# Ala-Too International University

## Faculty of Engineering and Informatics

## Department of Applied Mathematics and Informatics


# Climate Change in Central Asia


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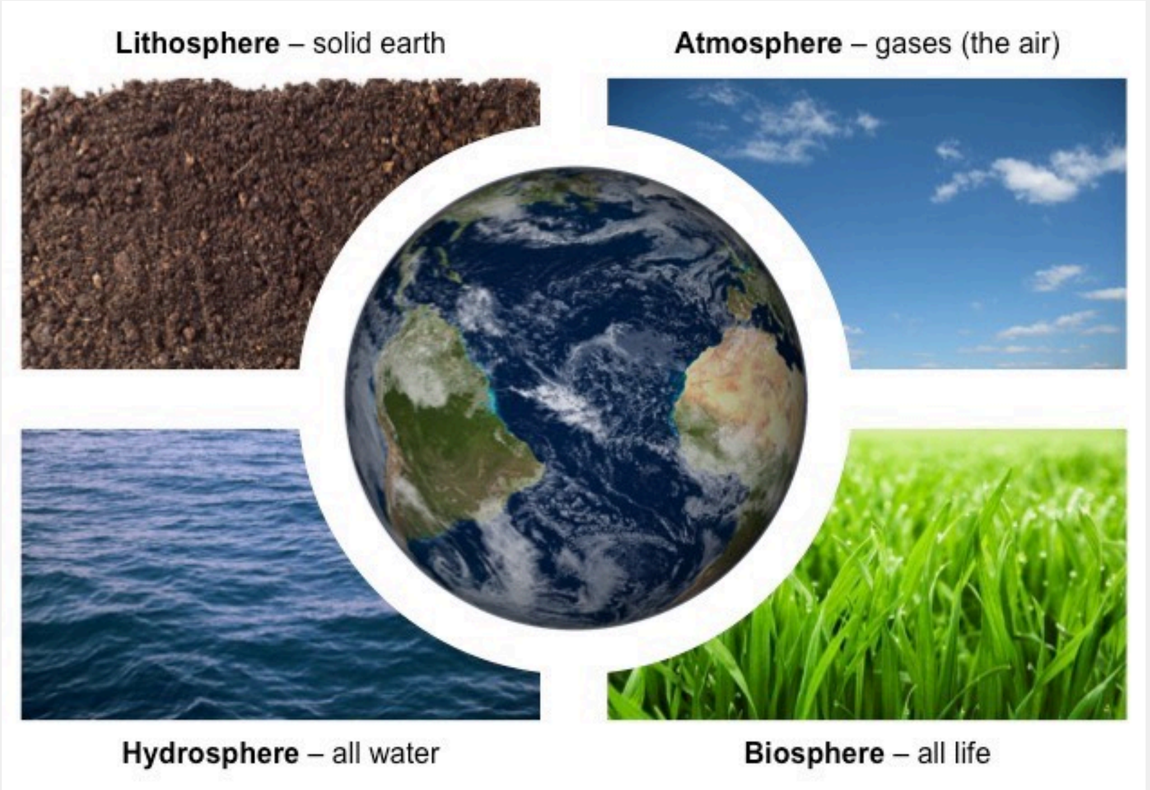
**Location: Bishkek, Kyrgyz Republic**

# Introduction

**Climate change is one of the most urgent global issues today.**
**We are already witnessing alarming consequences:**
**melting glaciers,extreme heatwaves,droughts,floods,rising sea levels.**

**Despite these facts, many people in Central Asia are unaware or dismissive of the seriousness of the climate crisis.**
**There is a lack of accessible digital tools to help visualize and understand climate risks.**
**Many individuals believe they can’t make a difference — and therefore, do nothing**

**It is importantant because everything is interconnected:**
**🌍 atmosphere, 🌊 hydrosphere, lithosphere,🌿 biosphere —**
**if one suffers, everything begins to collapse.**



# Objectives:

## General Objective

**To build an interactive web platform that raises awareness about climate risks in Central Asia and makes climate data more accessible and visual.**

## Specific Objectives

- Collect and preprocess real climate data from Central Asian countries
- Visualize key risks such as heatwaves, droughts, floods, and glacier loss
- Create interactive dashboards and maps to explore climate trends
- Analyze changes in temperature and rainfall patterns over time
- Apply machine learning models to forecast possible future scenarios

# Literature Review/Background Study Slide

**Key Theories, Concepts, or Related Work:**

- **Numerous climate data platforms and web applications already exist to monitor and visualize climate risks on a global scale.**
- **These platforms often provide scientific models, interactive maps, and projections based on data from NASA, IPCC, and similar institutions.**
- **Theoretical background includes concepts such as greenhouse gas emissions, global warming, and climate vulnerability assessment.**

**Gaps in Existing Studies:**

- **Many platforms are too complex for the average user — requiring advanced knowledge or multiple steps to access simple visualizations.**
- **Overloaded datasets make it difficult to quickly extract meaningful insights for specific areas.**
- **Some tools suffer from slow performance and are not optimized for accessibility or user experience.**

