Undergraduate Research Award 2023

Project Report

Analyzing Future Water Availability in Dehradun City considering Anthropogenic Factors and Climate Change

Supervisor
Dr. Saran Aadhar

Submitted by:
Mohit Bansal (B21CI028)

Contents:

1. Abstract:

In recent years, rapid population growth and industrialization in urban areas have contributed to significant environmental changes, including alterations in the Hydrological Cycle. These changes have led to variations in precipitation patterns, impacting the availability of water resources for human use. This study focuses on Dehradun city (the capital of Uttarakhand, located in the Himalayan region) to investigate water availability under the changing and anthropogenic climate.

2. Introduction:

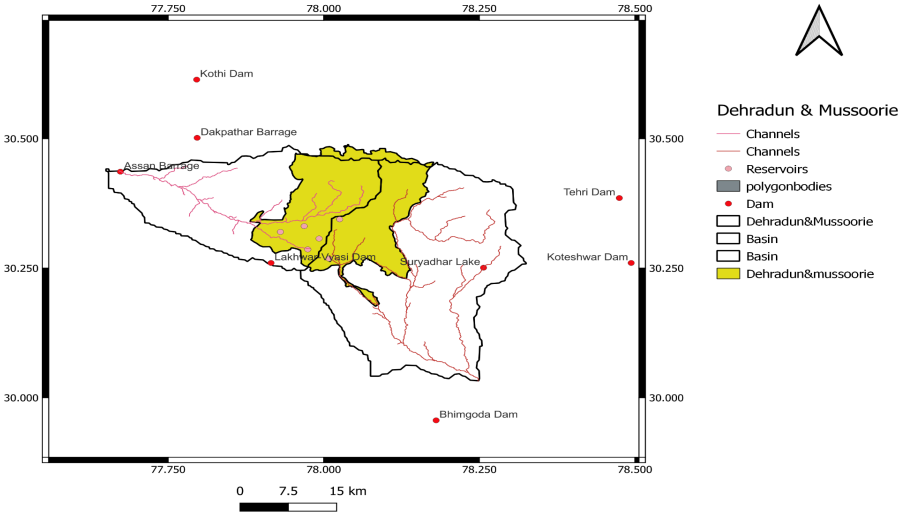
Water availability is a critical concern in the face of rapid urbanization, population growth, and the impending impacts of climate change. Dehradun, nestled in the Himalayan foothills, the nexus of anthropogenic factors and climate change threatens the future availability of water resources. Anthropogenic influences, including rapid urbanization and industrial expansion, have placed immense stress on the region's water ecosystems (UNEP, 2019). Simultaneously, the looming specter of climate change adds an unprecedented layer of complexity, with alterations in precipitation patterns and hydrological cycles affecting water availability (Immerzeel et al., 2020).

This study aims to bridge these critical gaps by addressing the specific context of Dehradun's water landscape and bringing together insights from global climate models and regional datasets.

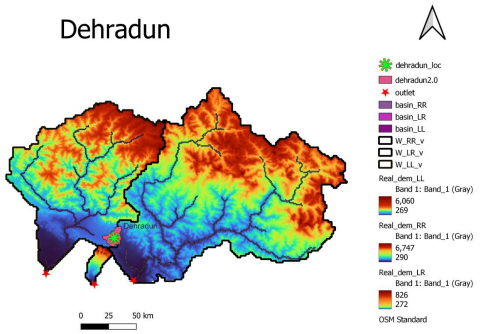
2.1. Science Question

Substantial increase in the water demand in the region due to various factors along with anthropogenic and climatic change and concerns for its sustainable growth.

