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# Spatial Data Studio

## Working with global climate data

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# 1 Introduction

Khyber Pakhtunkhwa (KPK) is a diverse region in northwestern Pakistan, known for its varied topography, ranging from high mountains in the north to plains in the south. The region experiences a distinct climate influenced by its altitude, with cold winters and warm summers in the mountainous areas, while the plains have hotter summers and milder winters. Monsoon rains impact the central and southern areas, bringing significant seasonal rainfall. KPK's climate patterns and solar exposure make it a unique area for studying environmental and climatic variations across different landscapes.

# 2 Description of work

## 2.1 Task 1 - Mapping average temperature for Kpk Region

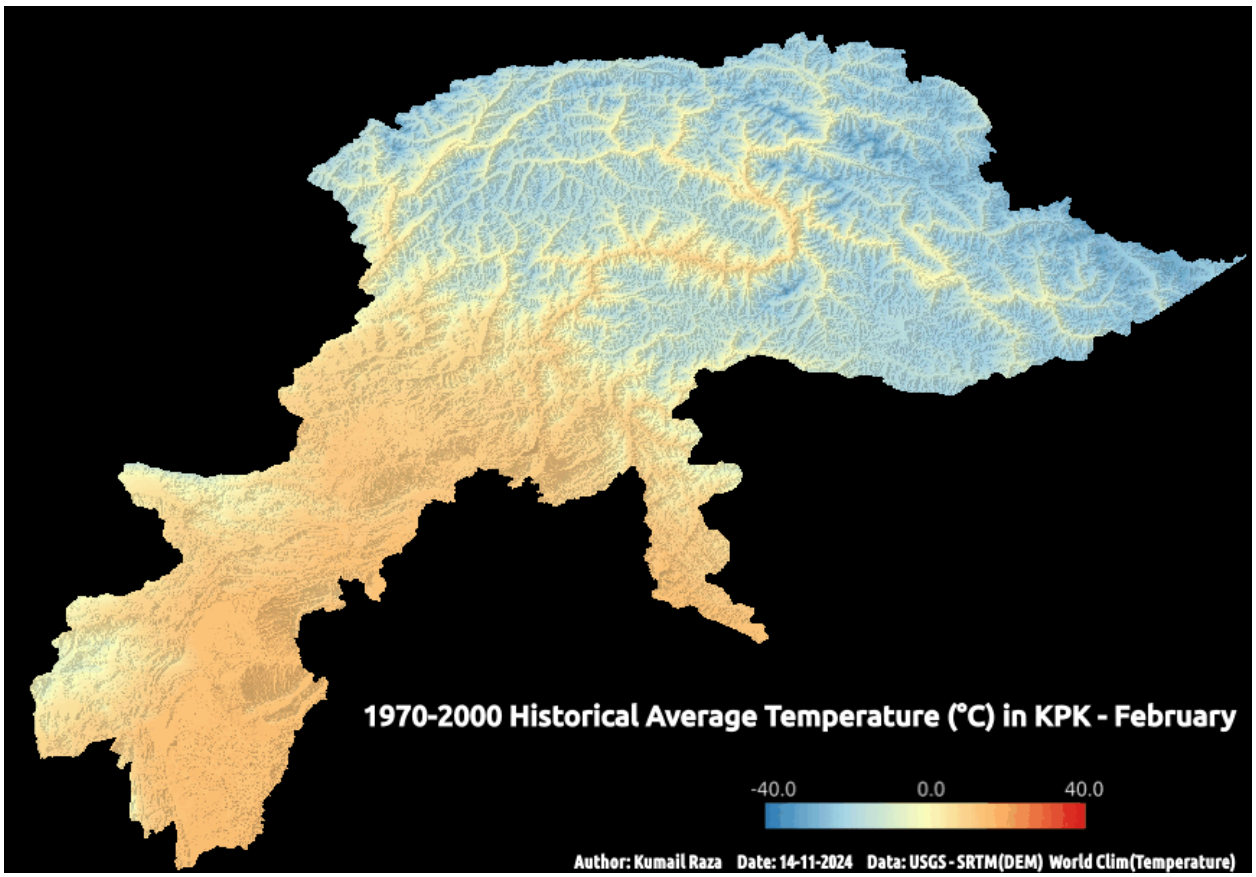


Fig 1. Animated Time Series of Average Temperature

### 2.1.1 Temperature Distribution Per Season

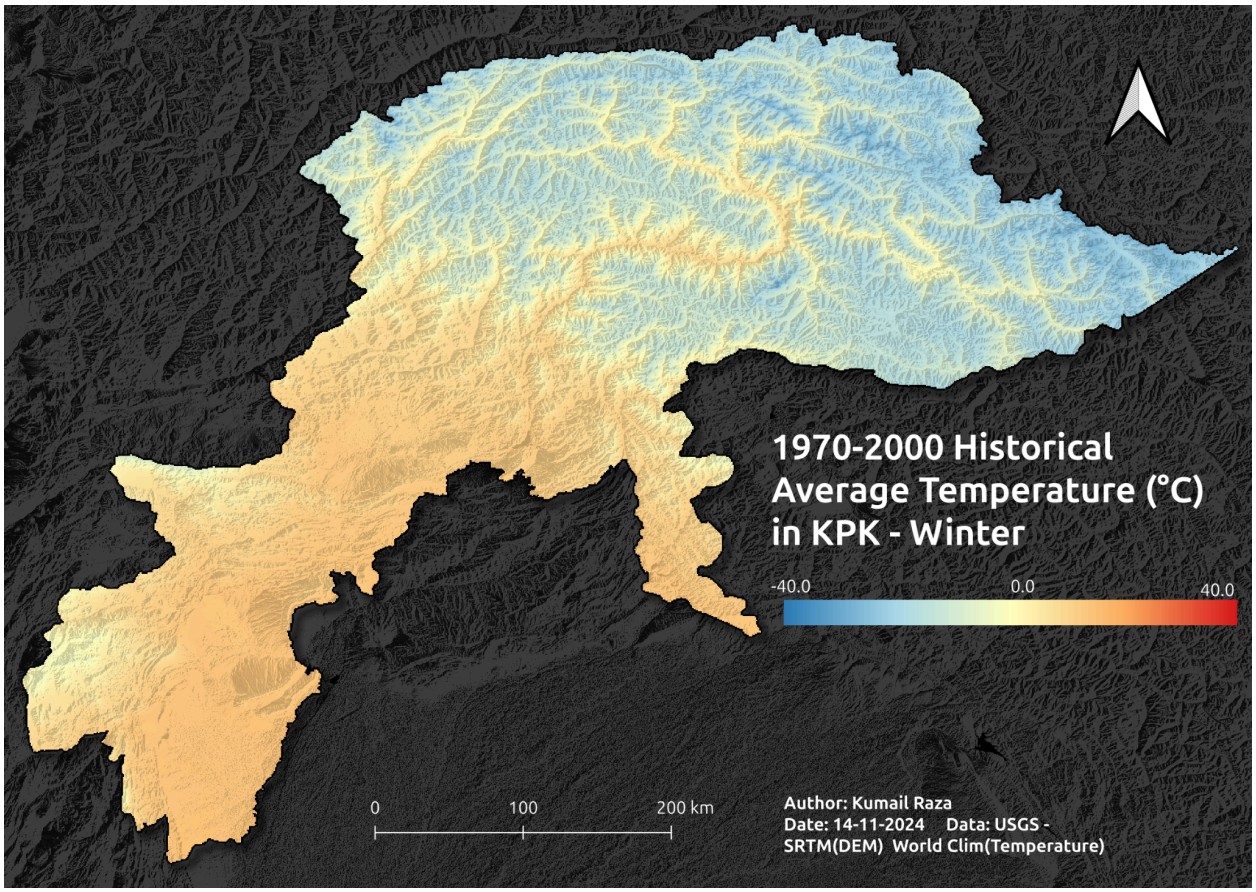


*Fig 2. This map shows the distribution of average January temperatures across KPK from 1970 to 2000. Cooler blue shades dominate the northern mountainous regions, where winter temperatures dip the most, while the southern areas warm up with orange tones. It's a clear reflection of how temperature varies with altitude and geography in the region.*