# Methodology

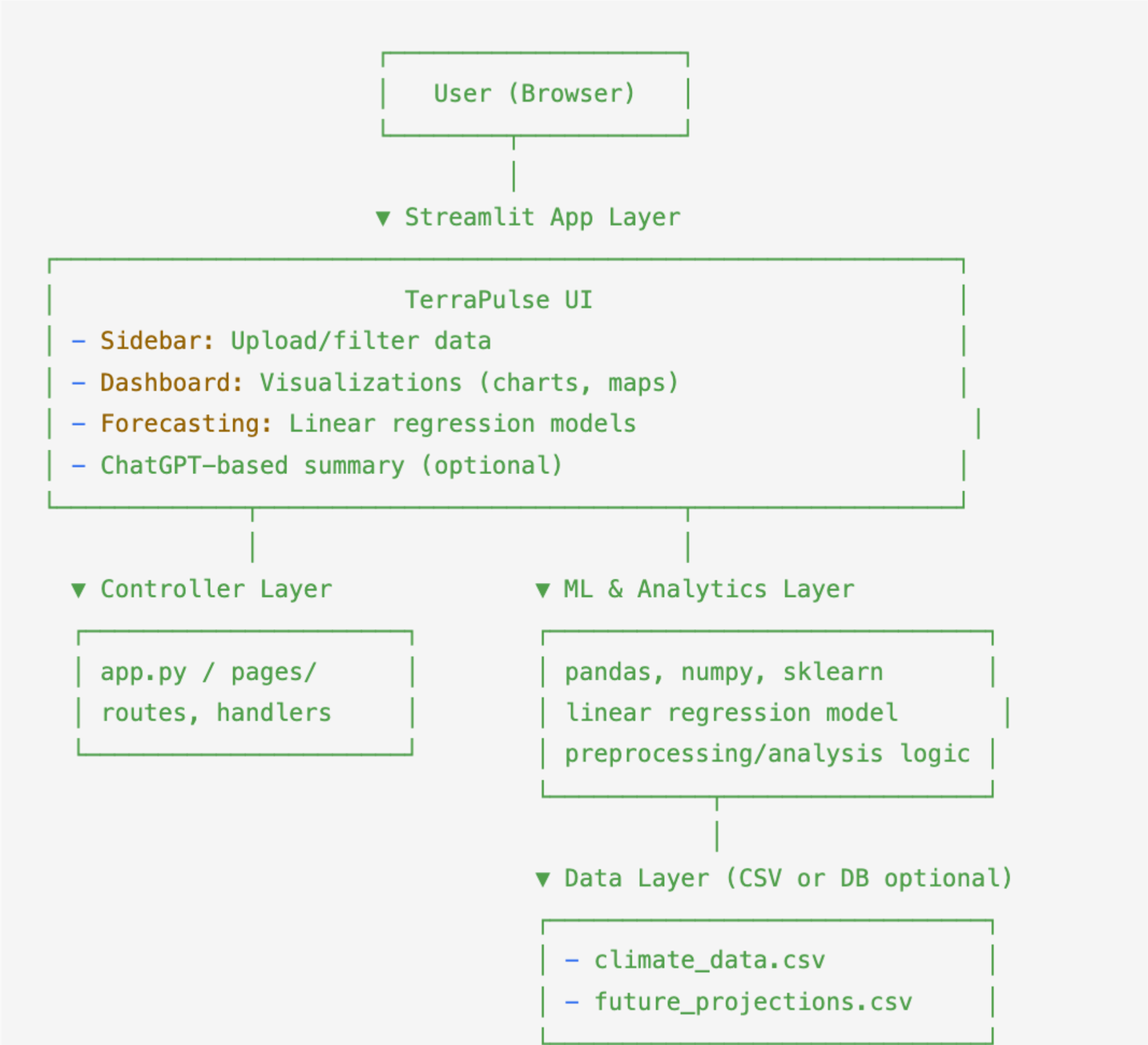
Tools & Technologies:

- Python (Pandas, Seaborn, Matplotlib, Plotly)
- Streamlit (for interactive web app)
- Scikit-learn (Linear Regression)
- Development environments: PyCharm, Jupyter Notebook, GitHub

Project Design & Development:

- Data collection and preprocessing
- Exploratory data analysis and visualization
- Implementation of predictive modeling using linear regression
- Building and refining the user-friendly interactive dashboard in Streamlit

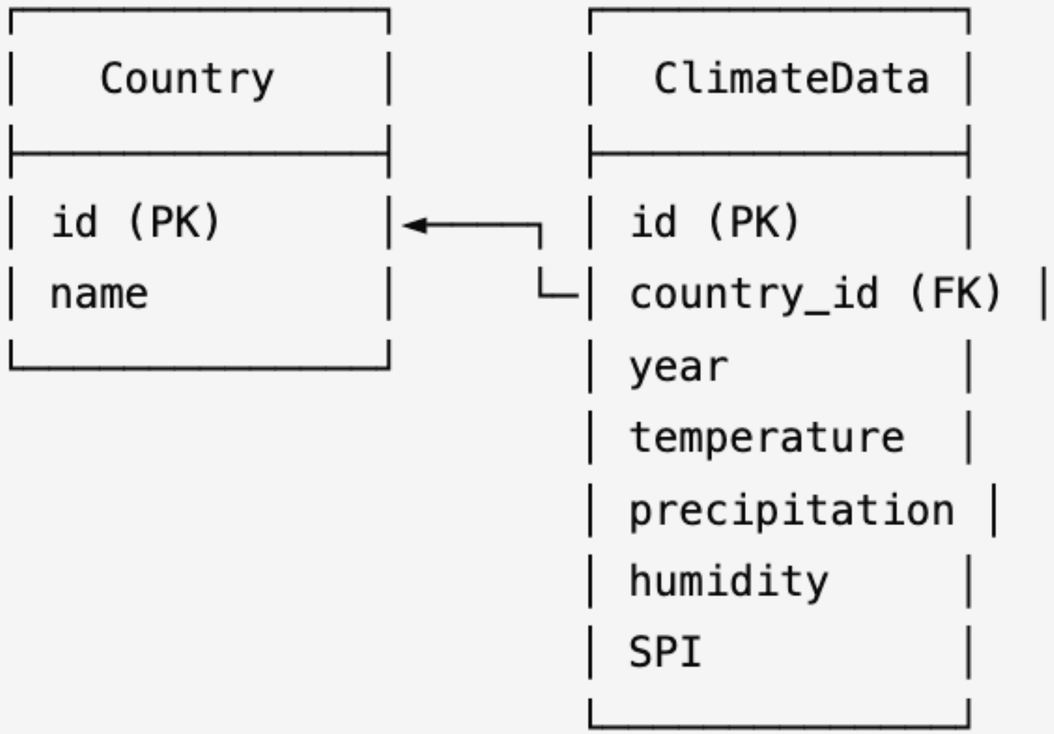
# System Design/Architecture Slide



Actor: User

Use Cases:

- Upload Climate Dataset
- Filter by Country/Year/Parameter
- View Summary Statistics
- Visualize on Charts/Maps
- Run Forecast Model
- Download Analysis (optional)



## Design Decisions

**1.Why Streamlit?**
**Easy to deploy and interactive for data apps, ideal for dashboards and visual storytelling.**
**2.Why CSV?**
**Simplicity in loading structured climate data from multiple sources without a backend database.**
**3.Why Linear Regression?**
**Transparent and interpretable model for climate trend prediction.**
**4.Why PyDeck/Choropleth?**
**Intuitive geospatial visualization of climate metrics across Central Asia.**