2.2. Study Area



2.3. Water Sources



Water Sources	Percentage (%)
Surface Water	**13.35663422**
Bijapur Canal	3.266479389
Galogi	2.98882864
Mausifall	2.286535572
Bindal River	2.204873587
Kyarikuli	1.76389887
Nanurkheda pump	0.3756451297
Kolhukhet Spring	0.176389887
Shivlok pump	0.1110602992
Malsi (Karligarh)	0.09146142288
Jodhi Mini pump	0.05226367022
Bhitarigarh	0.03919775266
Ground Water	**86.64336578**
Tubewells(192)	37.56451297
Handpumps(289)	49.07885281
Total	**100**

Different Watershed Basins

Different Watershed Basins

3. Data and Methods:

3.1. Data

Data		Source
DEM(Upstream)		hydroshed.org
Precipitation	Observed Data	IMD
	Future Data	Global Climate Model (GCM)
Groundwater	Observed Data	India WRIS

3.2. Methods

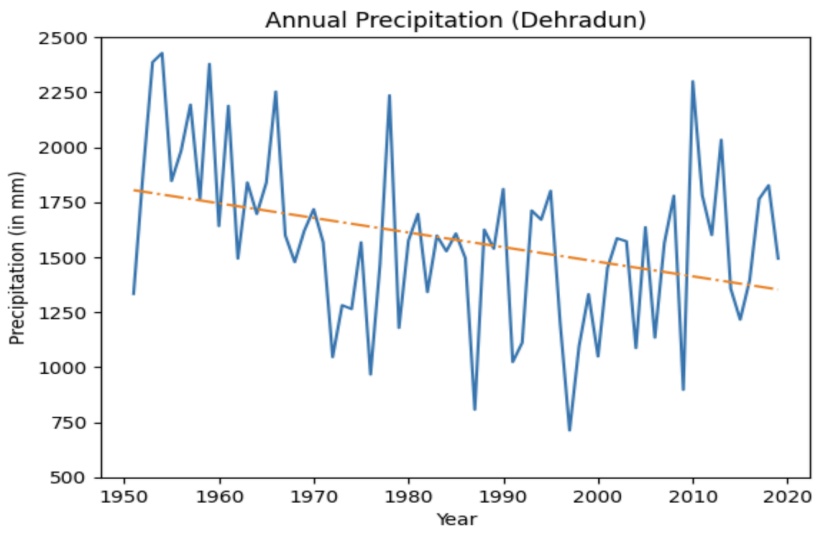
- Studying different water sources and their availability.
- Preparing Hydrological Modelling for the study area.
- Based on hydrological modeling, the Vulnerability and Risk Assessment (VRA) points to the following specific areas of future impact on water resources in the region:
    - Changes in precipitation
    - Increased risk of flooding
    - Increased risk of droughts

4. Results and Analysis:

4.1. Observed Climate(1950-2020)

In the following analysis, drought years are referred to the years with anomalous decrease in the precipitation(annual).

