Analysis of Rainfall in India Using Tableau

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1. INTRODUCTION

1.1 Overview

The analysis of rainfall in India is a complex and multifaceted topic due to the country's diverse climatic conditions, geographical features, and monsoon system. Here's an overview of the key aspects related to the analysis of rainfall in India:

Monsoon System: India experiences a predominantly monsoon climate, with the southwest monsoon (June–September) and the northeast monsoon (October–December) being the primary rainfall seasons. The southwest monsoon, also known as the summer monsoon, brings the

majority of India's annual rainfall, while the northeast monsoon affects primarily the southeastern coast.

Rainfall Distribution: Rainfall distribution across India is highly variable due to regional and topographical factors. The Western Ghats, Eastern Ghats, Himalayas, and coastal regions receive heavier rainfall, while arid and semi-arid regions like Rajasthan and Gujarat receive lower rainfall.

Interannual Variability: Rainfall patterns in India exhibit interannual variability, which means that there are variations in rainfall amounts from year to year. This variability is influenced by factors like the El Nio-Southern Oscillation (ENSO), the Indian Ocean Dipole (IOD), and other large-scale climatic phenomena.

Rainfall Measurement: Rainfall is measured using rain gauges, which are devices that collect and measure the amount of precipitation. The Indian Meteorological Department (IMD) operates a network of rain gauges across the country to monitor rainfall. Satellite-based remote sensing techniques are also used for rainfall estimation.

Rainfall Data Analysis: To analyze rainfall in India, historical rainfall data is collected and analyzed over different spatial and temporal scales. Statistical methods such as trend analysis, anomaly analysis, and rainfall indices like the Standardized Precipitation Index (SPI) are used to understand long-term patterns, trends, and extreme events.

Impact on Agriculture and Economy: Rainfall is crucial for agriculture, as the majority of India's population depends on farming. Adequate and well-distributed rainfall supports crop growth and ensures food security. Deviations from normal rainfall patterns can have significant implications for agricultural productivity, rural livelihoods, and the overall economy.

Climate Change and Rainfall: Climate change is expected to impact rainfall patterns in India. While the exact regional effects are uncertain, some projections suggest an increase in extreme rainfall events and changes in the timing and distribution of rainfall. Climate models are used to assess potential future scenarios, but uncertainties remain.

Water Resource Management: Proper management of water resources, including rainfall, is essential for sustainable development. Rainfall analysis helps in understanding water availability, planning irrigation systems, managing reservoirs, and mitigating the impact of droughts and floods**.**

1.2 Purpose

The purpose of using Tableau for the analysis of rainfall in India is to provide a comprehensive and visually intuitive representation of rainfall patterns and trends. Here are the key purposes for utilizing Tableau in this context:

Data Visualization: Tableau allows users to create visually appealing and interactive visualizations that make it easier to understand complex rainfall data. By representing data through maps, charts, and heat maps, Tableau enables users to grasp the spatial and temporal variations in rainfall across different regions of India.

Pattern Identification: Tableau's visualizations help identify patterns in rainfall data, such as seasonal variations, long-term trends, or anomalous events. By examining the visual representations, users can quickly identify regions with high or low rainfall, observe shifts in rainfall patterns over time, and detect any deviations from the norm.

Comparative Analysis: Tableau enables users to compare rainfall across different regions, seasons, or years through bar/column charts and other visualizations. This comparative analysis can help identify regions that experience similar rainfall patterns or explore how rainfall varies between different time periods.

Exploration and Interaction: Tableau's interactive features, including filters and parameters, allow users to dynamically explore the rainfall data. Users can select specific regions, time ranges, or variables of interest, enabling them to focus on specific aspects and gain deeper insights from the data.

Communication and Sharing: Tableau dashboards facilitate effective communication of rainfall analysis findings to a broader audience. By creating visually appealing and informative visualizations, users can share their insights with stakeholders, researchers, policymakers, or the general public, aiding in decision-making processes related to water resource management, agriculture, disaster preparedness, and climate change adaptation.

Enhanced Decision Making: The visual analysis of rainfall data in Tableau helps inform decision-making processes by providing a clear understanding of historical rainfall patterns and trends. These insights can guide strategies for water resource management, irrigation planning, agricultural practices, and disaster risk reduction, contributing to improved decision-making outcomes.

By leveraging the capabilities of Tableau, the purpose of rainfall analysis is to transform complex data into actionable insights, facilitate data-driven decision making, and communicate findings effectively to various stakeholders

2. LITERATURE SURVEY

2.1 Existing problem

Analyzing rainfall in India using Tableau can provide valuable insights into precipitation patterns, trends, and distribution across different regions. However, there might be several challenges or potential problems that you could encounter during this analysis. Here are a few examples:

Data Availability: The availability and quality of rainfall data can vary across different regions and time periods. In some cases, you might encounter missing or incomplete data, making it challenging to perform a comprehensive analysis.

Data Cleaning and Preparation: Before conducting any analysis, you'll likely need to clean and prepare the data for visualization in Tableau. This process involves handling missing values, correcting errors, standardizing units, and formatting the data appropriately. Dealing with large datasets can be time-consuming and complex.

Spatial and Temporal Aggregation: Rainfall data in India is often recorded at various spatial and temporal scales, such as daily, monthly, or yearly. Aggregating the data to a consistent level of granularity for meaningful analysis can be challenging and might require additional processing.

Geographical Considerations: India has diverse geographical features, including mountains, plains, coastal areas, and deserts. Analyzing rainfall patterns across such a varied landscape can be complex and requires careful consideration of geographic factors.

Data Visualization: Designing effective visualizations in Tableau to represent rainfall analysis can be both an art and a science. Choosing appropriate chart types, color schemes, and interactivity can significantly impact how well the insights are communicated.

Seasonal and Climate Variability: India experiences distinct monsoon seasons, which greatly influence rainfall patterns. Analyzing and accounting for seasonal and climate variability is crucial to understanding rainfall dynamics accurately.

Interpreting Results: Analyzing rainfall data can generate various statistical measures, correlations, and trends. However, interpreting these findings accurately and drawing meaningful conclusions might require domain knowledge and expertise in meteorology or climatology.

To tackle these challenges, it's essential to approach the analysis systematically, collaborate with domain experts, and leverage the capabilities of Tableau to explore, visualize, and communicate the rainfall patterns effectively.

2.2 Proposed solution

To perform an analysis of rainfall in India using Tableau, here's a proposed solution:

Data Collection: Gather rainfall data from reliable sources such as meteorological departments, government agencies, or research organizations. Ensure that the data includes relevant attributes like location, date, and rainfall measurements.

