Climate Trends in Capital Cities

75 Year SQL-Based Analysis (1950-2024)

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Agenda

- Introduction and project objective
- Global temperature trends (1950–2024)
- Identification of fastest warming capital cities
- Analysis of extreme weather events (heatwaves, heavy rainfall)
- Geographic comparisons: latitude and climate patterns
- Seasonal variation across regions and hemispheres
- Sunshine duration analysis and solar potential
- Key climate impacts
- Conclusions and recommendations

Introduction

This project presents a data-driven analysis of long-term climate trends across global capital cities from 1950 to 2024. Using a 75-year historical weather dataset and SQL queries, we examine key indicators such as temperature, precipitation, and sunshine duration to uncover regional climate shifts and anomalies.

The goal is to identify patterns of global warming, extreme weather events, and environmental changes that affect urban resilience and policy planning. Through this analysis, we highlight the cities most impacted and provide insights to support climate-aware decision-making.

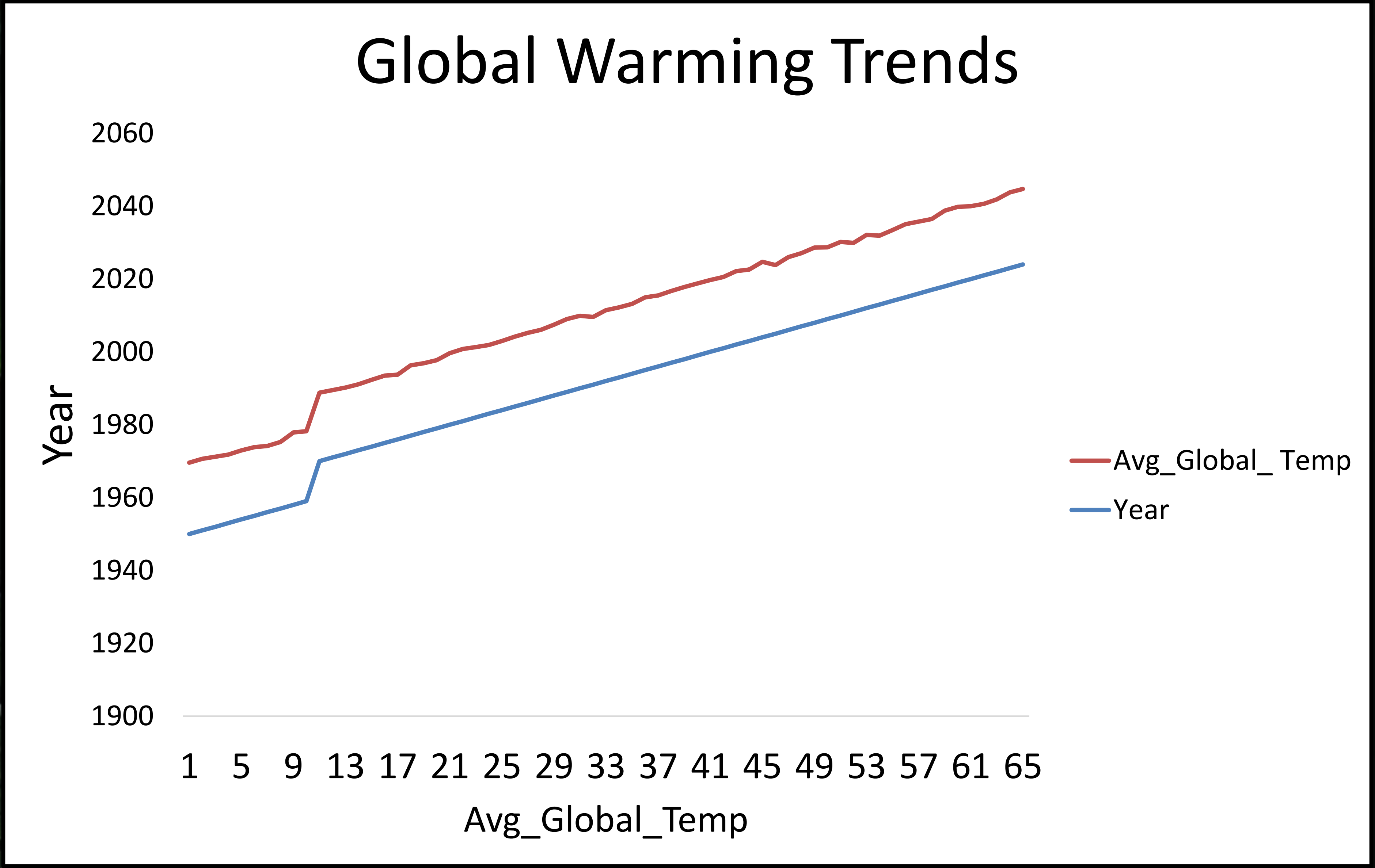
PROJECT OVERVIEW

- Objective: Analyze long-term climate patterns across global capital cities using SQL and weather data.
- Dataset: 75 years of daily weather data for global capital cities.
- Data Tables : cities, daily_data
- Data Sources: @Kaggle Dataset

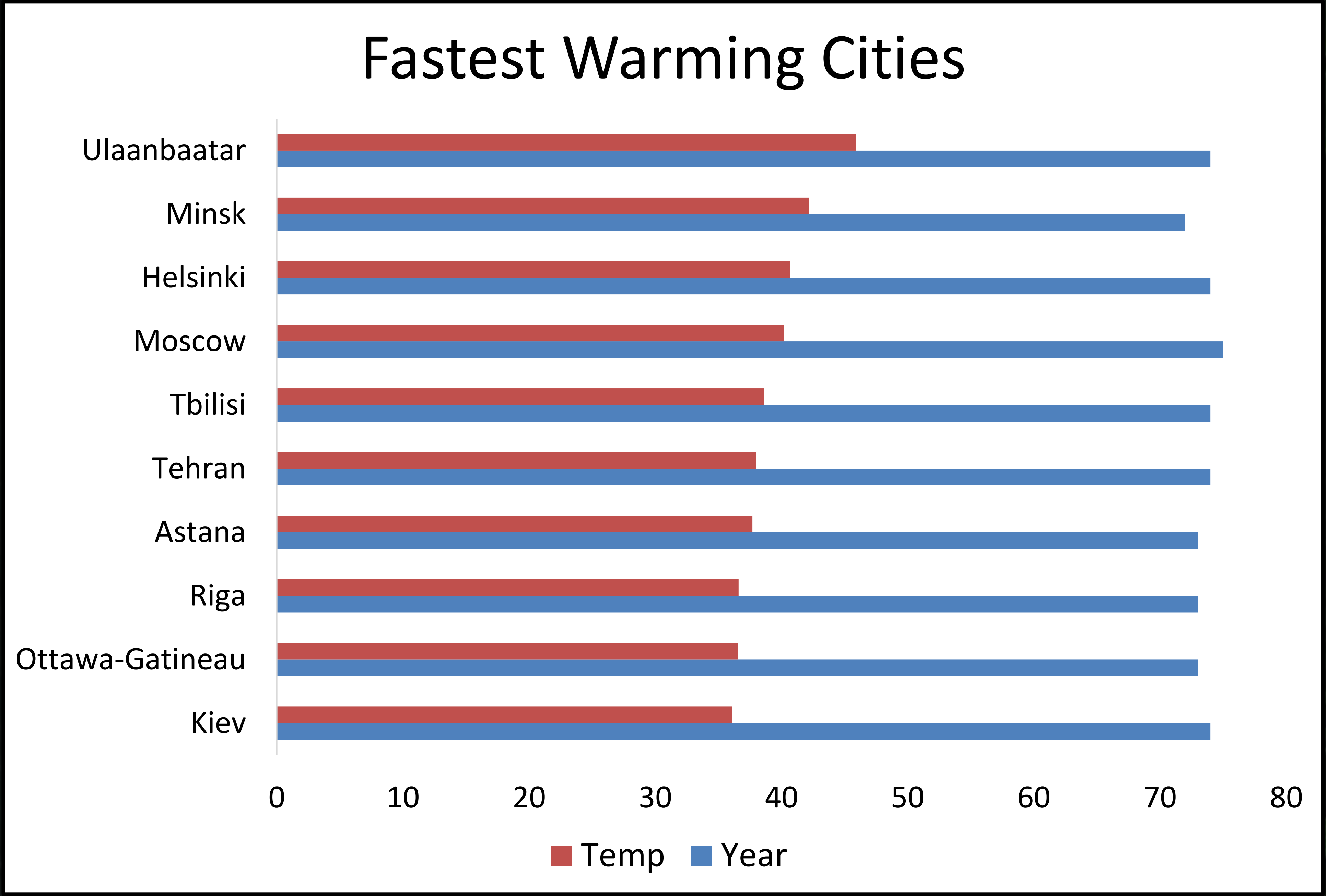
Global Warming Trends

```sql
-- Global average temperature trend per year
SELECT year,
ROUND(AVG(temperature_2m_mean), 2) AS avg_global_temp
FROM daily_data
WHERE year BETWEEN 1950 AND 2024
GROUP BY year
ORDER BY year;
```