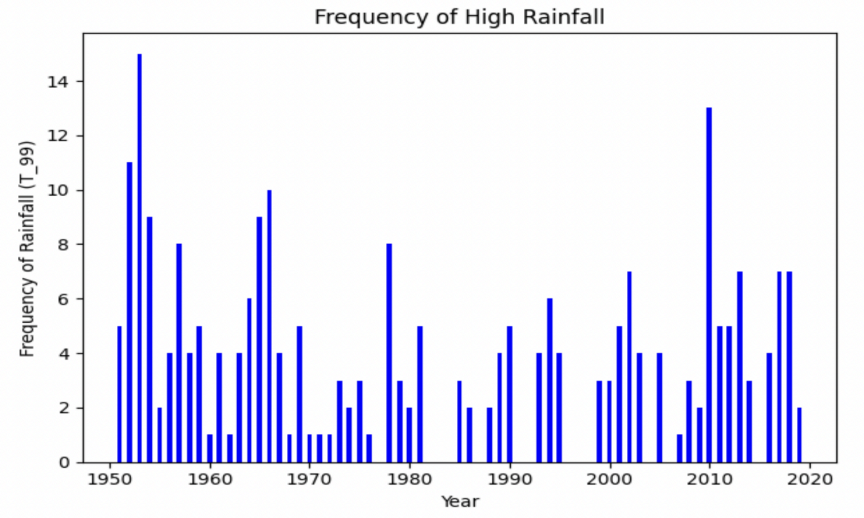
(i) Annual Precipitation Analysis



Annual Precipitation

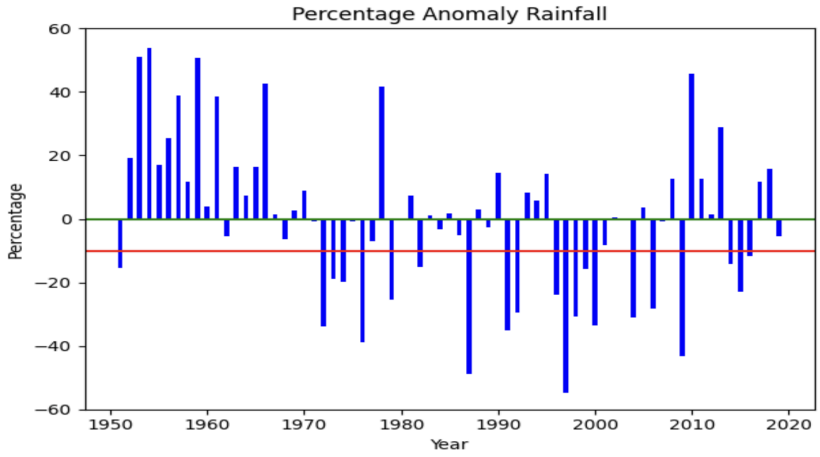
Linear trend in the annual precipitation in Dehradun region reports a decrease in the Annual Precipitation.

(ii) Flood Analysis



Frequency of Anomalous Precipitation (Daily)

(iii) Drought Analysis

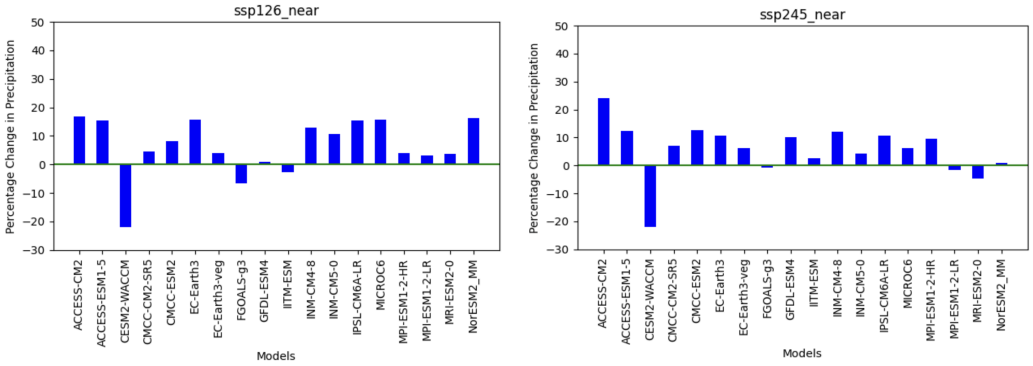


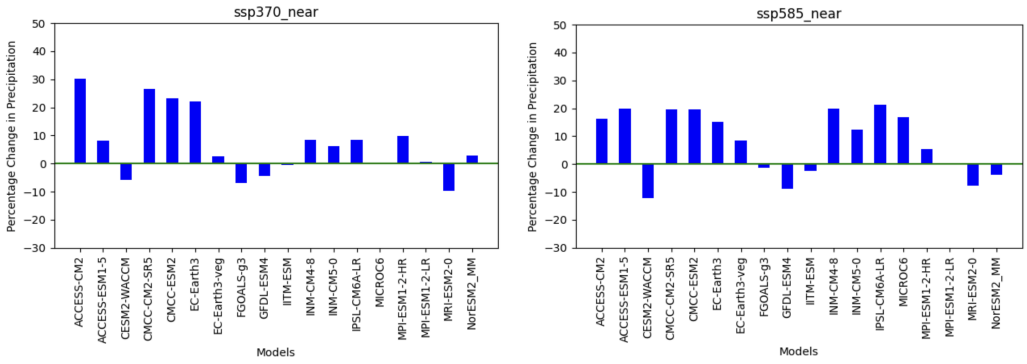
Percentage of Anomalous Precipitation (Annual)

Significant increase in the number of drought years can be observed from the first half (1950-1985) of the time period shown to the next half (1985-2020).