Data Cleaning and Preparation: Clean the data by addressing missing values, outliers, and inconsistencies. Convert units if necessary and ensure consistent formatting. Perform any necessary transformations or aggregations based on the analysis objectives.

Data Integration: If you have multiple datasets from different sources, integrate them into a single dataset. Ensure that the datasets are properly linked based on common fields such as location or date.

Data Exploration: Use Tableau's visualization capabilities to explore the data. Create visualizations like line charts, bar charts, or maps to examine rainfall patterns across different regions and time periods. Identify any notable trends, seasonal variations, or outliers.

Geographic Analysis: Leverage Tableau's mapping features to visualize rainfall distribution across India. Create choropleth maps to depict average rainfall levels by region or state. Overlay topographical data to analyze the influence of geography on rainfall patterns.

Temporal Analysis: Use Tableau's time series analysis capabilities to investigate rainfall trends over time. Create line charts or area charts to showcase annual or monthly variations in rainfall. Apply filters and drill-down options to explore the data at different temporal granularities.

Statistical Analysis: Utilize Tableau's statistical functions to calculate descriptive statistics, such as mean, median, or standard deviation of rainfall. Conduct correlation analysis to identify relationships between rainfall and other variables like temperature or agricultural productivity.

Dashboard Creation: Design interactive dashboards in Tableau to consolidate your visualizations, allowing users to explore the data dynamically. Include filters, parameters, or tooltips to enhance interactivity and provide meaningful insights.

Storytelling and Presentation: Use Tableau's storytelling feature to create a narrative around your analysis. Build a coherent story by arranging visualizations in a logical sequence and adding annotations or captions. Present your findings to stakeholders or audiences, emphasizing the key takeaways.

Regular Updates: If you have access to real-time or ongoing rainfall data, consider automating the data extraction and analysis process in Tableau. Schedule regular updates to keep the analysis up-to-date and maintain the usefulness of your visualizations.

3.THEORETICAL ANALYSIS

3.1 Block diagram
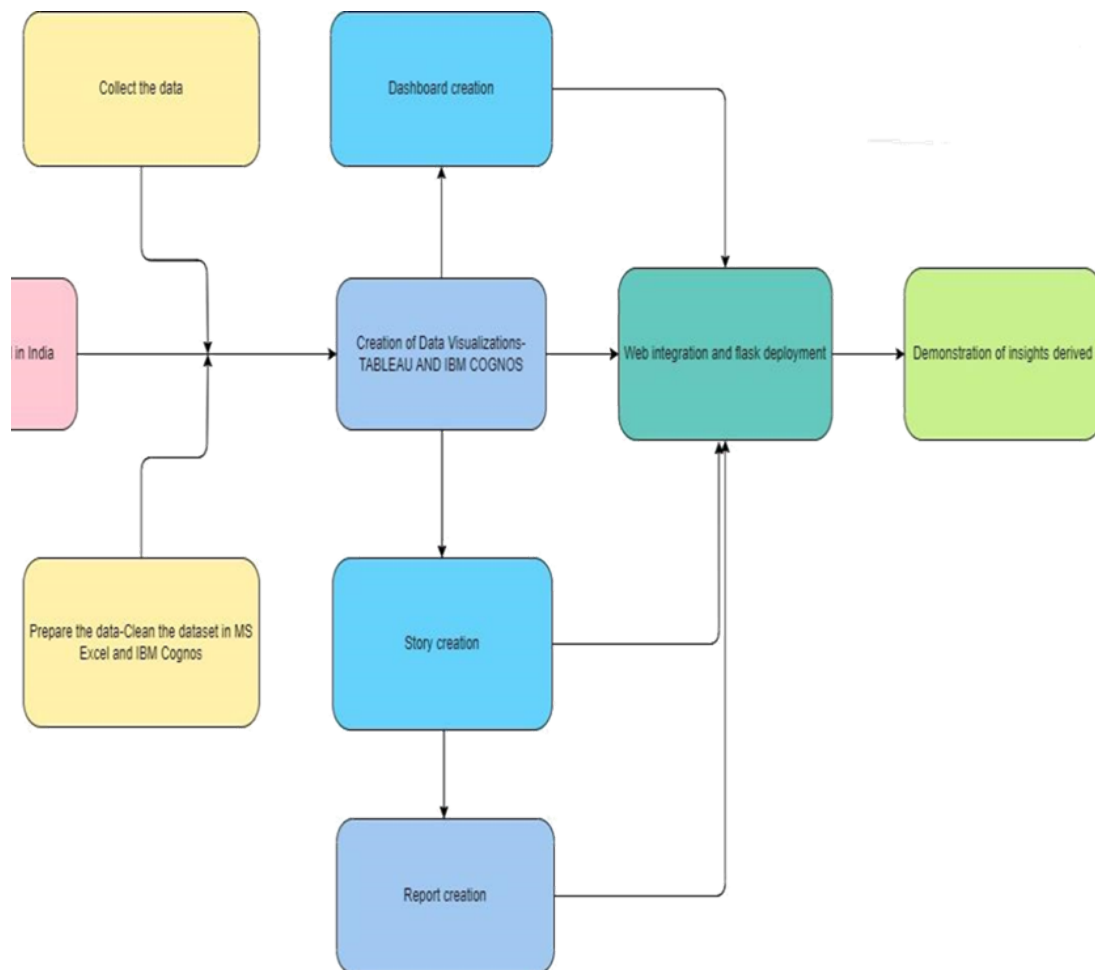
4. EXPERIMENTAL INVESTIGATIONS

In this project, we performed seven types of analysis using Tableau to create visualizations, dashboards, and stories in order to gain insights and references from the visualizations. The analyses we performed are as follows:

4.1. Map that shows average rainfall in all the states:

The dark red shows that average rainfall is higher than the others

4.2. States and average rainfall comparison:

We analyzed the state-wise average rain fall using a horizontal bar chart in Tableau.

4.3. Top 10 states that have the highest rainfall in January and February:

We found the top 10 states that have the highest rainfall in the months of January to February using a bubble chart in Tableau.

4.4. Top 10 states that have the highest rainfall in March–May:

We found the top 10 states that have the highest rainfall in the months of March to May using a bubble chart in Tableau.