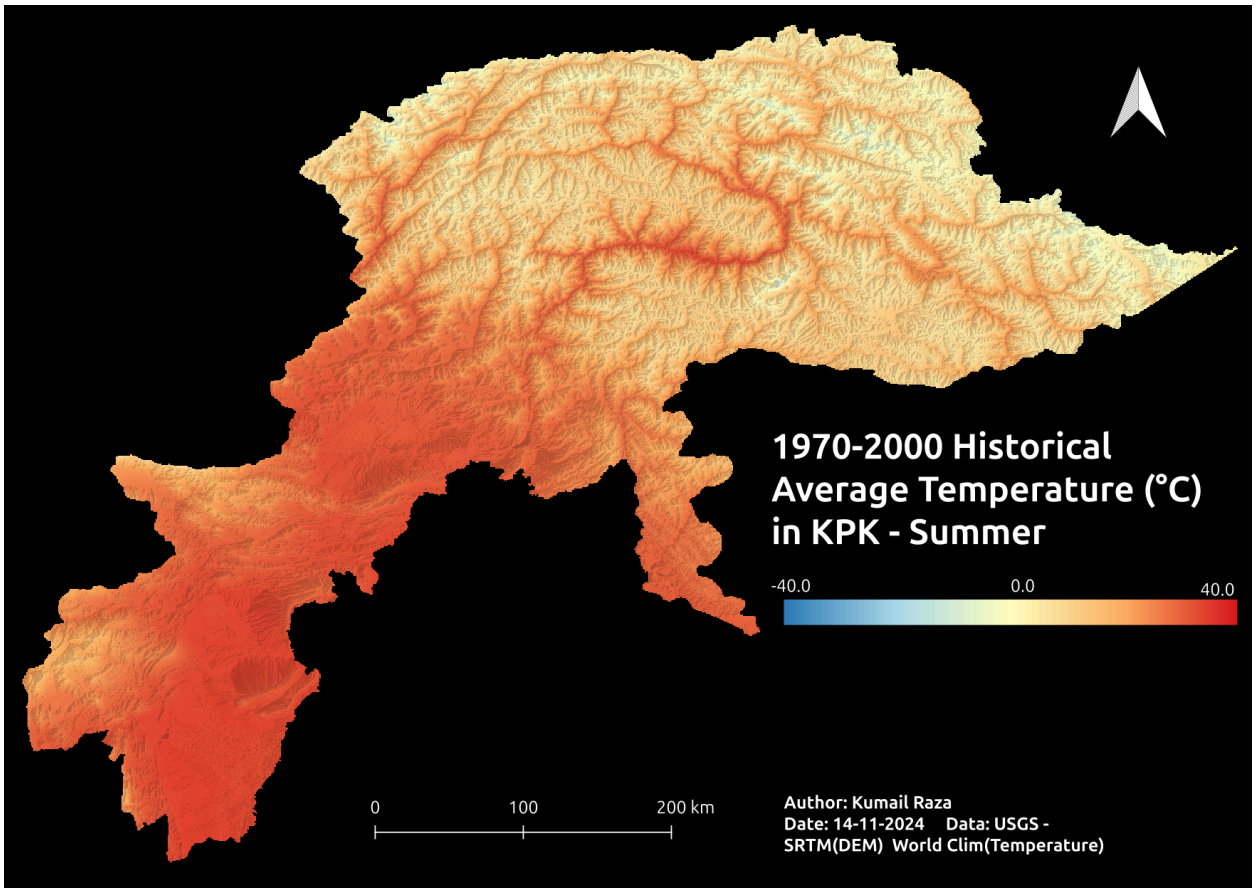


*Fig 3. This map presents the average temperature distribution for July in KPK, based on data from 1970 to 2000. The deep red shades indicate high temperatures, particularly in the southern plains, while the northern mountains display slightly cooler, lighter tones. It highlights the intense summer heat typical of KPK, especially in the lowland areas.*