4.2. Near Future Climate (2041-2070)

(i) Annual Precipitation Analysis

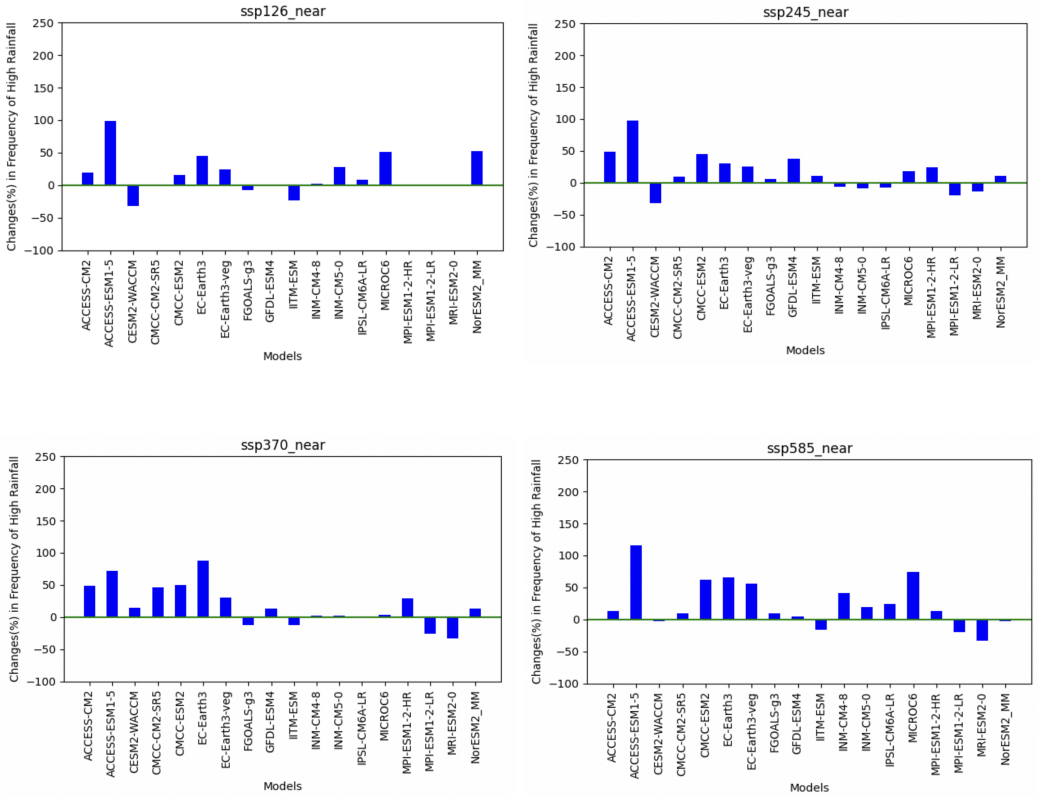




Projected Annual Precipitation

The precipitation in the near future seems to be enhanced as most of the scenario's report a positive change in the precipitation.