4.5. Top 15 States with the Highest Rainfall Annually:

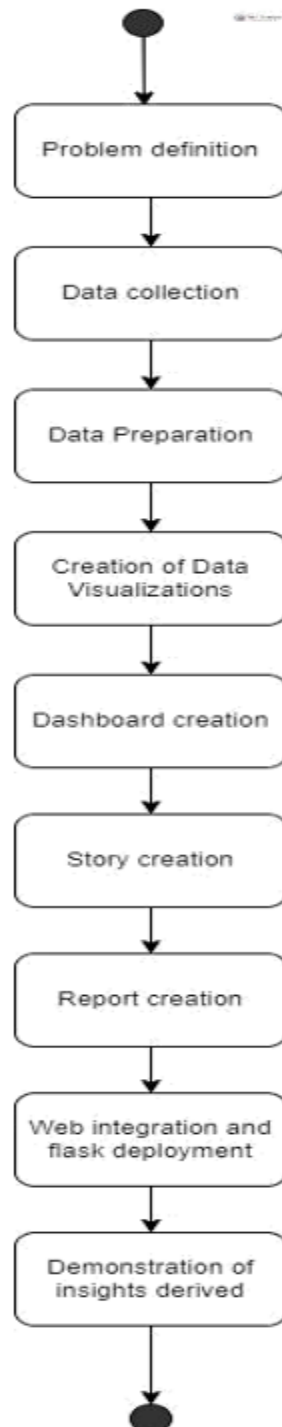We found the top 15 states with the highest rainfall for the whole year using a horizontal bar chart in Tableau.

4.6. Top 10 Districts with the Highest Rainfall Annually:

We performed an analysis to find the top districts that got the highest rainfall for the whole year using a bubble chart in Tableau.

Finally, we created two dashboards in Tableau. Dashboards are interactive visual displays that consolidate multiple views and visualizations on a single screen. They provide a comprehensive overview of data, allowing users to analyse and explore different aspects of the data in real-time. Dashboards are used to monitor key metrics, identify trends, and gain insights quickly.

Additionally, we created a story in Tableau. Stories are used to weave a narrative around the data and provide a structured and interactive way to communicate insights. They serve as powerful storytelling mechanisms to communicate insights, guide data exploration, support decision-making, and facilitate collaboration among stakeholders
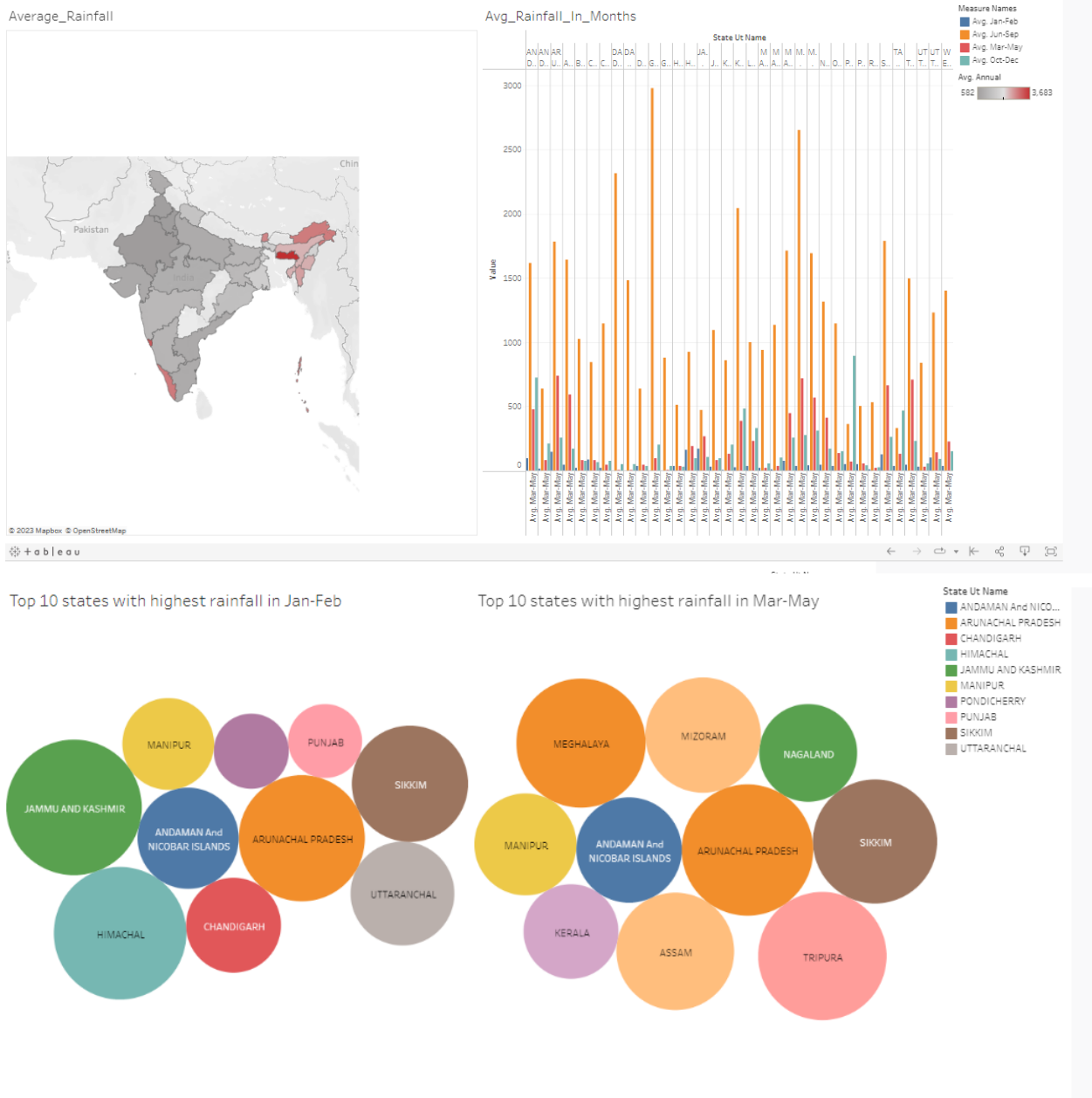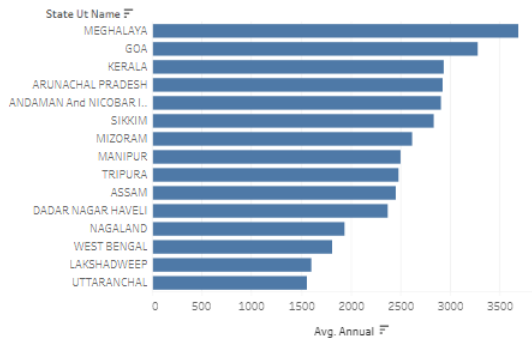
5. FLOWCHART

Screen Shots:

Dashboard

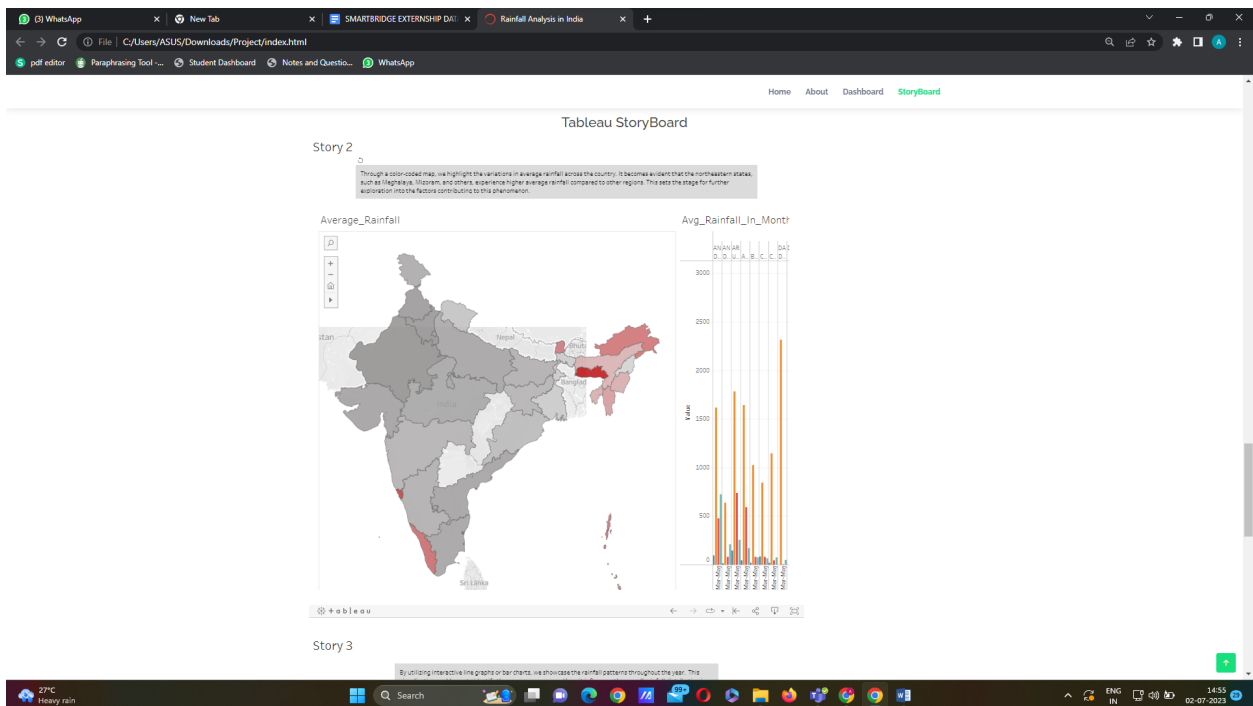Average_Rainfall

Avg_Rainfall_In_Months

Top 10 states with highest rainfall in Jan-Feb

Top 10 states with highest rainfall in Mar-May

Top 15 States with highest rainfall Anually

Top 10 Districts with highest rainfall Anually

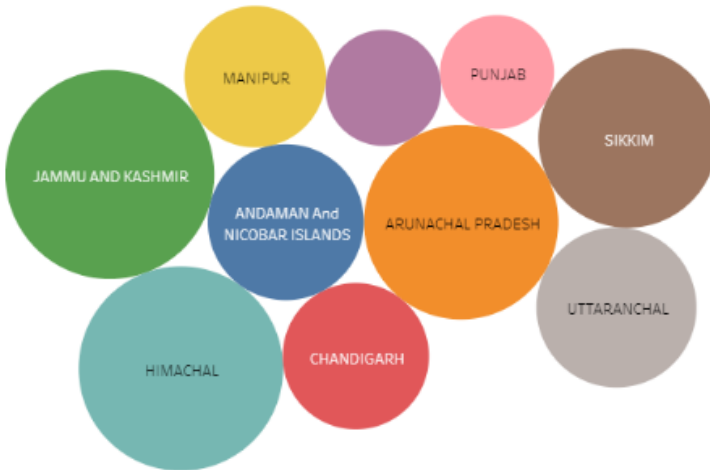**Story**

By utilizing interactive line graphs or bar charts, we showcase the rainfall patterns throughout the year. This visualization enables us to identify the monsoon season and how it influences the overall rainfall distribution in different parts of the country.

Top 10 states with highest rainfall in Jan-Feb

Top 10 states with highest rainfall in Mar-

WEB UI

Story 3

By utilizing interactive line graphs or bar charts, we can capture the rainfall patterns throughout the year. This visualization enables us to identify the monsoon season and how it influenced the overall rainfall distribution in different countries/states.

Top 10 states with highest rainfall in Jan-Feb   Top 10 states with highest rainfall in f

