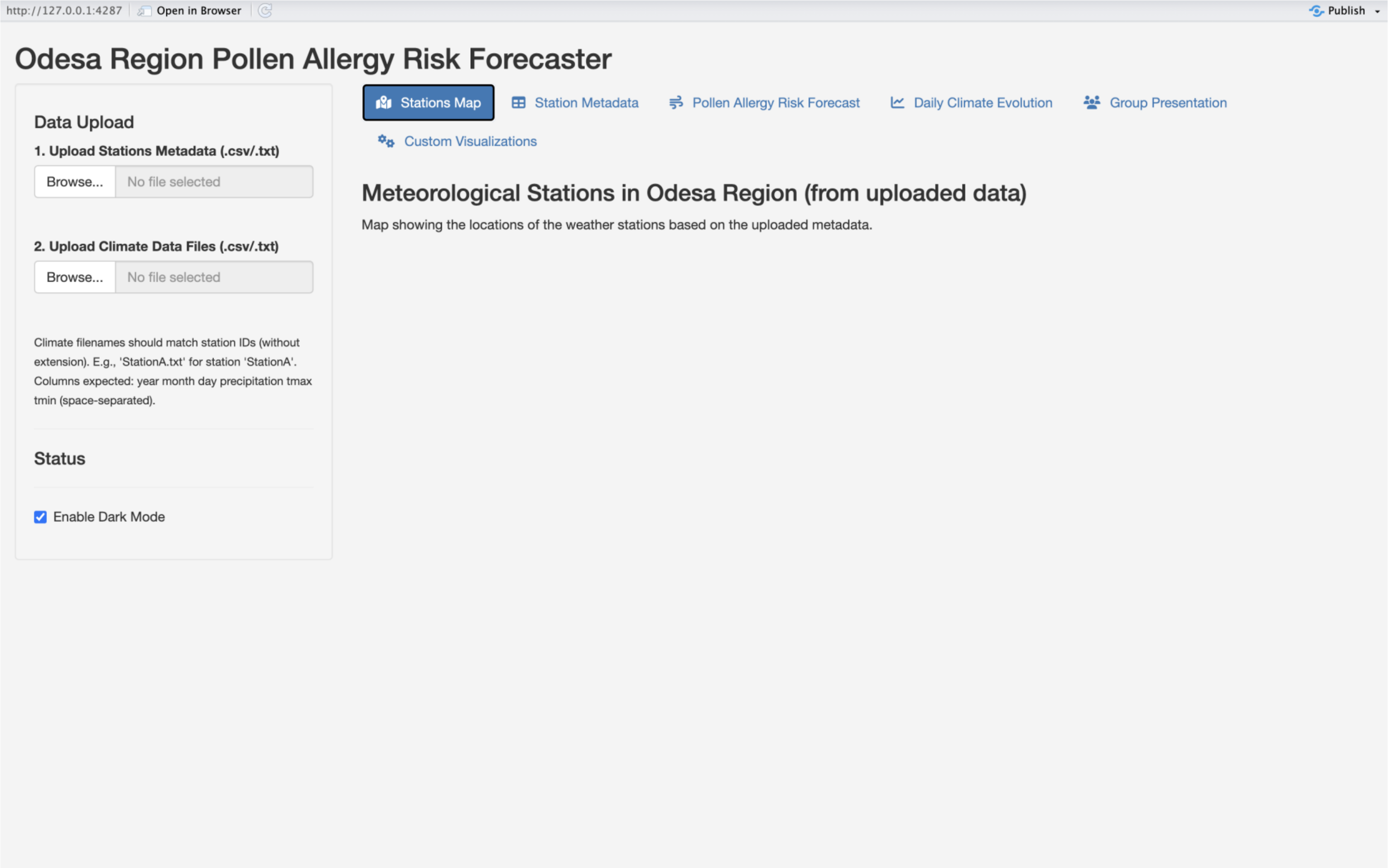
- Allergy sufferers and healthcare providers need timely, localized information to anticipate periods of high pollen exposure risk, allowing for preventative measures.