## 2.2 Mapping precipitation for your Kpk

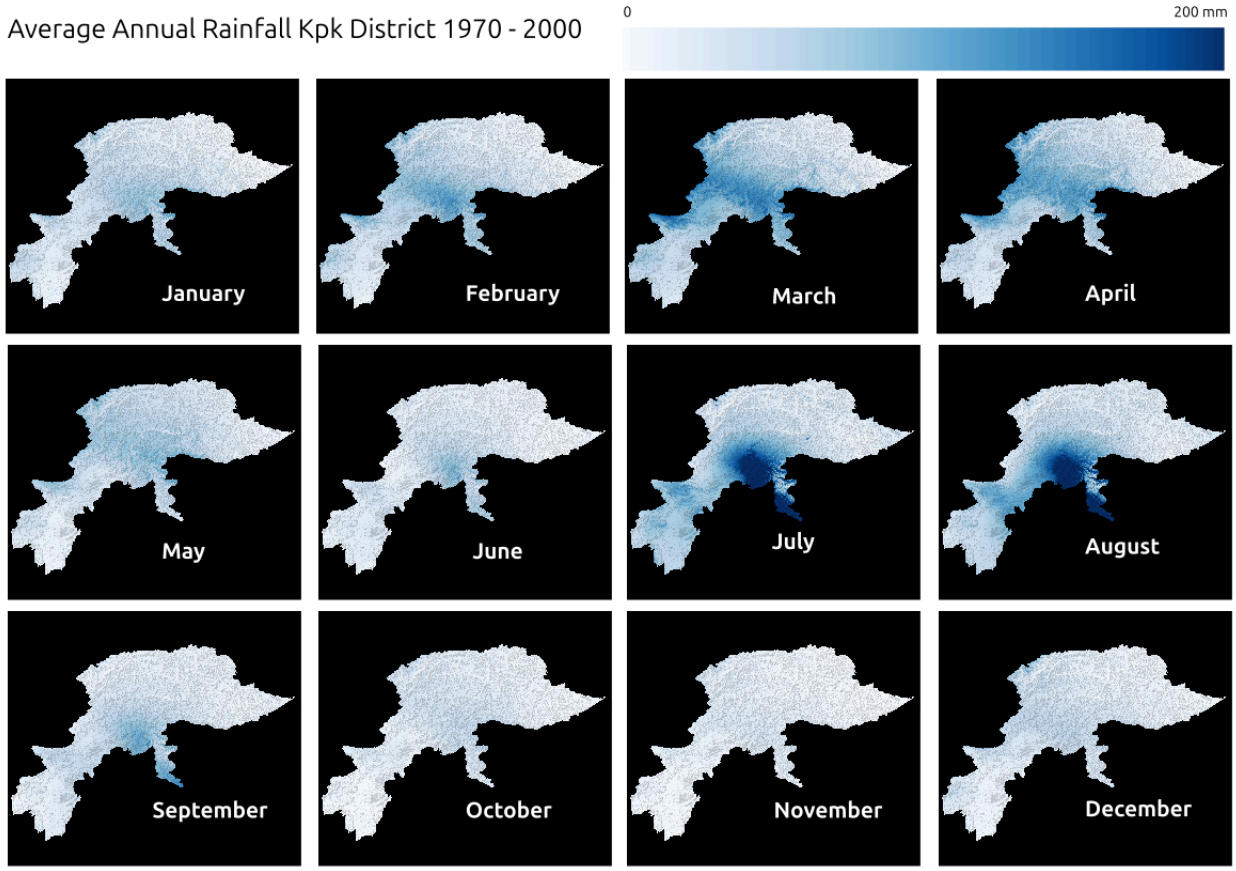


*Fig 4. This series of maps shows the average monthly rainfall distribution in KPK from 1970 to 2000. The rainfall is minimal in the winter months, with a slight increase starting in March. The monsoon impact is evident in July and August, where darker blue hues indicate higher rainfall, especially in the central regions. After August, rainfall gradually decreases, returning to lighter tones by the end of the year.*