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By utilizing interactive line graphs or bar charts, we can capture the rainfall patterns throughout the year. This visualization enables us to identify the monsoon season and how it influenced the overall rainfall distribution in different countries/states.
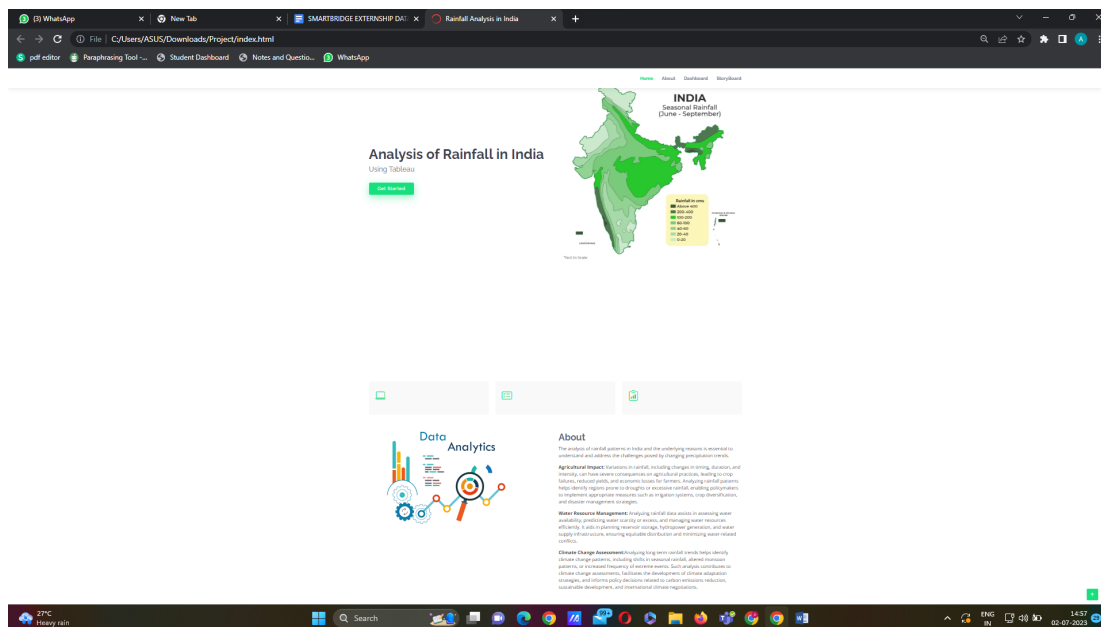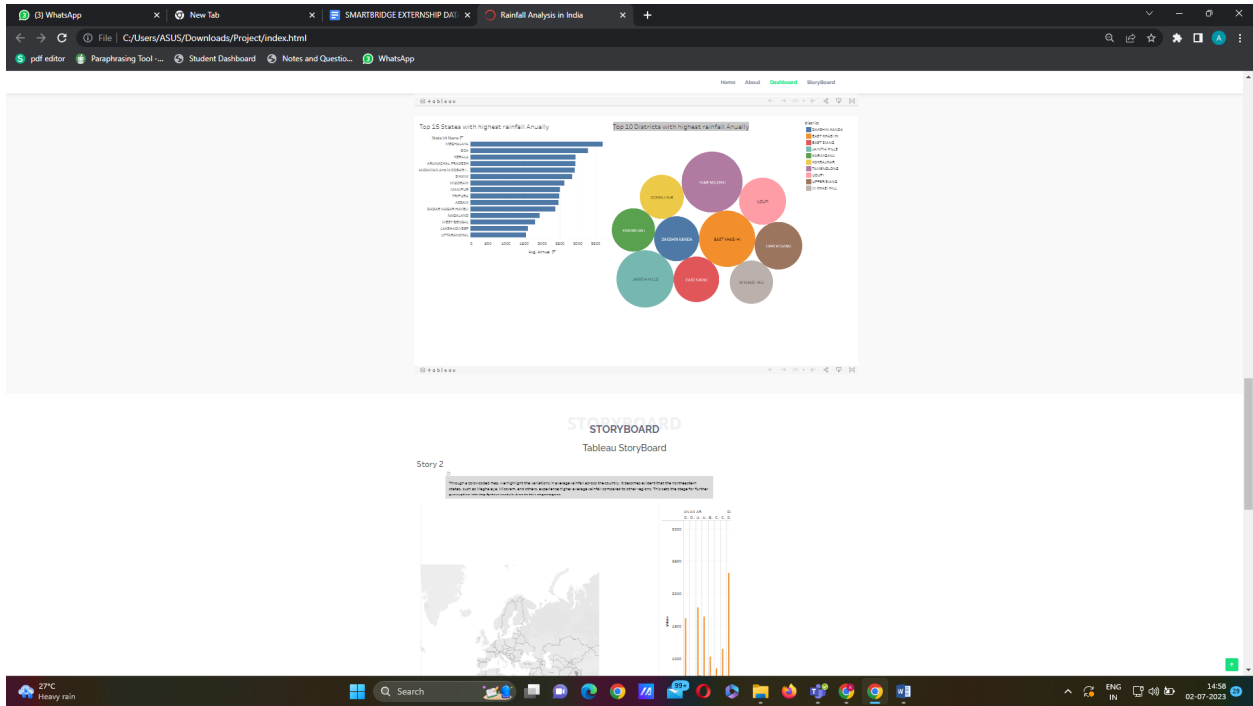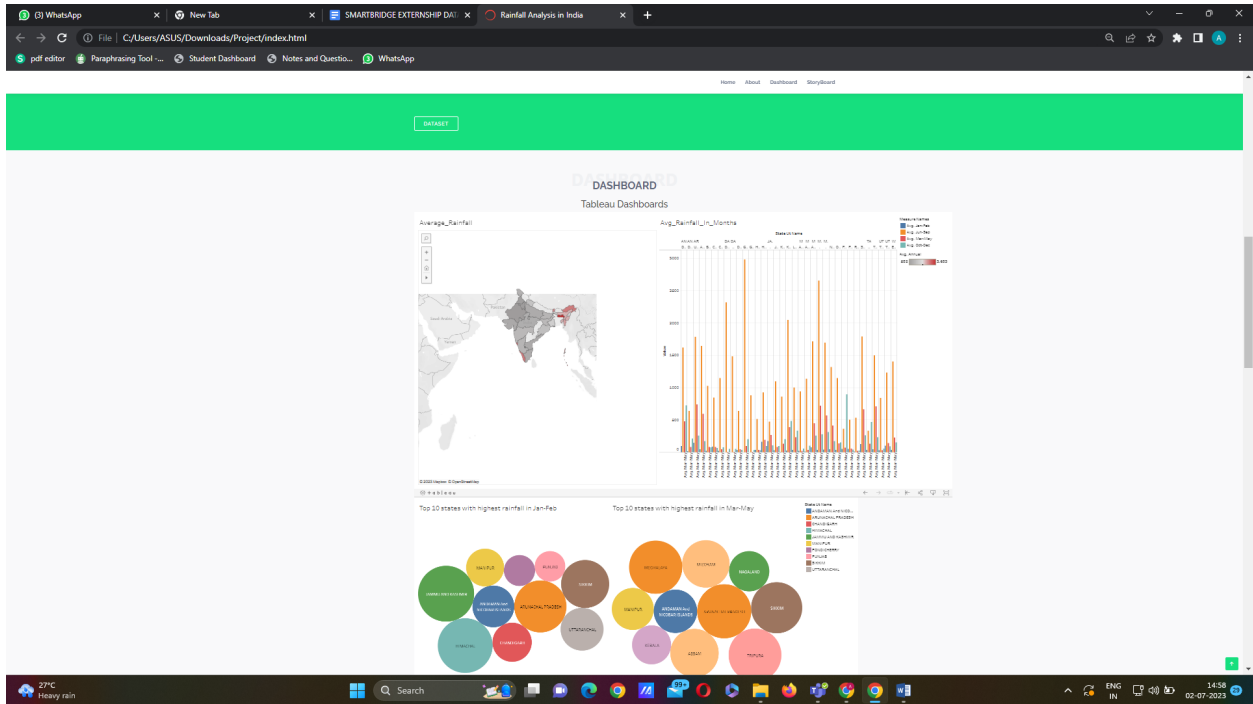
Top 10 states with highest rainfall in Jan-Feb   Top 10 states with highest rainfall in f

