India Drought Analysis (2000–2023)

Abstract

Drought is a major climatic challenge in India, affecting agriculture, water resources, and socio-economic stability. This project analyzes long-term drought patterns in India from 2000 to 2023 using satellite-derived groundwater data, rainfall records, drought indices, and agricultural yield statistics. The objective is to understand relationships between rainfall variability, groundwater depletion, drought severity, and crop productivity.

1. Introduction

India experiences frequent droughts due to uneven monsoon rainfall, climate variability, and increasing water demand. Drought impacts food security, farmer livelihoods, and groundwater sustainability. With advancements in remote sensing and climate datasets, it is now possible to study drought patterns using scientific and data-driven approaches.

2. Problem Statement

The increasing frequency and severity of droughts in India pose a serious threat to agricultural productivity and water resources. Traditional drought assessment methods are often limited in scope. There is a need to integrate satellite, climate, and agricultural data to analyze long-term drought behavior and its impacts systematically.

3. Objectives

• To analyze rainfall trends using CHIRPS data
• To study groundwater anomalies using GRACE satellite data
• To assess drought severity using the SPEI index
• To evaluate crop yield trends using ICRISAT agricultural data

4. Datasets Used

GRACE satellite data was used to analyze groundwater storage variations. CHIRPS rainfall data provided precipitation trends. SPEI index data was used to quantify drought severity. ICRISAT district-level agricultural data was used to study crop yield patterns over time.

5. Technology and Tools

The project was implemented using Python programming language. Pandas and NumPy libraries were used for data processing and analysis. Matplotlib was used for visualization. The analysis was conducted using Kaggle Notebook environment.

6. Methodology

The datasets were cleaned and preprocessed. Date fields were converted into yearly format. Year-wise aggregation was performed to identify long-term trends. Line graphs were generated to visualize rainfall, groundwater, drought severity, and crop yield patterns.

7. Results and Discussion

The rainfall analysis showed variability across years with declining trends in recent periods. Groundwater anomaly analysis revealed significant depletion during drought years. SPEI index indicated multiple drought phases. Crop yield trends showed sensitivity to rainfall and groundwater availability.

8. Limitations

The analysis is limited by the availability of aggregated district-level data. The study does not include socio-economic factors or irrigation infrastructure. Future studies may incorporate higher-resolution datasets.

9. Future Scope

Future work can include machine learning-based drought prediction models, district-wise spatial analysis, integration of temperature data, and real-time drought monitoring systems.

10. Conclusion

The project demonstrates the effectiveness of using satellite and climate data for drought analysis. The findings highlight the importance of integrated water resource management and data-driven decision-making to mitigate drought impacts.