## 2.3 Difference in Rainfall and Temperature per Season

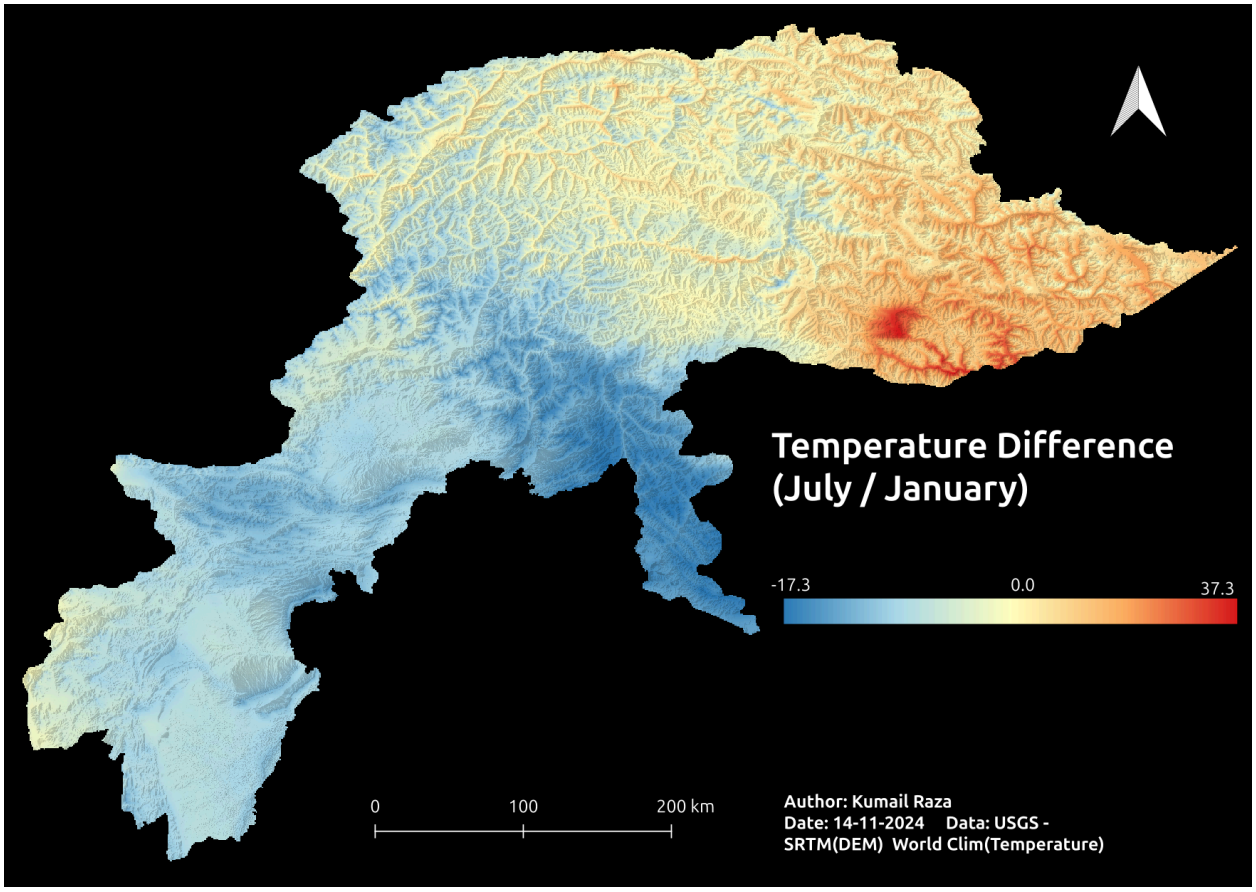


*Fig 5. This map displays the temperature difference between July and January across KPK, highlighting seasonal contrast. Warmer areas, shown in red, indicate regions with significantly higher summer temperatures compared to winter, particularly in the eastern parts. Cooler blue shades cover the mountainous regions in the north and west, where the temperature difference is less pronounced. This visualization showcases the seasonal temperature variability shaped by KPK's diverse landscape.*