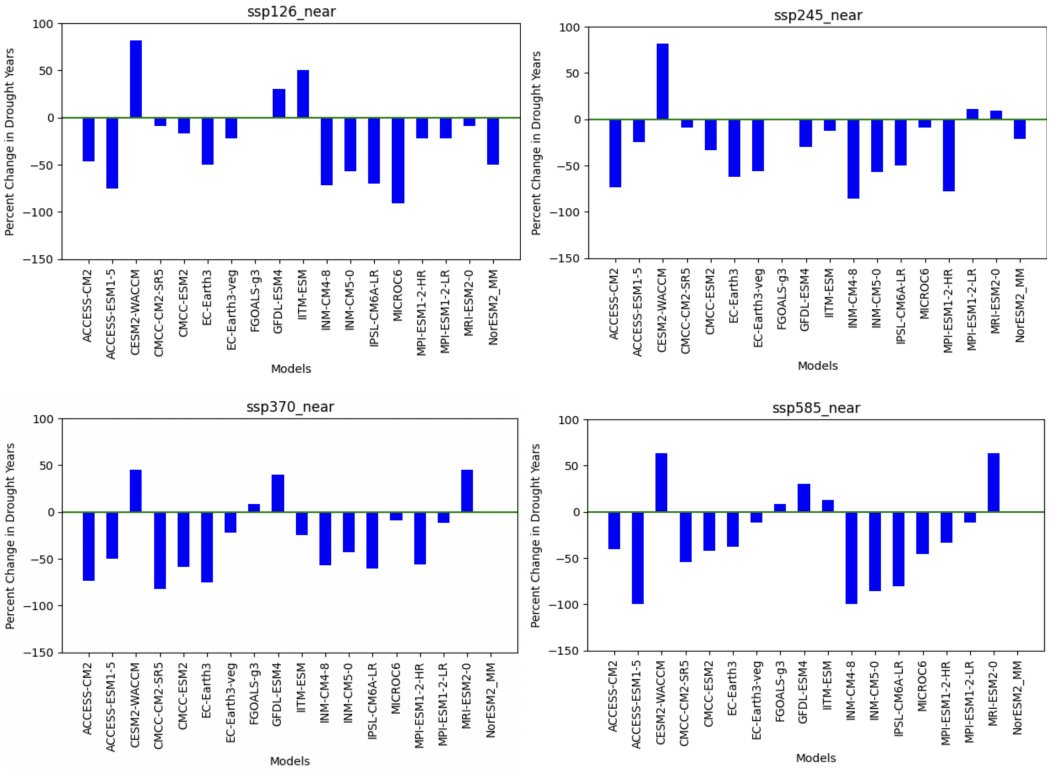
(ii) Flood Analysis



Projected Change in Frequency of Anomalous Precipitation (Daily)

Flood situations in the near future seem to increase as most of the scenario's report a positive change in the frequency of High Precipitation.