**Key Features and Functionalities:**

**Interactive map displaying climate data for Central Asian countries**
**Temperature forecasting using linear regression**

**Challenges Faced During Development:**

**Issues with installing required libraries and managing dependencies in the virtual environment**
**SSL certificate error when loading external GeoJSON files**
**Difficulties with rendering interactive maps using tools like pydeck and folium**
**Cache management and optimization in Streamlit for smoother performance**

# Datasets :
# (1990-2025 and 1991-2023)

| | Type | Min Temp | Mean Temp | Max Temp | Rainfall | Country |
|---|---|---|---|---|---|---|
| 0 | Jan | -17.75 | -12.83 | -7.96 | 25.57 | Kyrgyzstan |
| 1 | Feb | -15.17 | -10.24 | -5.35 | 35.55 | Kyrgyzstan |
| 2 | Mar | -7.74 | -2.73 | 2.26 | 46.84 | Kyrgyzstan |
| 3 | Apr | -1.01 | 4.73 | 10.48 | 55.63 | Kyrgyzstan |
| 4 | May | 3.02 | 8.99 | 15.00 | 66.94 | Kyrgyzstan |

| | Country | Date | AvgTemperature_C | Precipitation_mm | Humidity_% | DroughtIndex_SPI | Year |
|---|---|---|---|---|---|---|---|
| 0 | Kazakhstan | 1990-01-01 | 37.1 | 10.2 | 66.8 | 0.63 | 1990 |
| 1 | Kazakhstan | 1990-02-01 | 27.1 | 76.1 | 26.5 | 1.11 | 1990 |
| 2 | Kazakhstan | 1990-03-01 | 11.3 | 188.3 | 24.3 | -0.88 | 1990 |
| 3 | Kazakhstan | 1990-04-01 | 37.5 | 30.5 | 56.5 | -0.47 | 1990 |
| 4 | Kazakhstan | 1990-05-01 | -4.1 | 24.4 | 72.5 | -1.89 | 1990 |

```
final_df = pd.concat([main_df, uzbek_df], ignore_index=True)

# Сохраняем результат
final_df.to_csv(output_file, index=False)

print("✅ Данные по Узбекистану добавлены! Файл сохранён как:", output_file)
```

```
✅ Данные по Узбекистану добавлены! Файл сохранён как: central_asia_with_uzbekistan.csv
```

Ввод [20]:
```
final_df.fillna('Uzbekistan', inplace=True)
```

Ввод [21]:
```
import pandas as pd

# Загрузка CSV
final_df = pd.read_csv('central_asia_with_uzbekistan.csv')

# Заполнение всех пустых значений нулями
final_df.fillna('Uzbekistan', inplace=True)

# Сохранение обратно
final_df.to_csv('central_asia_clean.csv', index=False)

print("✅ Пустые значения успешно заполнены и файл сохранён.")
```

```
✅ Пустые значения успешно заполнены и файл сохранён.
```

Ввод [22]:
```
final_df.drop('Страна', axis=1, inplace=True)
final_df.to_csv('central_asia_.csv', index=False)
```

Ввод [23]:
```
print(final_df.columns)
```

```
Index(['Category', 'Average Minimum Surface Air Temperature',
       'Average Mean Surface Air Temperature',
       'Average Maximum Surface Air Temperature', 'Precipitation', 'Country'],
      dtype='object')
```

Ввод [39]:
```
final_df.rename(columns={
    'Category': 'Month',
    'Average Minimum Surface Air Temperature': 'Min Temp',
    'Average Mean Surface Air Temperature': 'Mean Temp',
```

```
Общие сведения о данных:
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 2160 entries, 0 to 2159
Data columns (total 6 columns):
 #   Column            Non-Null Count  Dtype
---  ------            --------------  -----
 0   Country           2160 non-null   object
 1   Date              2160 non-null   object
 2   AvgTemperature_C  2068 non-null   float64
 3   Precipitation_mm  2052 non-null   float64
 4   Humidity_%        2086 non-null   float64
 5   DroughtIndex_SPI  2063 non-null   float64
dtypes: float64(4), object(2)
memory usage: 101.4+ KB
None

Пропущенные значения по колонкам:
Country               0
Date                  0
AvgTemperature_C     92
Precipitation_mm    108
Humidity_%           74
DroughtIndex_SPI     97
dtype: int64

После обработки пропущенные значения:
Country             0
Date                0
AvgTemperature_C    0
Precipitation_mm    0
Humidity_%          0
DroughtIndex_SPI    0
Year                0
dtype: int64

Очищенный файл сохранен как central_asia_climate_cleaned.csv
```

# 🌡️ Climate Forecast for Central Asia

Select maximum forecast year

2062

2025

📊 Analysis Mode

- 📍 By Country
- 🌐 Compare All Countries

## 🌐 Country Comparison with Forecast

Select indicator

💧 Humidity (%)

- 🌡️ Temperature (°C)
- ☔ Precipitation (mm)
- 💧 Humidity (%)
- 🔥 Drought (SPI)