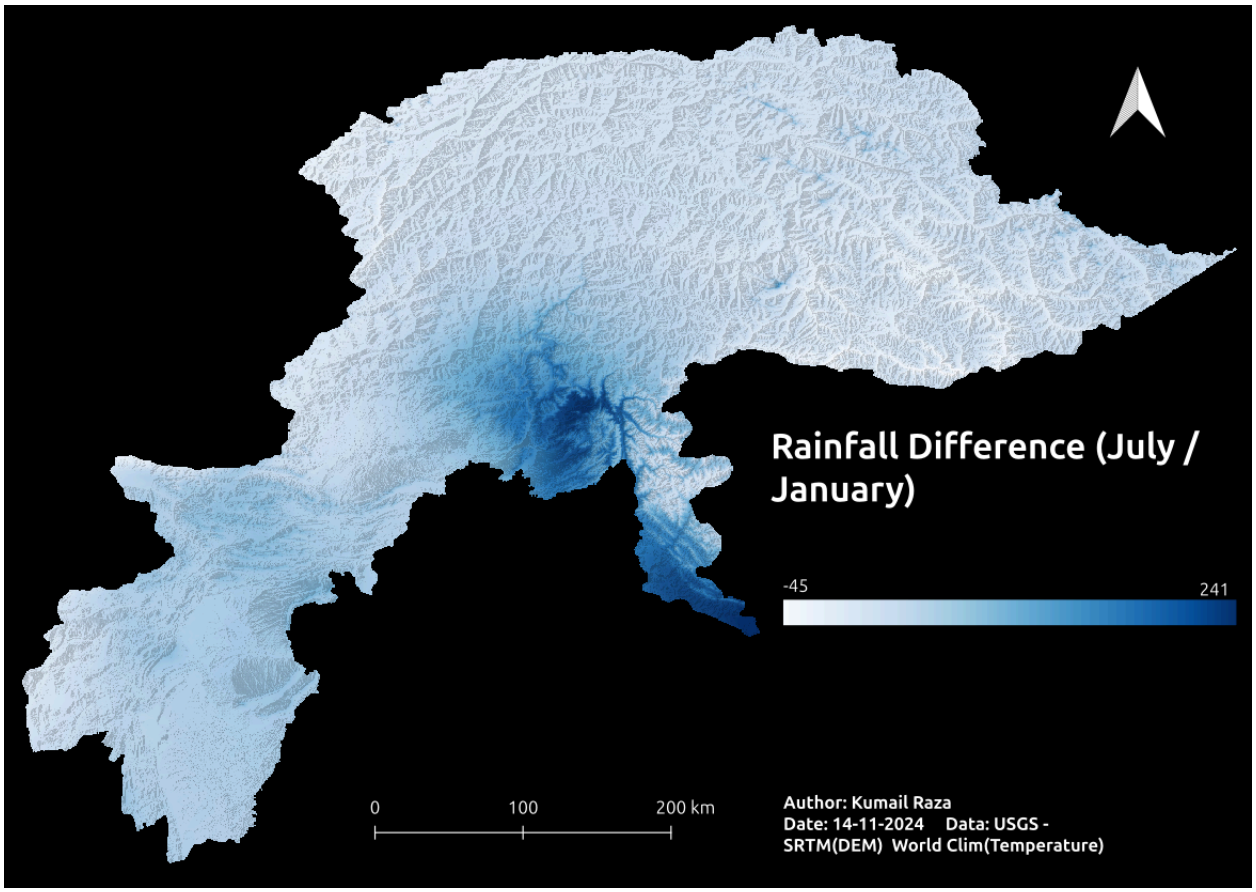


*Fig 6. This map illustrates the difference in rainfall between July and January in KPK, emphasizing the monsoon impact. The dark blue areas, particularly in the central and southeastern regions, show a significant increase in rainfall during July, reflecting the peak monsoon season. The lighter areas experience minimal seasonal variation, highlighting the contrast between summer monsoon rains and drier winter conditions.*

The correlation between the temperature and rainfall differences from July to January across KPK reveals distinct seasonal dynamics:

1. ***High Rainfall and Temperature Difference:*** *Central and southeastern areas show the highest rainfall difference in July compared to January, aligning with a significant temperature increase in summer. This is likely due to the monsoon, which brings both high temperatures and rainfall, especially in the low-lying areas that experience intense summer heat and heavy rains.*
2. ***Mountainous Regions:*** *The northern mountainous regions display a moderate temperature difference but a smaller rainfall difference. This indicates that while temperatures fluctuate seasonally, the rainfall impact from the monsoon is less pronounced in these high-altitude areas. The mountains maintain a cooler climate overall, even in summer.*
3. ***Western and Southwestern KPK:*** *These regions have relatively lower temperature and rainfall differences, suggesting a more stable climate without extreme monsoon effects.*

*The seasonal contrast is less sharp here, highlighting the area's distance from the monsoon influence.*