(iii) Drought Analysis

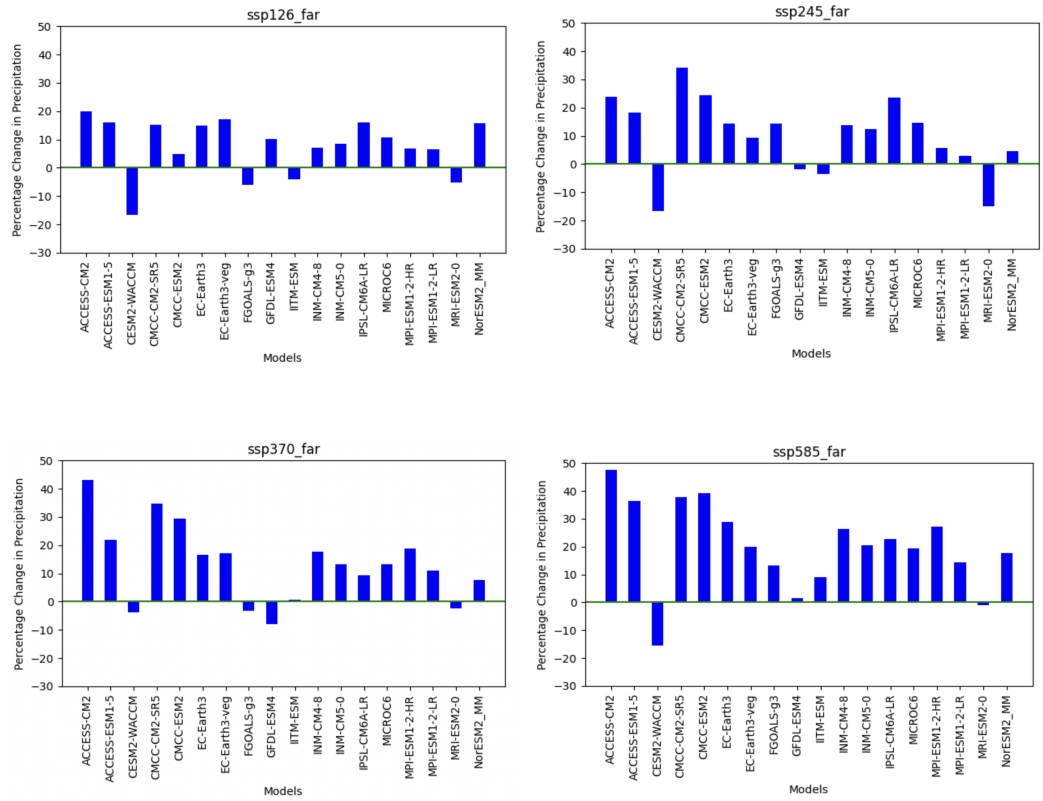


Projected Change in Frequency of Drought Years

The Drought years in the near future seems to decrease as most of the scenario's reports decrease in Drought Years.

4.3. Far Future Climate (2071-2100)

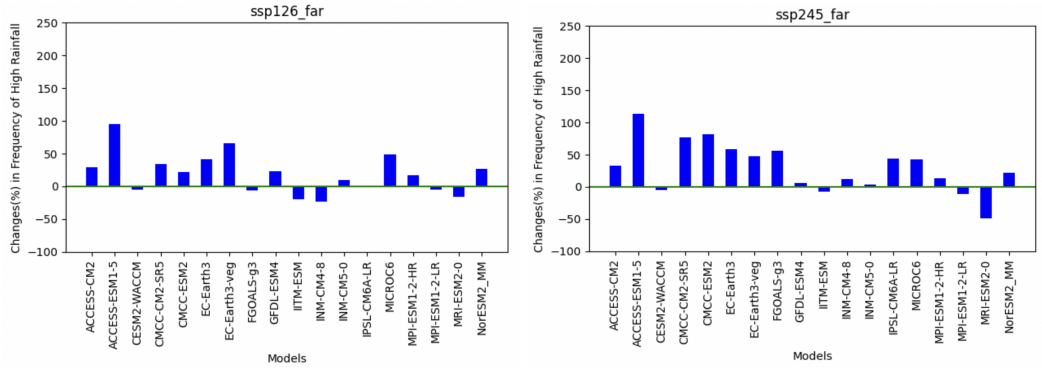
(i) Annual Precipitation Analysis

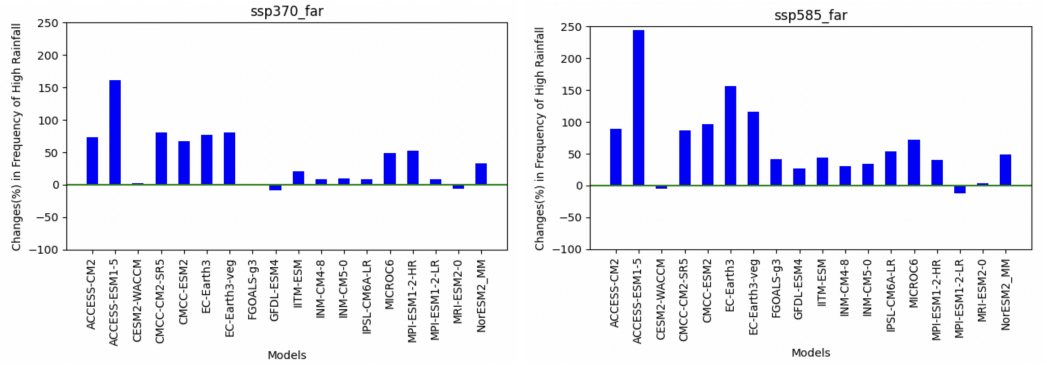


Projected Annual Precipitation

The precipitation in the far future seems to be enhanced as most of the scenario's report a positive change in the precipitation.