- **Goal:** To translate relevant climate parameters into a practical indicator of risk for a specific sector.
- Climate conditions directly 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

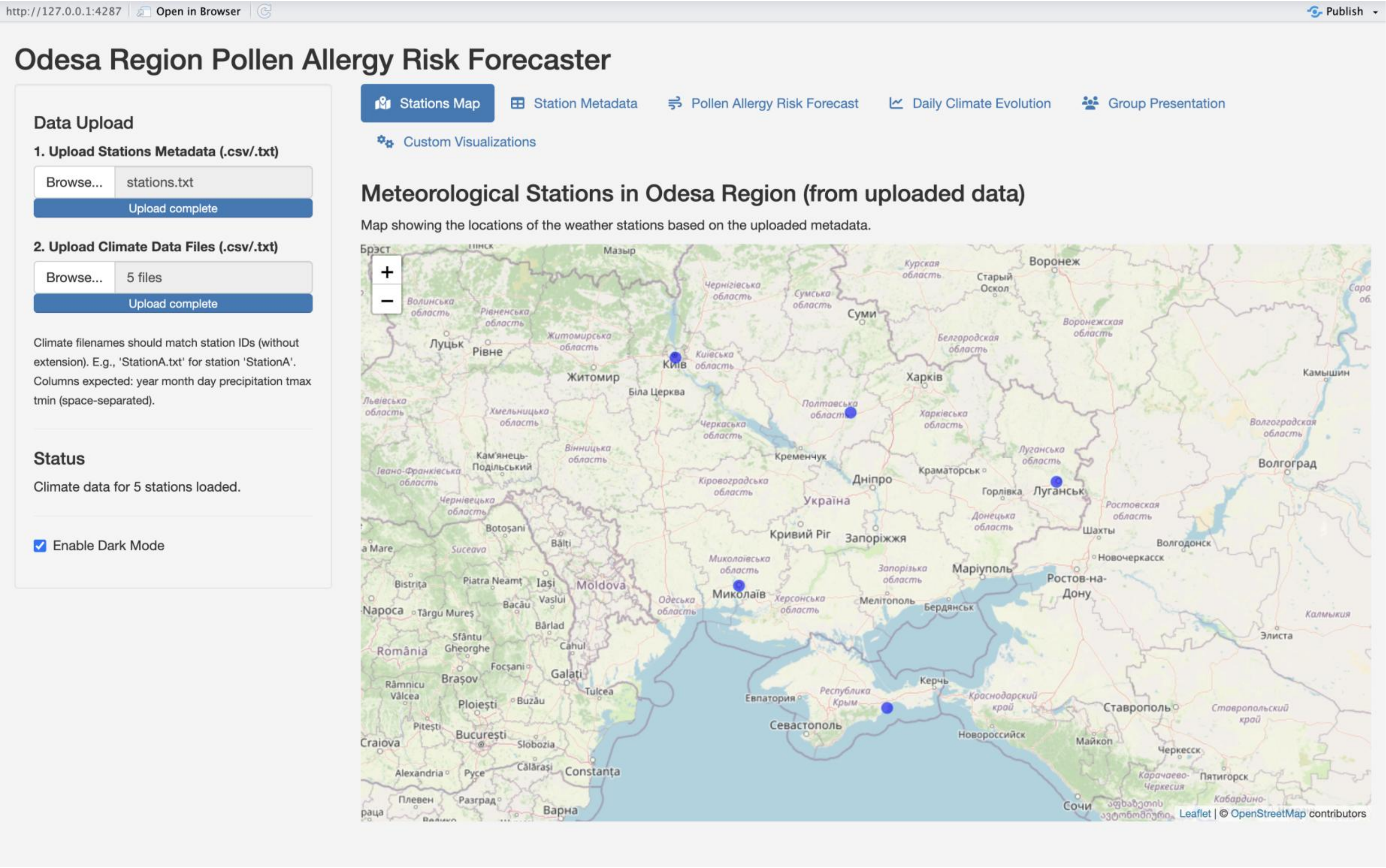
- **ui.R (User Interface):** Defines the layout and appearance.