## 2.4 Total Solar Radiation for the region

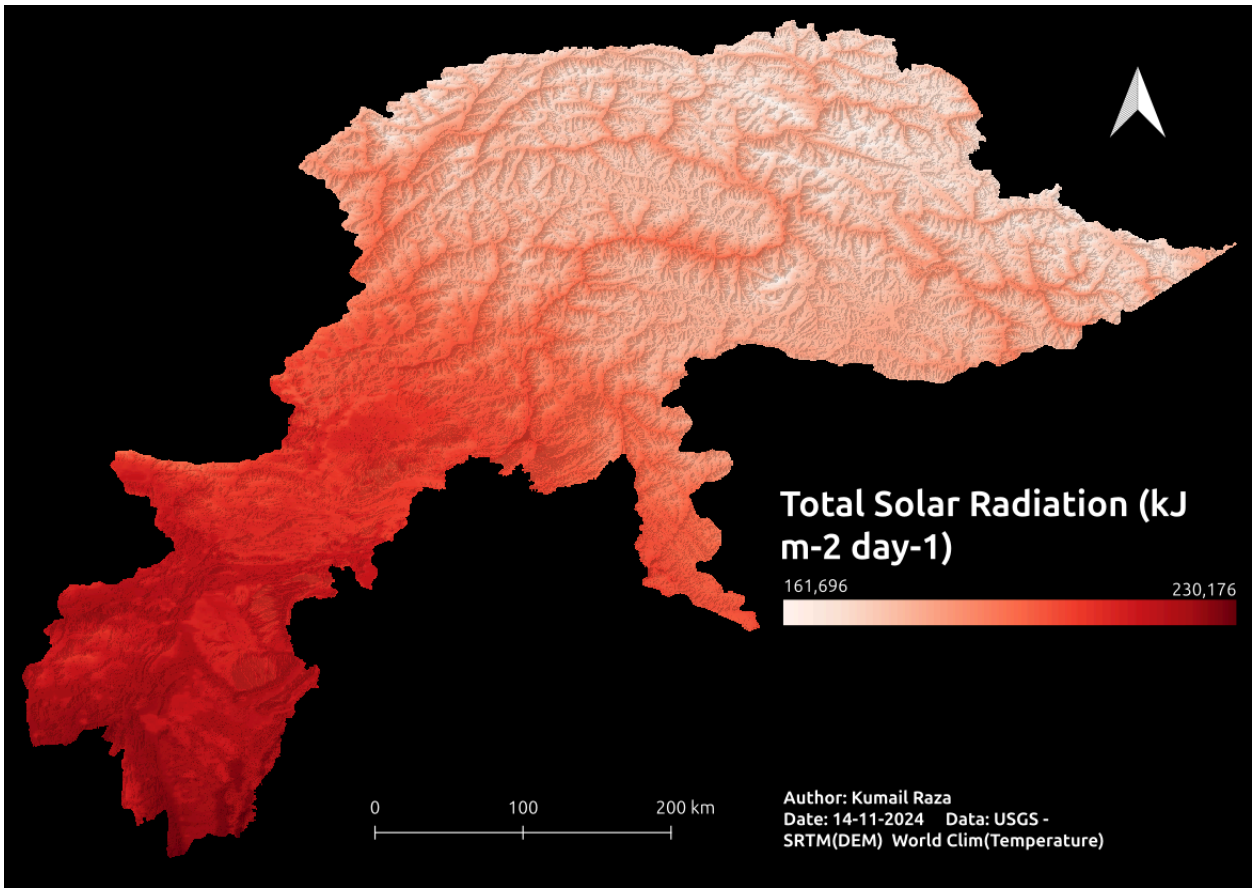


*Fig 7. This map illustrates the total solar radiation received in KPK, with values ranging from 161,696 to 230,176 kJ $m^{-2}$ $day^{-1}$. Higher radiation levels, shown in deeper red hues, are concentrated in the southwestern and southern parts of the region, reflecting greater solar exposure, likely due to lower cloud cover and elevation differences. The northern mountainous areas receive relatively lower solar radiation, aligning with the cooler temperatures and frequent cloud cover associated with higher altitudes. This distribution impacts temperature variations and potential solar energy applications across KPK.*