- **Average global temperature has risen by over 2°C since 1950**



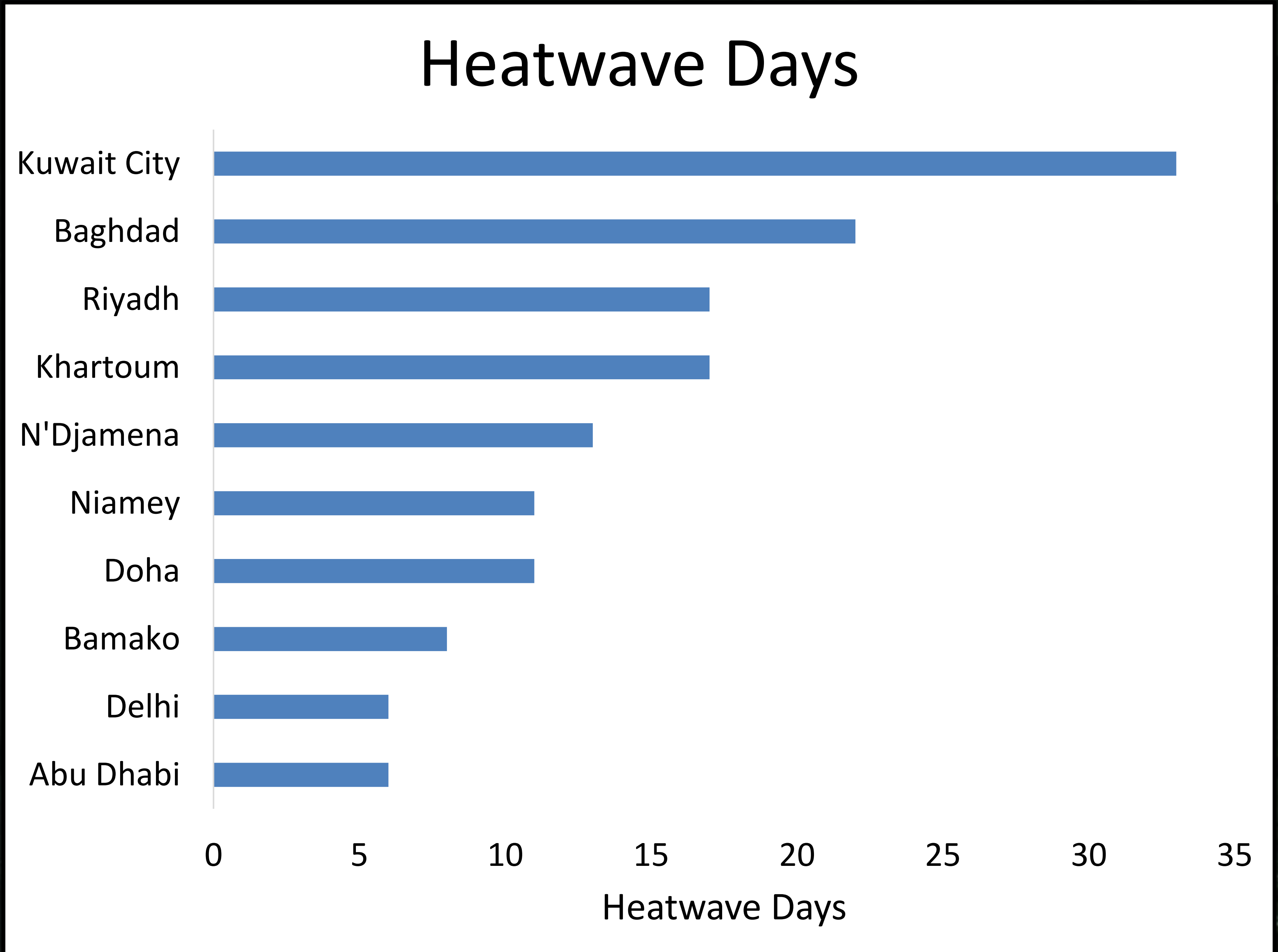
Fastest Warming Capital Cities




```sql
-- Fastest Warming Capital Cities (1950-2024)
SELECT city_name,
       MAX(year) - MIN(year) AS years_covered,
       MAX(avg_temp) - MIN(avg_temp) AS temp_rise
FROM ( SELECT city_name, year,
     ROUND(AVG(temperature_2m_mean), 2)
     AS avg_temp
     FROM daily_data
     GROUP BY city_name, year
) yearly_avg
GROUP BY city_name
ORDER BY temp_rise DESC
LIMIT 10;
```