# Climate Forecast for Central Asia

Select maximum forecast year

2070

2025 2090

Analysis Mode

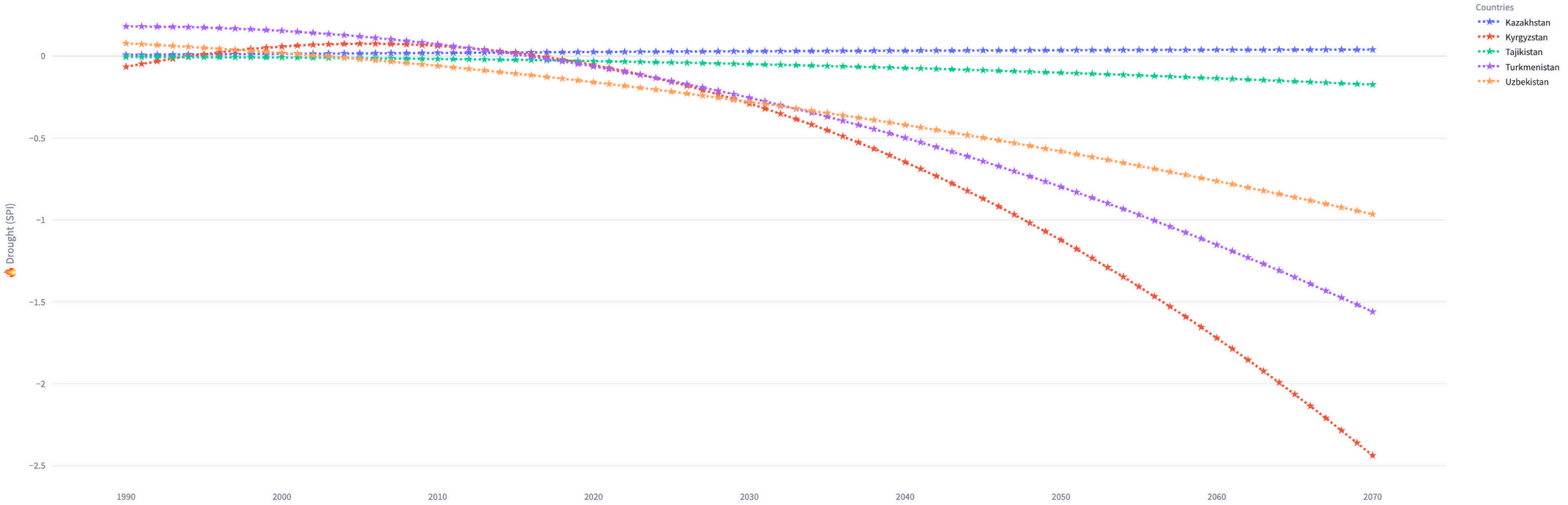
- By Country
- Compare All Countries

## Country Comparison with Forecast

Select indicator

Drought (SPI)