- **server.R (Server Logic):** Contains instructions for processing data and rendering outputs.



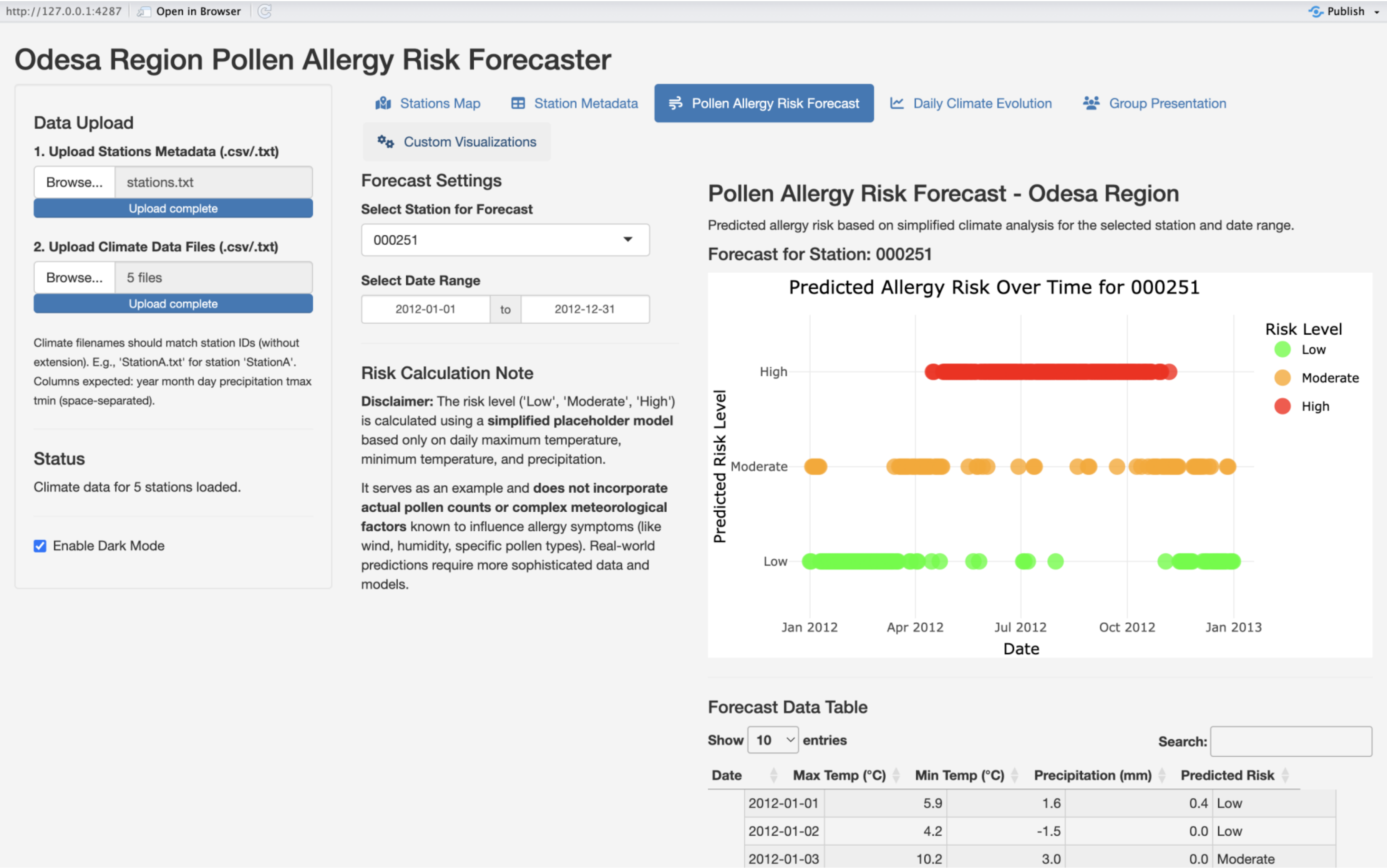
Using the App: Data Input to Insight