- **Cities like Ulaanbaatar, Minsk, and Helsinki have experienced the steepest rise in average temperatures since 1950, indicating rapid local climate change in colder regions.**

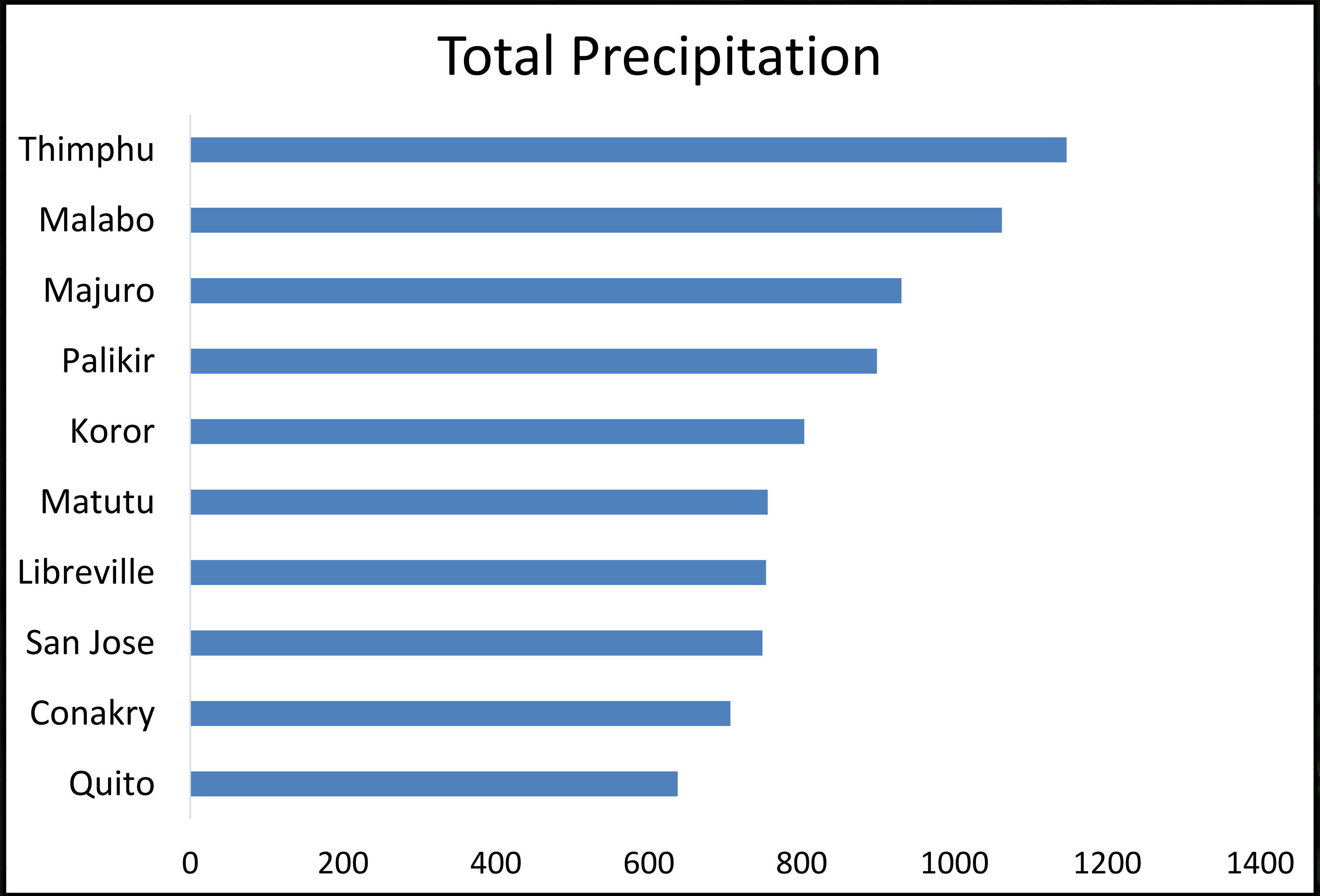
Heatwaves




```sql
-- Cities with Most Heatwave Days (> 40°C)
SELECT city_name,
    COUNT(*) AS heatwave_days
FROM daily_data
WHERE temperature_2m_max > 40
GROUP BY city_name
ORDER BY heatwave_days DESC
LIMIT 10;
```