## 2.5 Multidimensional Climate Data

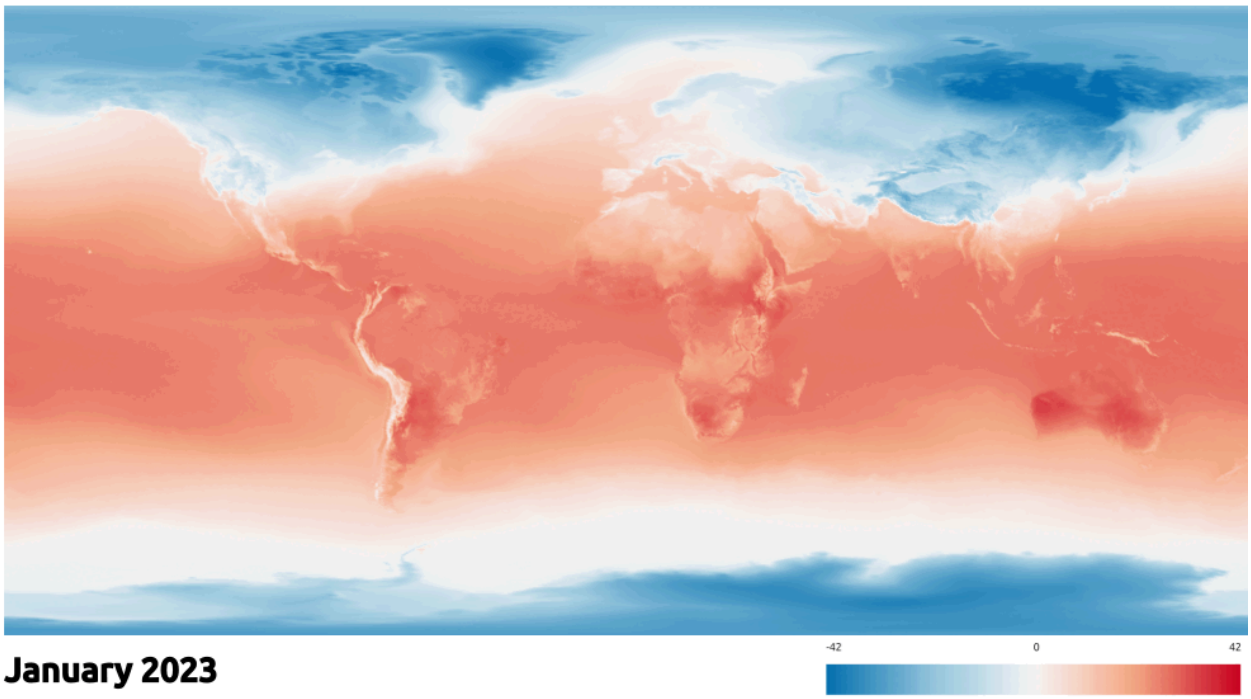


*Fig 8. Temperature Variation*

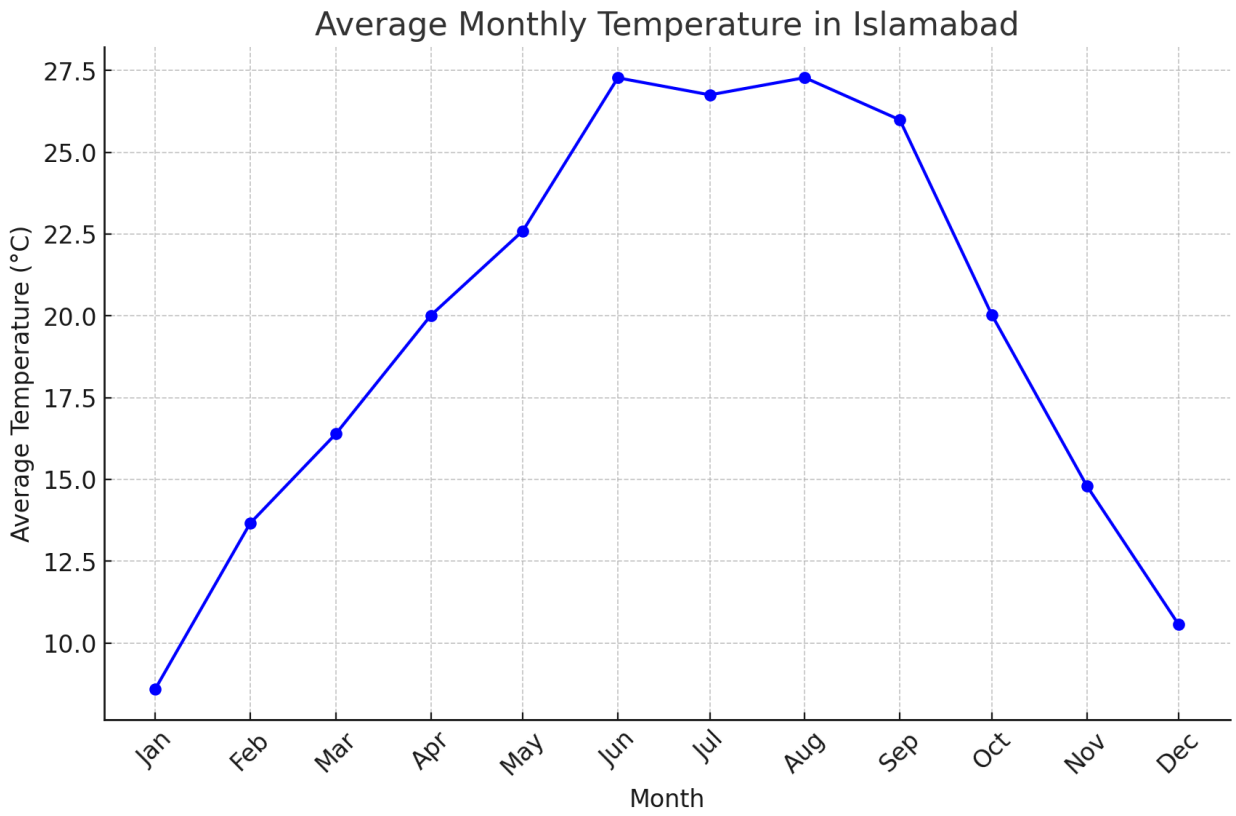


*Fig 9. This chart shows the average monthly temperature in Islamabad. The temperature starts low in January at around 10°C, gradually increases through spring, and peaks in June and July at approximately 27°C. After the summer peak, it starts to decline, with temperatures dropping back down to around 10°C by December. This trend reflects the seasonal variation, with the warmest months being June through September and the coolest months being December through February.*