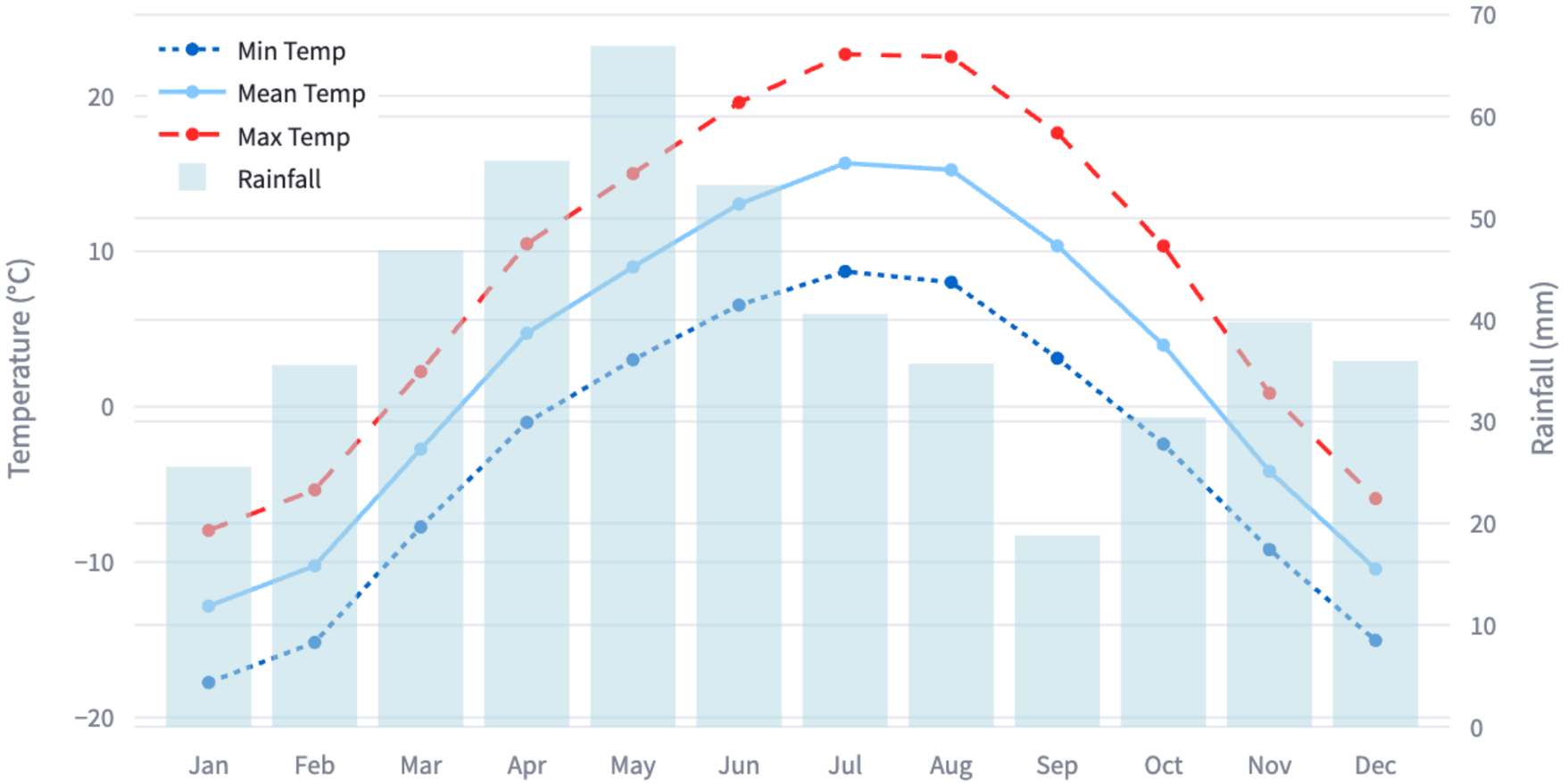
**Drought (SPI) — Country Comparison**



# 📈 Temperature and Rainfall by Country

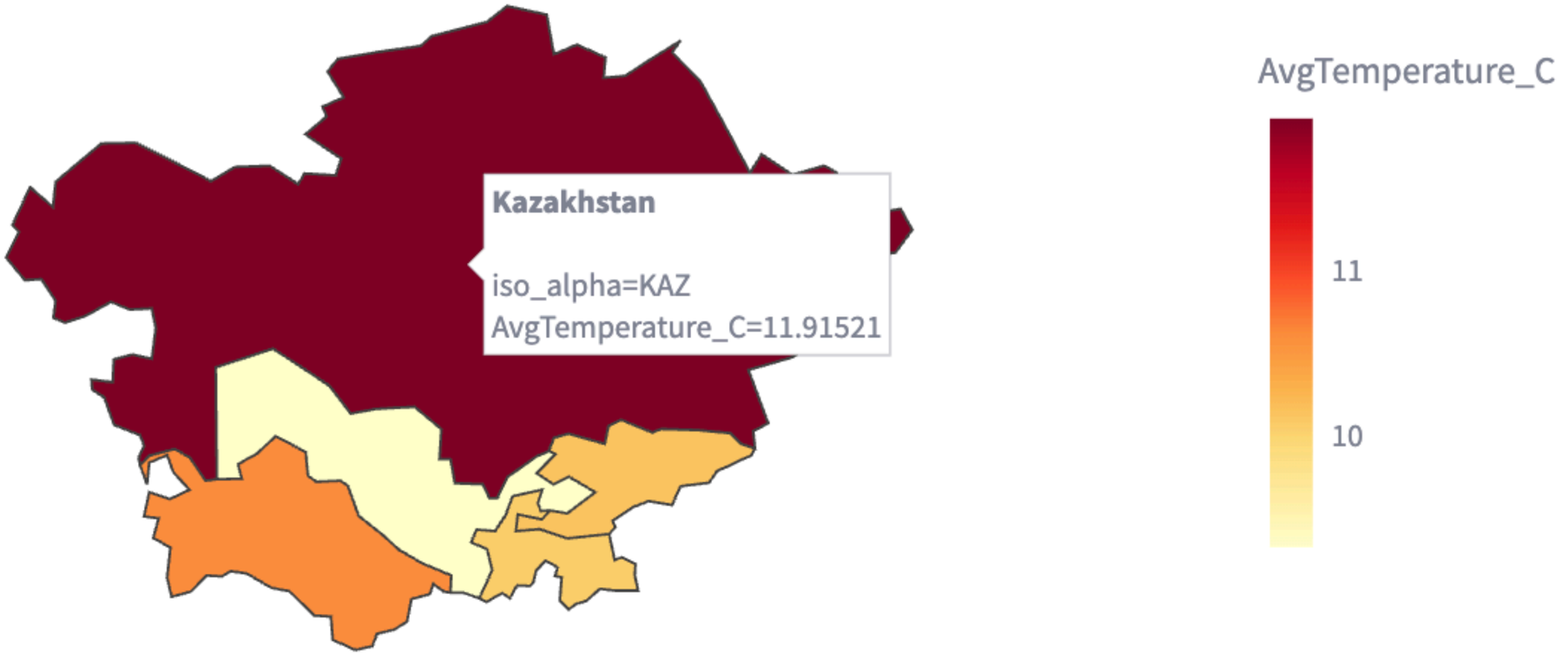
## Kyrgyzstan

**Temperature and Rainfall: Kyrgyzstan**



# 🗺️ Average Temperature Map of Central Asian Countries (1990–2025)

### 🌡️ Average Temperature by Central Asian Country



Select a Country

Kazakhstan

Select a Climate Parameter

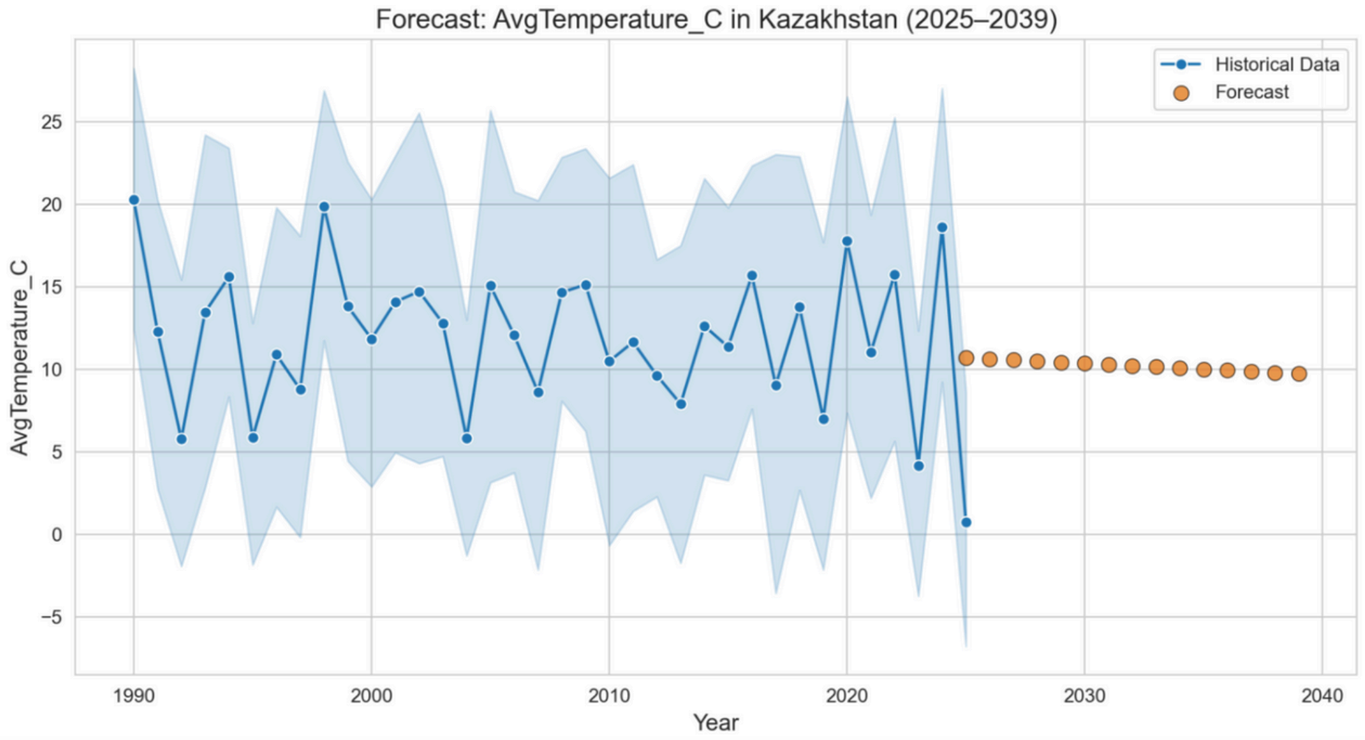
AvgTemperature_C

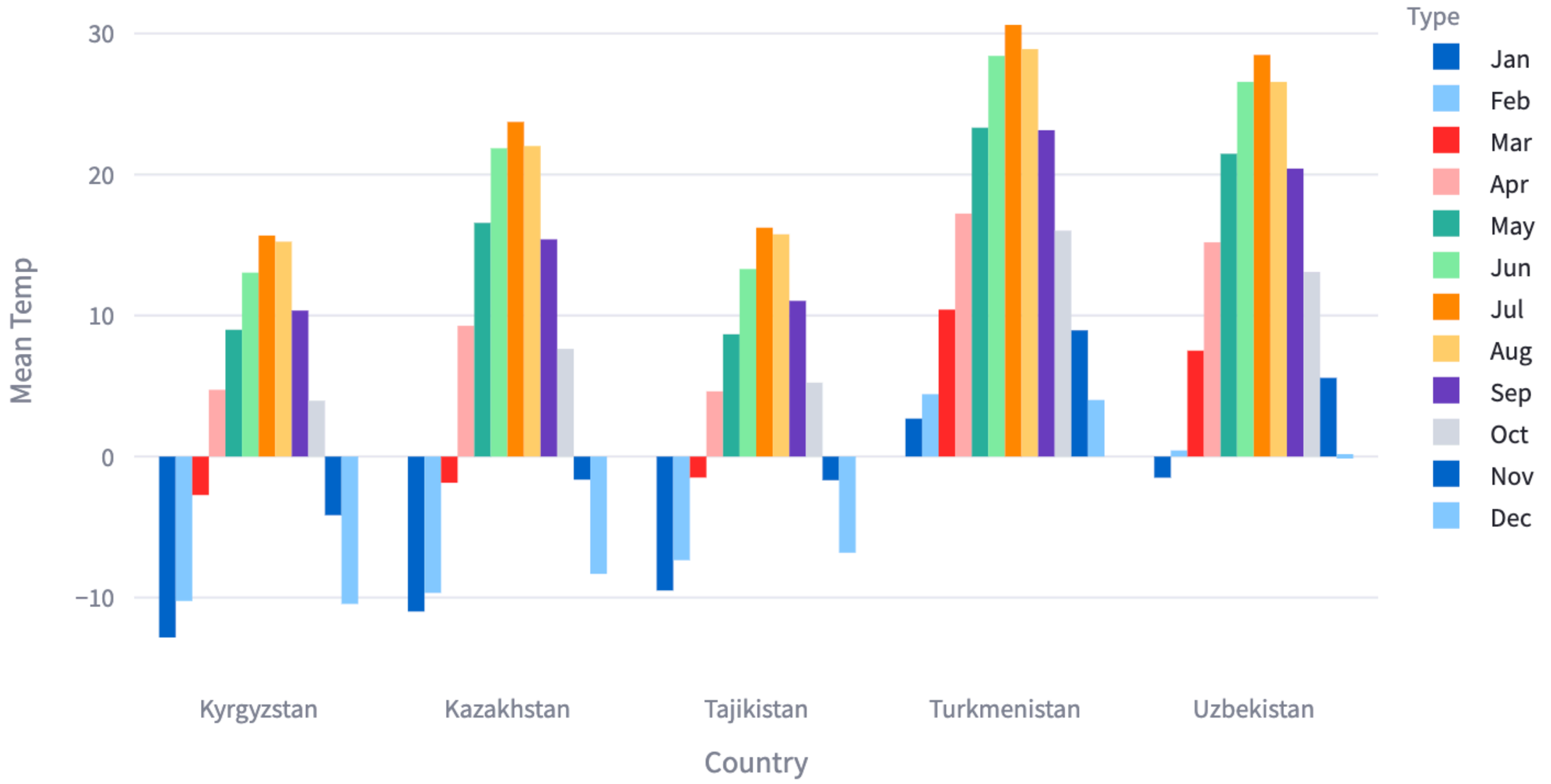
Select Forecast End Year

2039

2025 2090

# 📉 Forecast for: AvgTemperature_C in Kazakhstan




Mean Temp
30
20
10
0
−10
Kyrgyzstan
Kazakhstan
Tajikistan
Turkmenistan
Uzbekistan
Country
Type
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

unpredictable

**In this context, relying solely on short-term weather forecasts is not enough. What we need is a forward-looking, data-driven approach that enables governments, communities, and industries to prepare before the damage is done.**

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## The Need for an Early Warning System

### An effective early warning system does more than just track temperatures. It empowers us to:

### Predict long-term climate risks, not just daily weather

### Understand vulnerabilities across regions

### Deliver actionable insights that help prevent crisis

### Support climate resilience through smarter decisions

This project introduces an **AI-powered early warning platform for Central Asia** — designed to detect, visualize, and forecast climate risks across the region, giving people the tools to act **before the crisis hits**.

# 📊 Weather Data Visualization

## Data Table

| | Type | Min Temp | Mean Temp | Max Temp | Rainfall | Country |
|---|---|---|---|---|---|---|

## 🌍 Climate Risks in Central Asia

Central Asia — including Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan — faces increasing climate challenges due to global warming and environmental shifts. Based on recent climate data (1990–2025), the main risks include:

### 🔥 Rising Temperatures

Steady temperature growth, especially in Uzbekistan, Kyrgyzstan and southern Kazakhstan.
More heatwaves and higher energy demand for cooling.

### 💧 Water Scarcity

Glacier melt in Kyrgyzstan and Tajikistan 30% last 50 years threatens long-term water supply.
Severe drought risks in Uzbekistan, Turkmenistan, and Kazakhstan.
Tensions over transboundary water resources may increase.