- Kuwait City and Baghdad recorded the highest number of extreme heat days above 40°C, with several Middle Eastern and North African cities also showing high exposure.

Heavy Rainfall

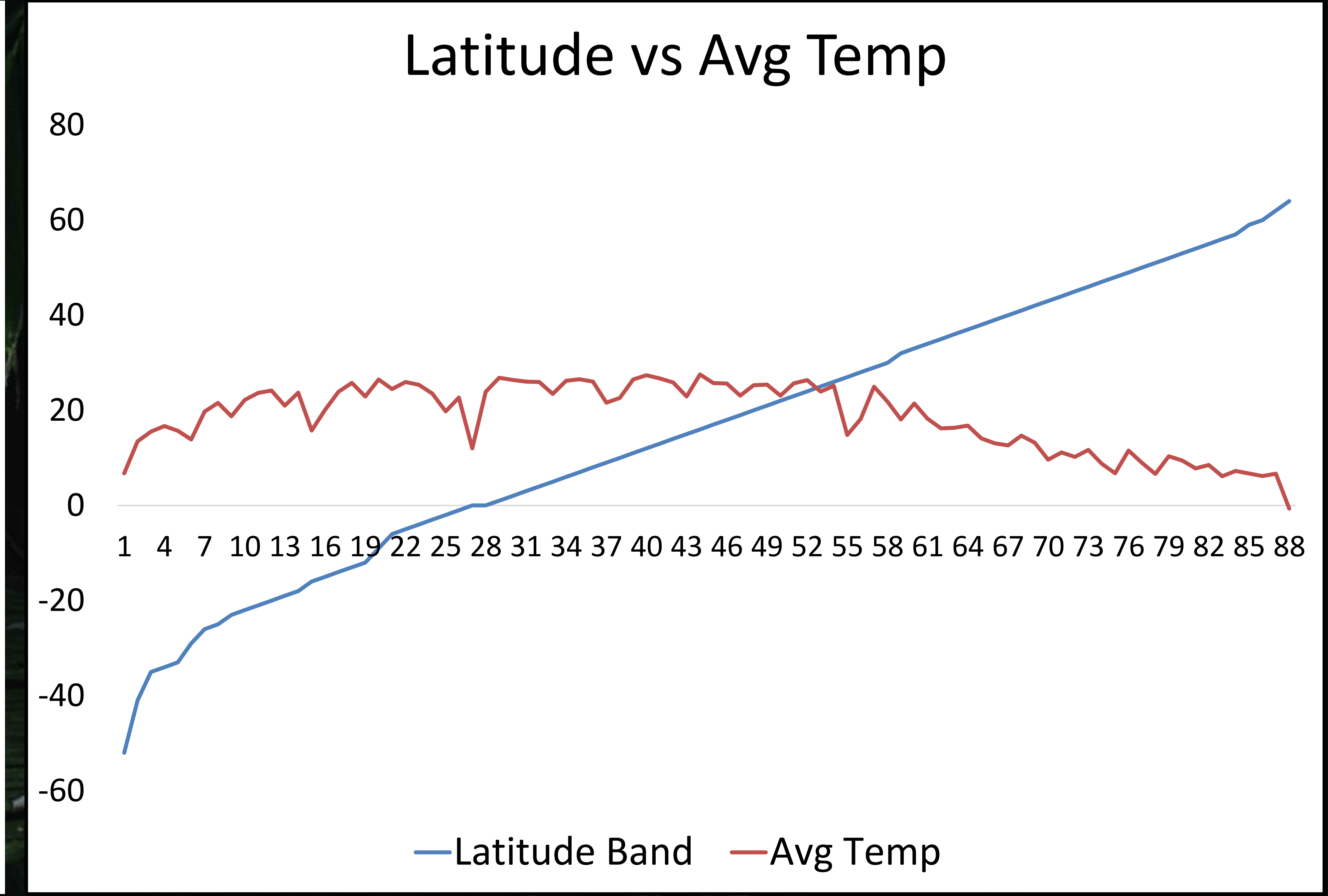



```sql
-- Cities with Highest Total Precipitation
SELECT city_name,
    ROUND(SUM(precipitation_sum), 2)
    AS total_precipitation
FROM daily_data
GROUP BY city_name
ORDER BY total_precipitation DESC
LIMIT 10;
```