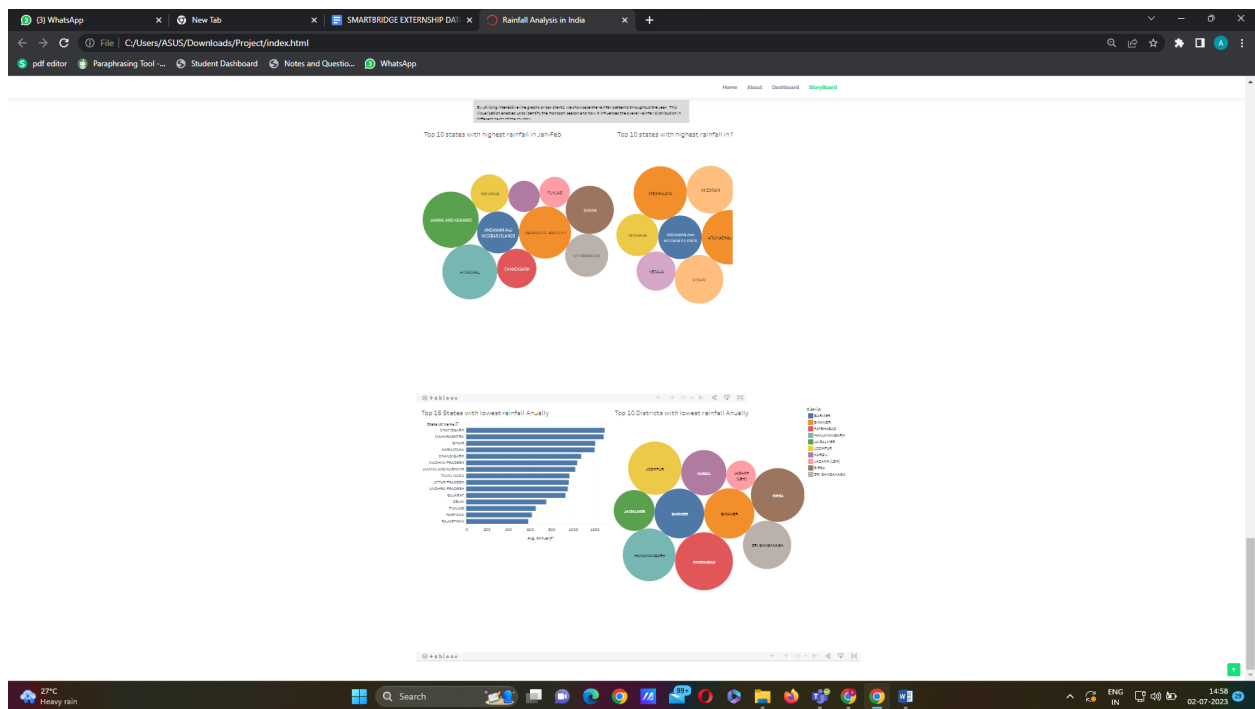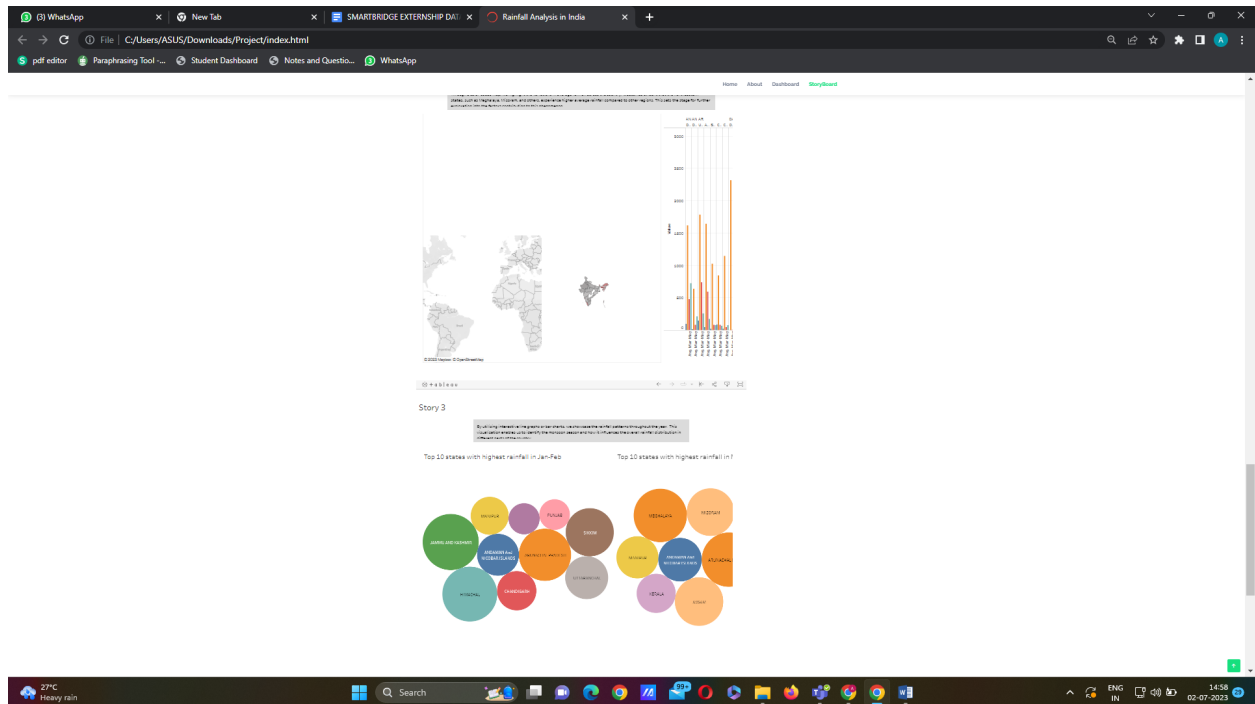Top 18 States with lowest rainfall Anually   Top 10 Districts with lowest rainfall in f

6. ADVANTAGES

Analyzing rainfall in India offers several advantages:

Water Resource Management: Rainfall analysis helps in understanding the availability and distribution of water resources across different regions of India. It provides valuable insights for water resource planning, allocation, and management, including the identification of areas with water scarcity or excess.

Agriculture and Food Security: Rainfall is a critical factor for agriculture, and analyzing rainfall patterns in India helps in assessing agricultural productivity, crop selection, and irrigation requirements. It enables farmers and policymakers to make informed decisions regarding crop planning, water management, and food security.