## 🌪️ Extreme Weather

**More floods in mountainous areas.**

**Dust storms likely in desert regions of Turkmenistan and Uzbekistan.**

## 🌾 Agricultural Impact

**Soil degradation and desertification reduce crop yields.**

**Changing precipitation patterns disrupt farming cycles and food security.**

## ⛰️ Infrastructure and Geohazards

**Risk of landslides, glacial floods, and infrastructure damage (especially from permafrost thaw in Kazakhstan).**

## 👷 Public Health Concerns

**Rising temperatures and humidity increase disease spread.**

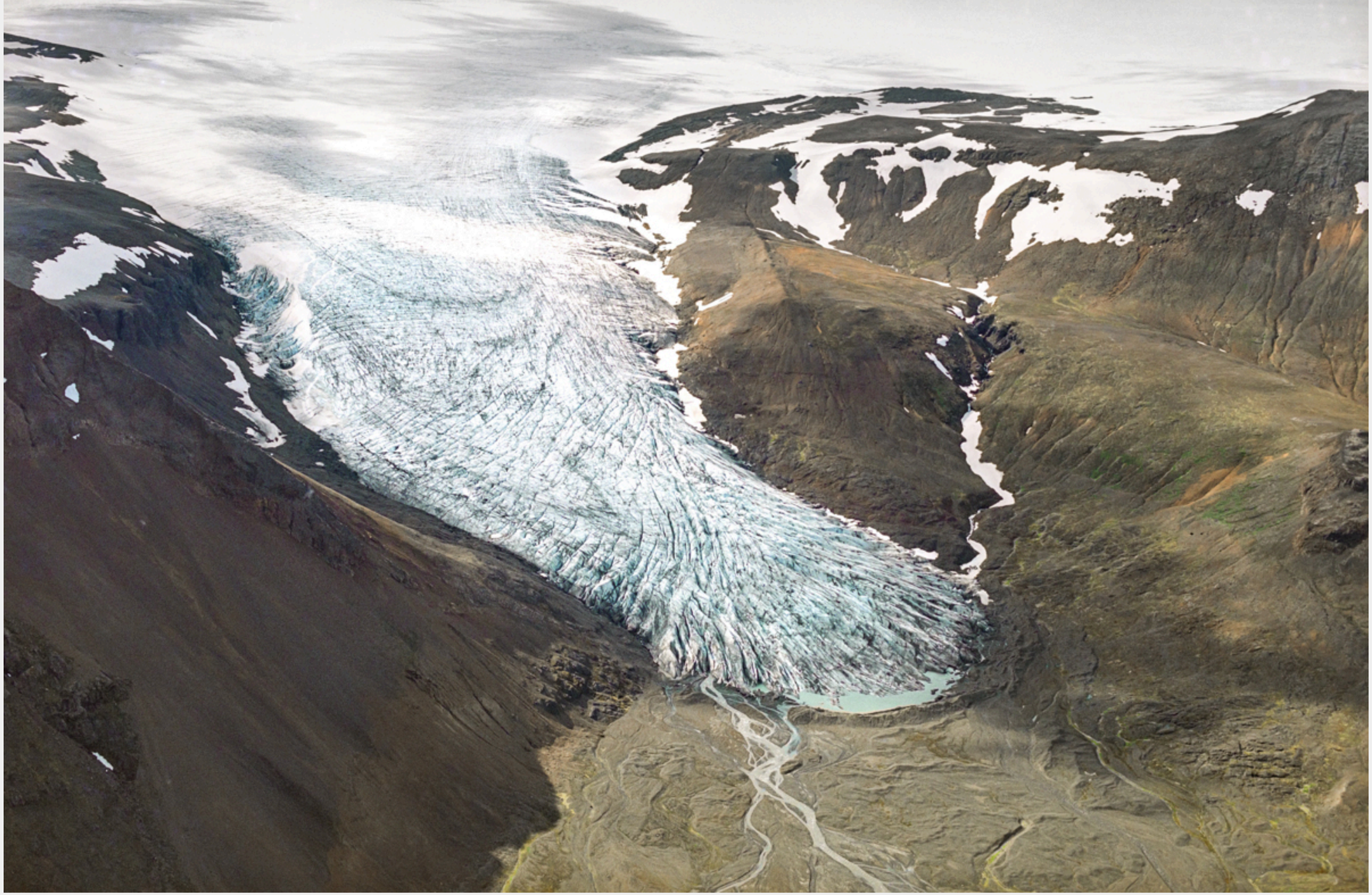
**More cases of respiratory and heat-related illnesses.**