- **Total annual rainfall has increased significantly in tropical zones since the 1980s**

Latitude & Climate Impact

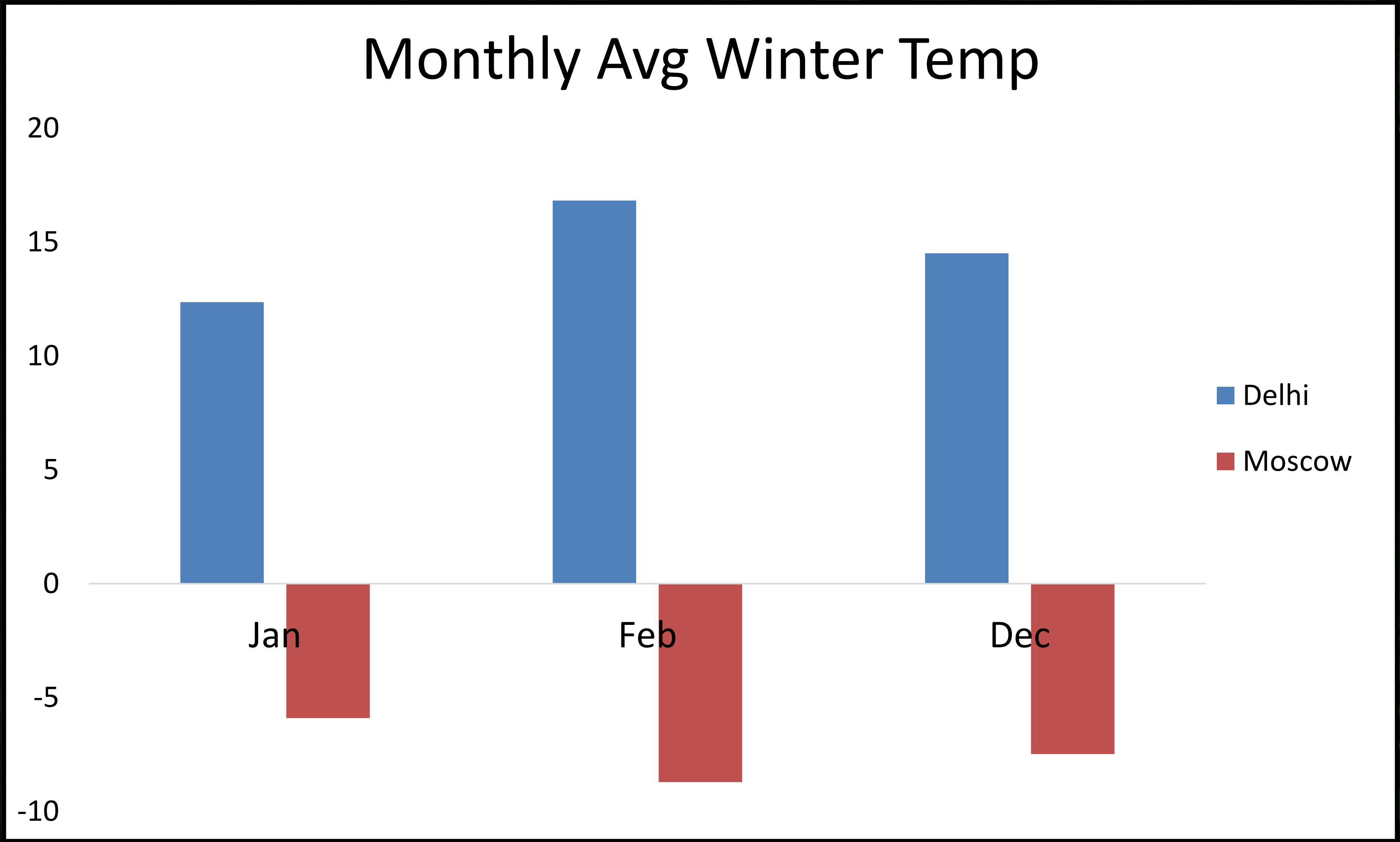
```sql
-- Average Temperature vs Latitude
SELECT
    ROUND(c.latitude, 0) AS latitude_band,
    ROUND(AVG(d.temperature_2m_mean), 2) AS avg_temperature
FROM daily_data d
INNER JOIN cities c ON d.city_name = c.city_name
WHERE d.year BETWEEN 1950 AND 2024
GROUP BY ROUND(c.latitude, 0)
ORDER BY latitude_band;
```