(ii) Flood Analysis

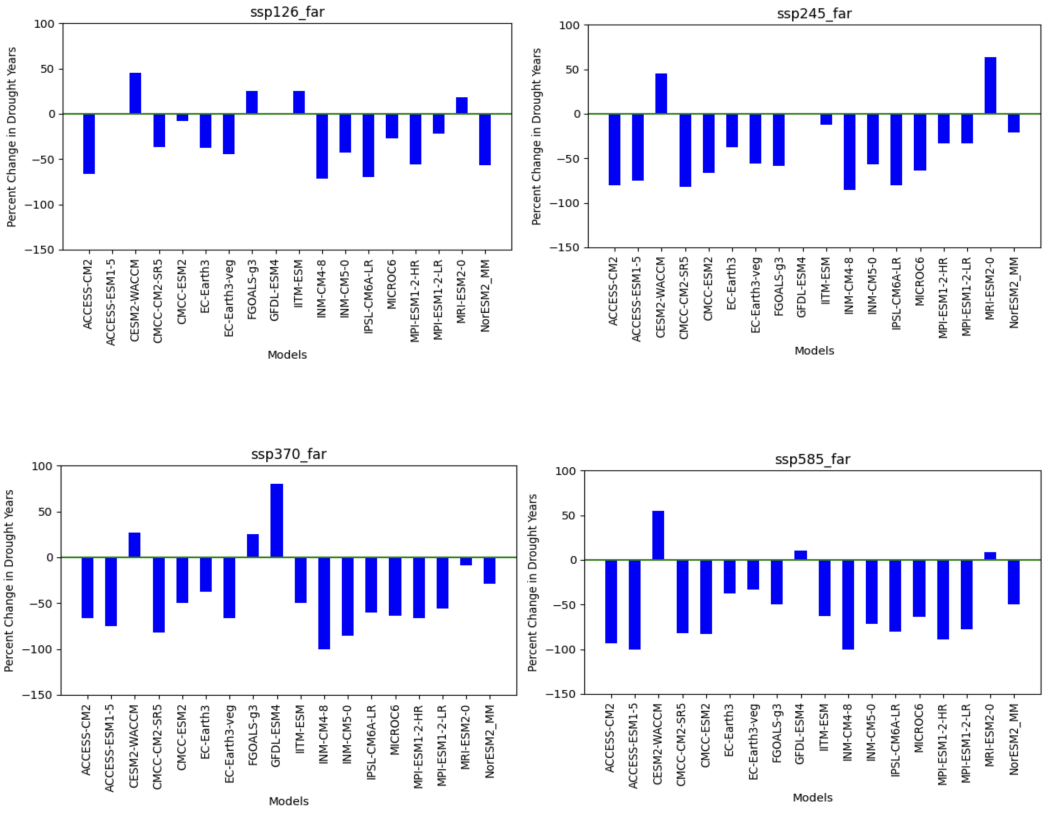




Projected Change in Frequency of Anomalous Precipitation (Daily)

Flood situations in the far future seem to increase as most of the scenario's report a positive change in the frequency of High Precipitation.

(iii) Drought Analysis



Projected Change in Frequency of Drought Years

The Drought years in the far future seem to decrease as most of the scenario's reports decrease in Drought Years.

5. Conclusion and Discussion

Using the observed data from IMD, we found that the precipitation has decreased in the last few decades, which resulted in an increase in the drought frequency in the recent period. For instance, the frequency of drought has doubled in the period 1986-2020 compared to the period 1951-1985. In contrast to the observed period, the precipitation is projected to increase in the future in all four scenarios (SSP1-2.6, SSP2-4.5, SSP3-6.0, and SSP5-8.5). Moreover, we found that the frequency of extreme precipitation is also projected to increase due to increased temperature and aerosol in the future. Due to the increased precipitation, the frequency of drought is projected to decrease in the future. Overall, the information obtained from our analysis can be used in the adaptation and mitigation strategies for sustainable water management and strategic planning in Dehradun City.