## 3) Pakistan – Floods


## 4) Somalia – Drought


## 2) Madagascar – Cyclones, Droughts & Floods


## 7) The Sahel – Droughts, Wildfires & Floods



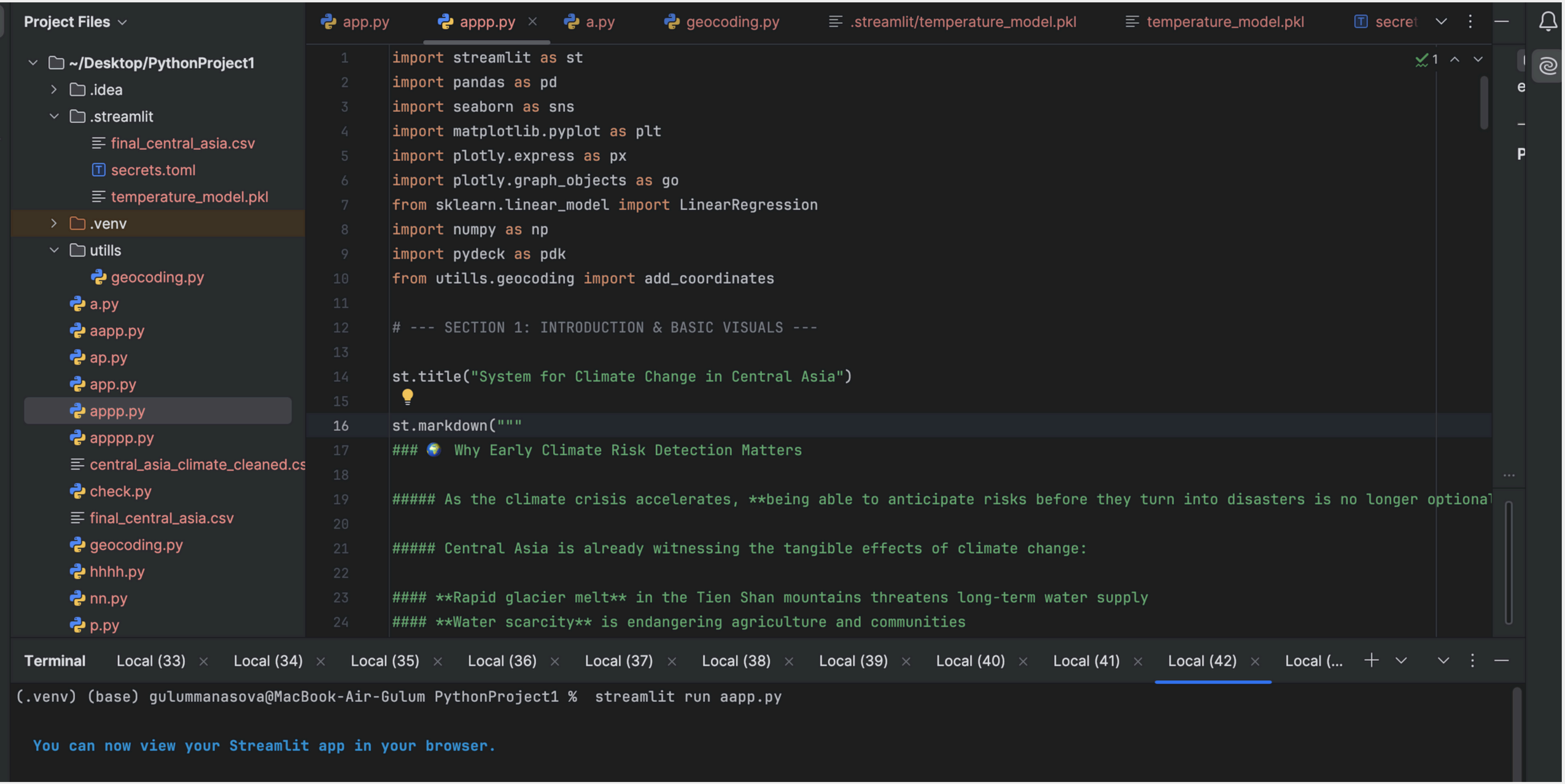
**Fossil fuels — coal, oil, and gas — are the largest contributors to global climate change, accounting for over 75 percent of global greenhouse gas emissions and nearly 90 percent of all carbon dioxide emissions.**

**Greenhouse gas emissions blanket the Earth, trapping the sun’s heat. This leads to global warming and climate change. Currently, the planet is warming faster than at any other time in human history. Rising temperatures over time alter weather patterns and disrupt the natural balance. This creates numerous risks for people and all other forms of life on Earth.**

**Here’s a clear and concise answer to “What must we do?” regarding climate change:**

**To combat climate change effectively, we must:**

- **Reduce fossil fuel use by transitioning to renewable energy sources like solar, wind, and hydro power.**
- **Increase energy efficiency in industry, transportation, and buildings.**
- **Protect and restore forests and natural ecosystems that absorb carbon dioxide.**
- **Adopt sustainable agriculture and water management practices.**
- **Promote global cooperation to set and meet emissions reduction targets.**
- **Invest in climate adaptation to protect vulnerable communities from unavoidable impacts.**
- **Raise public awareness and encourage behavioral changes toward a low-carbon lifestyle.**
- **Only through urgent, coordinated action can we limit global warming and protect the planet for future generations.**


Project Files
~/Desktop/PythonProject1
.idea
.streamlit
final_central_asia.csv
secrets.toml
temperature_model.pkl
.venv
utills
geocoding.py
a.py
aapp.py
ap.py
app.py
appp.py
apppp.py
central_asia_climate_cleaned.cs
check.py
final_central_asia.csv
geocoding.py
hhhh.py
nn.py
p.py
app.py
appp.py
a.py
geocoding.py
.streamlit/temperature_model.pkl
temperature_model.pkl
secret
import streamlit as st
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
import plotly.express as px
import plotly.graph_objects as go
from sklearn.linear_model import LinearRegression
import numpy as np
import pydeck as pdk
from utills.geocoding import add_coordinates
# --- SECTION 1: INTRODUCTION & BASIC VISUALS ---
st.title("System for Climate Change in Central Asia")
st.markdown("""
### 🌍 Why Early Climate Risk Detection Matters
##### As the climate crisis accelerates, **being able to anticipate risks before they turn into disasters is no longer optional
##### Central Asia is already witnessing the tangible effects of climate change:
#### **Rapid glacier melt** in the Tien Shan mountains threatens long-term water supply
#### **Water scarcity** is endangering agriculture and communities
Terminal
Local (33)
Local (34)
Local (35)
Local (36)
Local (37)
Local (38)
Local (39)
Local (40)
Local (41)
Local (42)
Local (...
(.venv) (base) gulummanasova@MacBook-Air-Gulum PythonProject1 % streamlit run aapp.py
You can now view your Streamlit app in your browser.

**Testing results:**

Login test — successful, no errors found

Data processing test — correct, no issues detected

Performance test — response time around 0.5 seconds

**User feedback:**

No real user feedback collected yet, interviews planned

Expected user-friendly interface

heatmap showing data by month, year, and region

Performance metrics:

Response time — approximately 0.5 seconds

Memory usage — 150Kb

# Conclusion

**Recap of the project:**
**This project analyzed climate risks in Central Asia based on historical and recent climate data, focusing on temperature changes, droughts, and precipitation patterns.**

**Future work, improvements, and recommendations:**

**There are significant risks of drought and anomalous heat in the future for Central Asia and worldwide.**

**To mitigate these risks, urgent actions are needed:**

- **Reduce carbon dioxide emissions globally by transitioning to renewable energy sources.**
- **Improve water management and conservation techniques to prepare for droughts.**
- **Increase ecological restoration efforts and protect forests and wetlands.**
- **Promote public awareness and policies supporting climate adaptation and resilience.**

References:


- NASA. (2023). Greenland Ice Loss. Retrieved from: https://climate.nasa.gov/vital-signs/ice-sheets/

- IPCC. (2023). Sixth Assessment Report – Climate Change 1990-2025: Synthesis Report. Intergovernmental Panel on Climate Change. https://www.ipcc.ch/report/ar6/syr/

**Thank you for your attention!**