- Cities at similar latitudes show up to 3°C temperature differences due to local factors

Seasonal Variations

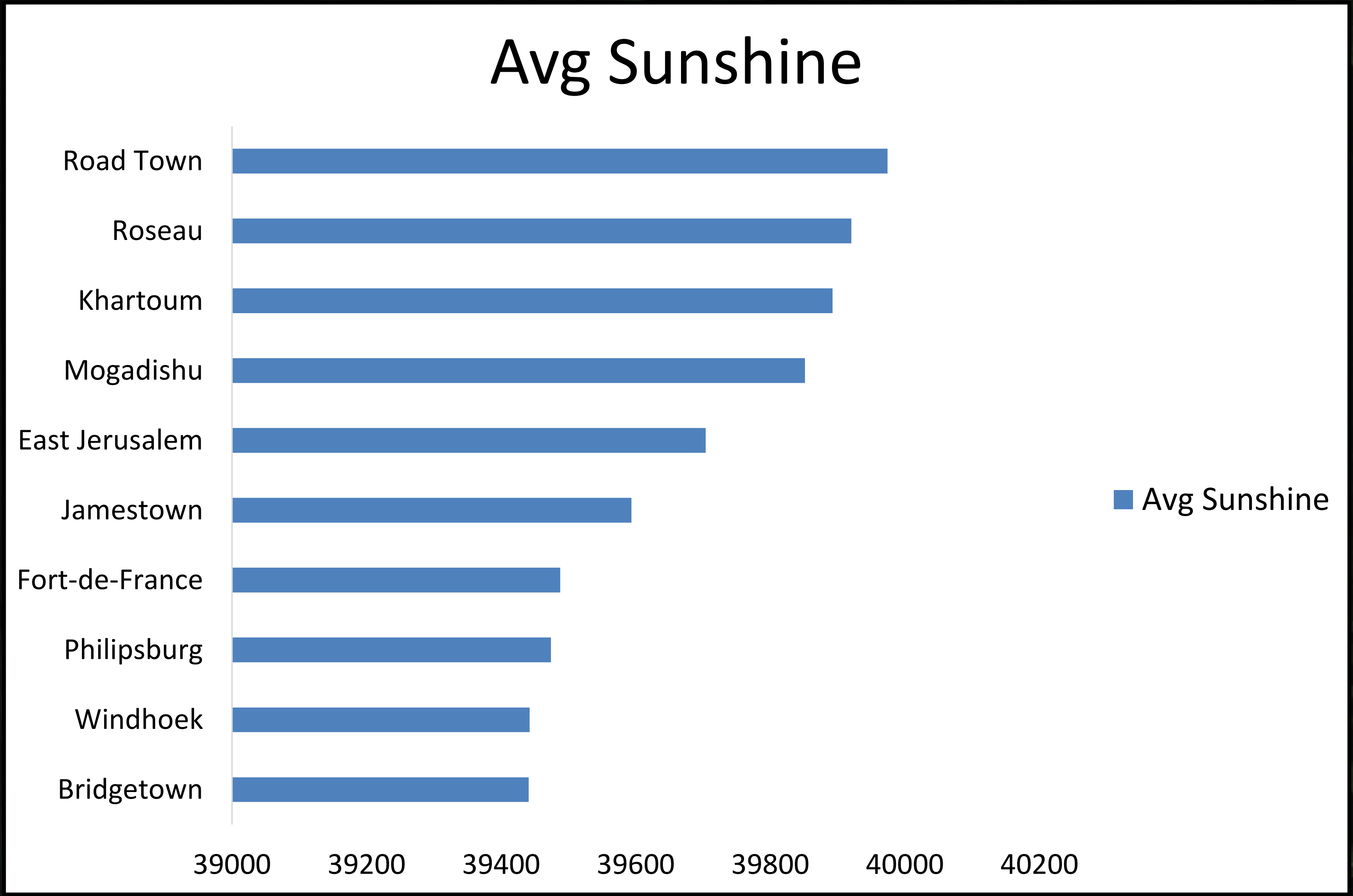
Compare average winter temperatures
(e.g. Moscow vs Delhi)




```sql
SELECT city_name, EXTRACT(MONTH FROM sunrise) AS month,
ROUND(AVG(temperature_2m_mean), 2) AS avg_temp
FROM daily_data
WHERE city_name IN ('Moscow', 'Delhi') AND
EXTRACT(MONTH FROM sunrise) IN (12, 1, 2)
GROUP BY city_name, month;
```