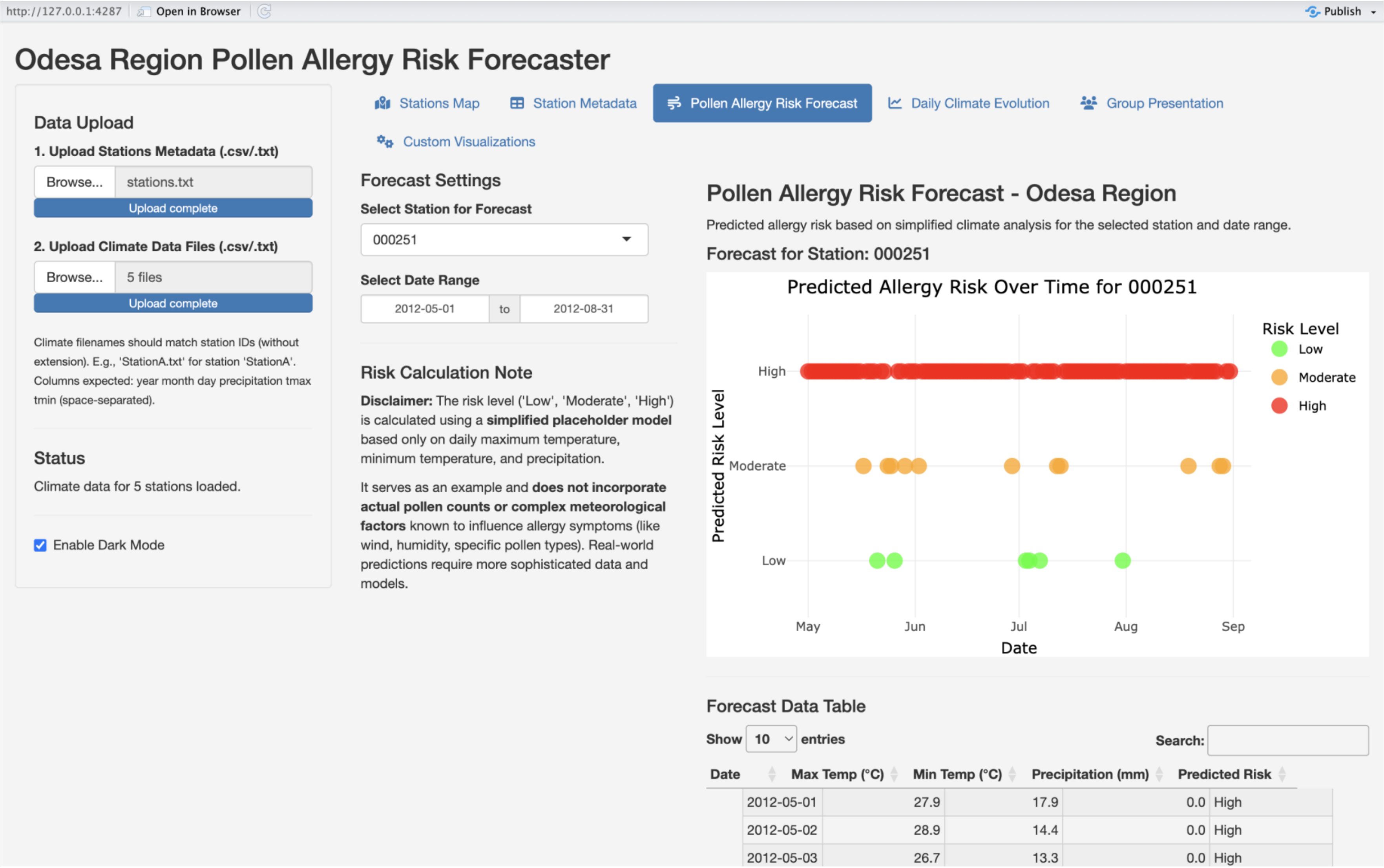
Using the App: Data Input to Insight



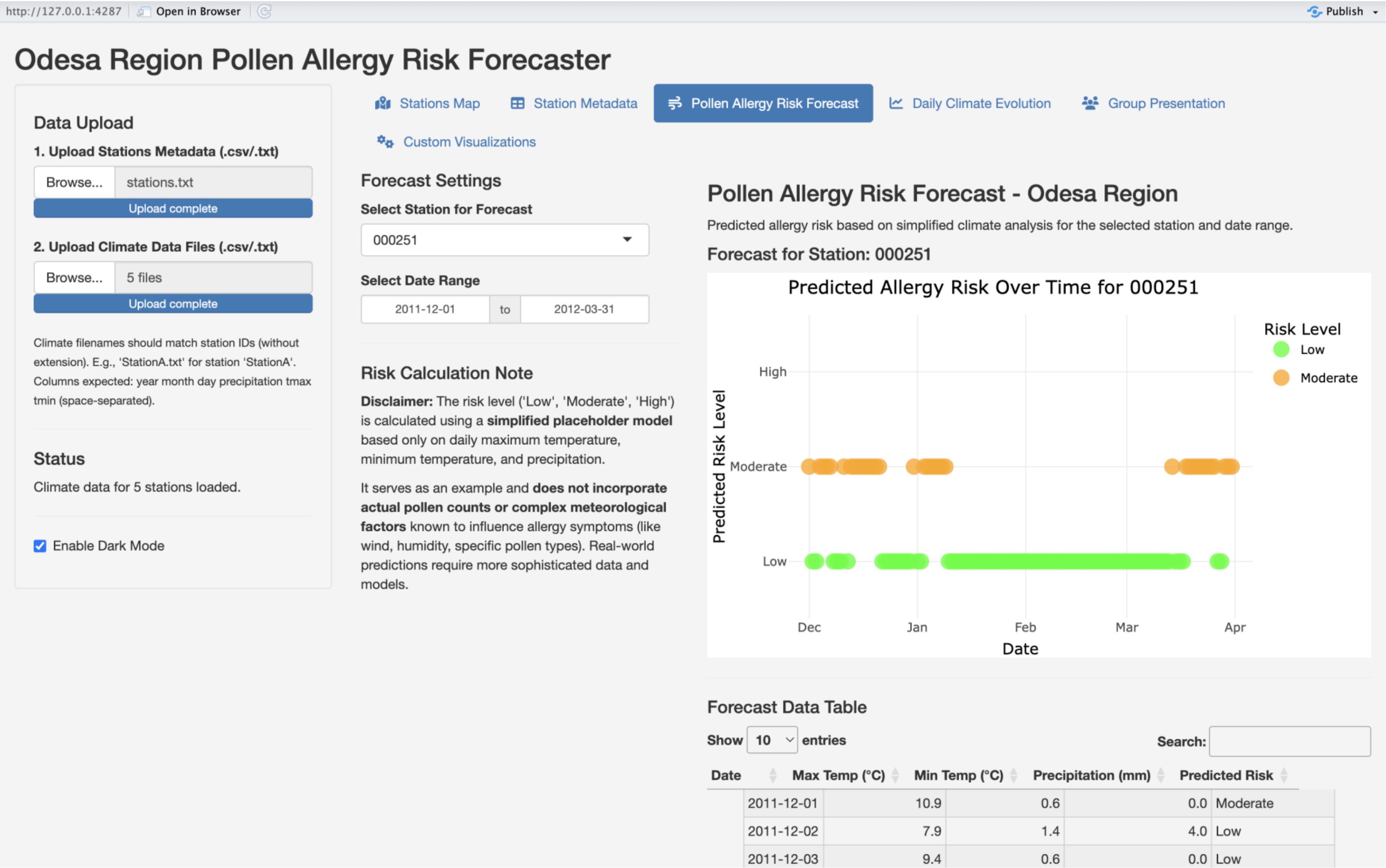
Using the App: Data Input to Insight



Using the App: Data Input to Insight



Using the App: Data Input to Insight



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!

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