Natural Disaster Management: Rainfall analysis contributes to the prediction and management of natural disasters like floods, landslides, and droughts. By understanding historical rainfall patterns and trends, authorities can develop early warning systems, emergency response plans, and infrastructure development strategies to mitigate the impact of such disasters.

Climate Change Studies: Rainfall analysis plays a crucial role in studying the effects of climate change on precipitation patterns. It helps identify long-term trends, shifts in rainfall distribution, and the impact of climate variability on ecosystems, agriculture, and water resources in India. Such insights are essential for climate change adaptation and mitigation strategies.

Urban Planning and Infrastructure: Analyzing rainfall data is crucial for urban planning, particularly in cities prone to heavy rainfall or monsoons. It assists in designing effective drainage systems, flood management infrastructure, and sustainable water management strategies in urban areas.

Policy Formulation: Rainfall analysis provides valuable inputs for policymakers and government agencies to formulate appropriate policies related to water resources, agriculture, disaster management, and climate change adaptation. It helps in evidence-based decision-making and the allocation of resources for sustainable development.

Research and Scientific Studies: Rainfall analysis in India serves as a foundation for scientific research, academic studies, and climate modeling. Researchers can explore correlations between rainfall patterns and various factors like temperature, vegetation, or atmospheric phenomena, contributing to a better understanding of the Earth's climate system.

Economic Planning: Rainfall analysis has economic implications, particularly for sectors like agriculture, hydropower, tourism, and water-dependent industries. Understanding rainfall patterns and variability helps in economic planning, risk assessment, and the development of strategies to minimize the economic impact of rainfall fluctuations.

Public Awareness and Education: By visualizing and communicating rainfall analysis effectively, it raises public awareness about the importance of water resources, climate change, and disaster preparedness. It facilitates education and engagement on environmental issues, encouraging sustainable practices and community involvement.

International Collaboration: Analyzing rainfall in India contributes to global efforts in climate research, hydrology, and sustainable development. Sharing rainfall data and collaborating with international organizations and researchers enhances knowledge exchange and fosters collective actions to address global challenges.

Overall, the analysis of rainfall in India offers advantages that extend beyond individual sectors, impacting various aspects of society, environment, and economy. It supports evidence-based decision-making, resource management, and resilience-building in the face of climate variability and change.

7.DISADVANTAGES

While analyzing rainfall in India brings numerous benefits, there are also some potential disadvantages or challenges to consider:

Data Quality and Availability: Rainfall data in India may suffer from issues such as data gaps, inconsistencies, or inaccuracies. The availability of high-quality and reliable data across all regions and time periods can be a challenge, which may affect the accuracy and reliability of the analysis.

Data Limitations: Rainfall data alone may not provide a comprehensive understanding of the factors influencing water resources, agriculture, or climate patterns. Additional data, such as temperature, humidity, land use, or topography, may be necessary to obtain a more holistic view. The availability and integration of diverse datasets can pose challenges.

Spatial and Temporal Variability: Rainfall patterns in India exhibit significant spatial and temporal variations due to its diverse geographical and climatic conditions. Analyzing and interpreting these variations accurately can be complex, and it requires careful consideration of regional differences and local factors.

Limited Contextual Information: Rainfall data, on its own, may not provide sufficient context for understanding its impact on ecosystems, agriculture, or communities. Additional qualitative information, such as local farming practices, water usage, or socio-economic factors, is crucial for a comprehensive analysis.

Interpretation Challenges: Analyzing rainfall data requires expertise in meteorology, climatology, or related fields to interpret the findings accurately. Lack of domain knowledge or misinterpretation of statistical measures may lead to incorrect conclusions or inappropriate actions based on the analysis results.

Complexity of Analysis: Analyzing rainfall data in India can be a complex task, especially when dealing with large datasets, spatial analysis, or time series analysis. It may require advanced statistical techniques, data processing, and specialized software tools, which can be challenging for users with limited technical skills or resources.

Uncertainties and Predictability: Rainfall patterns, especially in the context of climate change, are subject to uncertainties and future unpredictability. Analyzing historical data may not fully capture or predict future changes in rainfall patterns, making long-term forecasting or projections challenging.

Communicating Complexity: Presenting the analysis results to a broader audience, including policymakers or non-technical stakeholders, can be challenging due to the complexity of the data and analysis techniques involved. Ensuring effective communication of findings and actionable insights requires clear and concise visualization and storytelling.

Changing Data Landscape: Rainfall patterns in India may evolve over time due to climate change, land-use changes, or other factors. Continuous monitoring and updating of data, as well as adapting analysis techniques to changing conditions, are necessary to maintain the relevance and usefulness of the analysis.

Resource Constraints: Conducting a comprehensive analysis of rainfall in India may require significant resources in terms of data collection, processing, computing power, and expertise. Limited resources can pose constraints on the scope, depth, or frequency of the analysis, impacting its overall effectiveness.

Despite these disadvantages, addressing data quality, incorporating contextual information, collaborating with domain experts, and understanding the limitations of the analysis can help mitigate these challenges and ensure a more accurate and meaningful analysis of rainfall in India**.**

8. APPLICATIONS

The analysis of rainfall in India using Tableau has various applications across different sectors. Here are some specific examples:

Water Resource Management: By analyzing rainfall patterns, water resource managers can make informed decisions regarding water allocation, reservoir management, and water conservation strategies. They can identify areas experiencing water scarcity or excessive rainfall, enabling them to implement targeted measures for efficient water resource management.

Agriculture Planning: Rainfall analysis helps in agricultural planning and crop management. Farmers can use the insights to determine the optimal planting and harvesting schedules, select appropriate crop varieties, and plan irrigation strategies based on rainfall availability. This improves agricultural productivity, minimizes water usage, and enhances crop yield.

Disaster Management: Analyzing rainfall patterns is crucial for effective disaster management. By identifying regions prone to heavy rainfall or prolonged dry spells, authorities can develop early warning systems, evacuation plans, and infrastructure for flood control, drought mitigation, and landslide prevention.

Climate Change Impact Assessment: Rainfall analysis in the context of climate change enables the assessment of changing precipitation patterns and their impact on ecosystems, agriculture, and water resources. It helps researchers and policymakers understand how climate change affects rainfall variability and supports the development of adaptation and mitigation strategies.

Urban Planning and Infrastructure: Urban planners can leverage rainfall analysis to design resilient infrastructure, drainage systems, and flood control measures in cities. By understanding rainfall patterns and their impact on urban areas, they can ensure sustainable development and minimize the risks associated with urban flooding.