- **Winter temperatures in Moscow drop below freezing, while New Delhi remains above 15°C**

Sunshine Duration Patterns




```sql
-- Cities with most sunshine hours per year
SELECT city_name,
ROUND(AVG(sunshine_duration), 2) AS avg_sunshine
FROM daily_data
GROUP BY city_name
ORDER BY avg_sunshine DESC;
```

- **Road Town, Roseau, and Khartoum receive the lowest sunshine duration, suggesting strong solar energy potential**

Key Problems Identified

- **Global Warming**:
Average temperatures in many capital cities have risen by over 2–4°C since 1950

- **Heatwave Frequency**:
Increasing number of days exceeding 40°C, especially in arid and tropical regions

- **Rising Precipitation**:
Significant increases in annual rainfall in several regions, raising flood risks

- **Urban Heat Islands**:
Cities showing higher average temperatures than nearby areas or similar-latitude locations

- **Sunshine Disparity**:
Uneven distribution of sunshine hours impacts solar energy planning and availability

- **Latitude-Climate Mismatch**:
Cities at similar latitudes show vastly different climates due to local geography and urbanization

- **Seasonal Extremes**:
Opposite seasonal patterns across hemispheres affect energy demand and agriculture

Impacts of Climate Trends

- **Global Warming**
  – More heatwaves
  – Higher cooling costs
  – Ecosystem stress

- **Extreme Weather**
  – Floods, snow damage
  – Emergency costs
  – Displacement risks

- **Increased Rainfall**
  – Flood risk
  – Crop loss
  – Infrastructure strain

- **Urban Heat Islands**
  – Hotter cities
  – Poor air quality
  – Energy overload

- **Seasonal Variability**
  – Opposite hemispheres
  – Energy demand shifts
  – Travel & agriculture impact

- **Uneven Sunshine**
  – Solar power issues
  – Grid instability
  – Crop cycle changes

- **Latitude–Climate Mismatch**
  – Poor climate planning
  – Misallocated resources
  – Policy inaccuracy

Conclusion

- Climate change is clearly visible in capital cities across the globe, with some cities experiencing a temperature rise of more than 3.5°C over 75 years.
- Precipitation trends show increased rainfall in tropical and subtropical regions.
- Latitude alone does not define climate; local and urban factors play a major role.
- SQL-based historical analysis has helped uncover meaningful insights, which can guide climate policy and planning.

Recommendations

- Promote renewable energy adoption in rapidly warming cities
- Increase green infrastructure to reduce urban heat island effects
- Upgrade drainage and flood management systems in high-rainfall areas
- Use sunshine duration data to optimize solar energy deployment
- Base climate strategies on localized data, not just geographic assumptions
- Implement seasonal planning in sectors like agriculture, energy, and tourism
- Integrate SQL-based climate analysis into policy and decision-making frameworks

Thank you for your attention!