Environmental Monitoring: Analyzing rainfall data helps in monitoring the health and status of ecosystems. It allows researchers to assess the impact of rainfall on biodiversity, water quality, and the overall ecosystem functioning. This information is valuable for conservation efforts, ecological studies, and environmental policy formulation.

Public Health and Disease Monitoring: Rainfall analysis can contribute to public health planning and disease monitoring. Certain diseases, such as malaria or dengue fever, are

influenced by rainfall patterns. By understanding the relationship between rainfall and disease incidence, health officials can implement appropriate prevention and control measures.

Infrastructure Development: Infrastructure projects such as dams, canals, or irrigation systems require a thorough understanding of rainfall patterns for their planning and design. Analyzing rainfall data helps engineers and project managers estimate water storage requirements, design flood protection measures, and optimize infrastructure investments.

Tourism and Recreation Planning: Rainfall analysis aids in tourism and recreation planning by identifying regions with favorable weather conditions for outdoor activities. It enables the development of tourism strategies, event planning, and resource allocation for tourism-dependent areas.

Research and Education: The analysis of rainfall in India using Tableau contributes to scientific research, climate studies, and educational purposes. Researchers can use the insights to develop models, test hypotheses, and contribute to the scientific understanding of rainfall dynamics. Educators can use visualizations to enhance learning about weather, climate, and environmental science.

These applications highlight how the analysis of rainfall in India using Tableau supports decision-making, planning, and understanding across various sectors, leading to sustainable development and effective resource management.

9. CONCLUSION

In conclusion, the analysis of rainfall in India using Tableau provides valuable insights into precipitation patterns, enabling better decision-making and planning in various sectors. Through Tableau's powerful visualization capabilities, users can explore and understand rainfall data in a visual and interactive manner, uncovering trends, spatial distributions, and temporal variations. The advantages of this analysis include improved water resource management, enhanced agricultural planning, effective disaster management, and climate change impact assessment. Additionally, the applications extend to urban planning, infrastructure development, environmental monitoring, public health, and research. Despite some challenges, such as data limitations and interpretation complexities, Tableau serves as a valuable tool for analyzing rainfall data in India, facilitating data-driven approaches to address water scarcity, climate change impacts, and sustainable development. By harnessing the power of Tableau, stakeholders can gain valuable insights into rainfall patterns and make informed decisions to ensure the efficient use of resources and mitigate risks associated with rainfall variability. Overall, the analysis of rainfall in India using Tableau contributes to a better understanding of precipitation dynamics, fostering resilience, and supporting sustainable development efforts in the country.

10. FUTURE SCOPE

The future scope of analyzing rainfall in India using Tableau is promising and opens up several opportunities for further advancements and applications. Here are some potential future directions:

Integration of Advanced Data Sources: In addition to traditional rainfall data, incorporating advanced data sources such as satellite imagery, remote sensing data, and weather forecasts can enhance the accuracy and granularity of rainfall analysis. Integration of real-time data feeds and advanced data sources can enable more precise and up-to-date analysis, aiding in timely decision-making and early warning systems.

Machine Learning and Predictive Analytics: Applying machine learning algorithms and predictive analytics techniques to rainfall data can improve the ability to forecast rainfall patterns, identify trends, and detect anomalies. By leveraging historical rainfall data and additional relevant variables, such as climate indices or land-use data, advanced models can provide more accurate predictions and support proactive measures for water resource management and disaster preparedness.

Spatial Analysis and Geospatial Modeling: Expanding the spatial analysis capabilities of Tableau can facilitate more in-depth examination of rainfall patterns at different spatial scales. By integrating geospatial data, such as land cover, elevation, or hydrological features, it becomes possible to identify correlations between rainfall and environmental factors, enabling a more comprehensive understanding of rainfall dynamics in India.

Climate Change Impact Assessment: Given the increasing concern over climate change, future analysis can focus on assessing the impact of climate change on rainfall patterns in India. By incorporating climate models and projecting future scenarios, it becomes possible to anticipate changes in rainfall distribution, intensity, and seasonality, supporting adaptation strategies and policy formulation.

Interactive Dashboards for Stakeholder Engagement: Developing interactive dashboards and visualizations specifically designed for different stakeholders, such as policymakers, water resource managers, or farmers, can enhance engagement and communication. By tailoring the analysis outputs to address specific information needs and presenting the data in a user-friendly and actionable format, stakeholders can make more informed decisions based on the rainfall analysis.

Mobile and Cloud-Based Solutions: As mobile devices and cloud computing continue to advance, the future of rainfall analysis using Tableau may involve developing mobile applications or cloud-based solutions. This would enable users to access and interact with rainfall data and visualizations on the go, empowering field workers, researchers, and decision-makers to make real-time, data-driven decisions.

Collaborative Data Sharing and Benchmarking: Encouraging collaborative data sharing and benchmarking among different agencies, researchers, and institutions can enhance the accuracy and reliability of rainfall analysis. Establishing data sharing protocols, standardizing data formats, and creating platforms for data exchange can facilitate cross-disciplinary collaboration and enrich the analysis process.

Automated Data Processing and Reporting: Streamlining data processing and automating report generation can save time and effort in analyzing rainfall data. Developing tools or workflows that automate data cleaning, transformation, and visualization processes can free up analysts' time to focus on interpreting the results and generating meaningful insights.

Integration with Decision Support Systems: Integrating rainfall analysis outputs with decision support systems can enhance the practical utility of the analysis. By connecting rainfall data with other relevant datasets, models, or tools, decision-makers can obtain a comprehensive view of the impacts of rainfall on various sectors and use it as a basis for informed decision-making.

Continued Research and Innovation: The field of rainfall analysis is continuously evolving, and future advancements may involve incorporating new technologies, data sources, and analytical techniques. Continued research and innovation in the field can lead to improved methodologies, better models, and enhanced tools for analyzing rainfall in India using Tableau.

By exploring these future avenues, the analysis of rainfall in India using Tableau can continue to evolve and contribute to better understanding, management, and utilization of rainfall data for sustainable development and effective decision-making.

11. REFERENCES

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12. APPENDIX

Source code

```python
from flask import Flask,redirect,url_for,render_template
app=Flask(__name__)
@app.route("/")
def home():
    return render_template(r"index.html")

if __name__ == "__main__":
    app.run(debug=False,port=8080)
```

Output

```
* Debug mode: off
WARNING: This is a development server. Do not use it in a production deployment. Use a production WSGI server instead.
* Running on http://127.0.0.1:8080
Press CTRL+C to quit
```