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Vellore Institute of Technology
(Deemed to be University under section 3 of UGC Act, 1956)

Smart bridge Internship
Data Analytics
PROJECT TITLE : Indian major cities daily
temperature: Tracking the heating of indian urban
centres

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Introduction:

The daily temperature tracking and monitoring of heating in major cities are critical in understanding and addressing the challenges posed by urban heat islands and climate change. The rise in urbanization, increasing population, and changing land use patterns have led to the formation of urban heat islands, where cities experience higher temperatures compared to surrounding rural areas. This phenomenon poses several environmental, health, and infrastructure-related concerns.

India, with its rapidly growing urban centers, is particularly susceptible to the urban heat island effect. Monitoring the daily temperature fluctuations in major Indian cities allows for a comprehensive understanding of the heating dynamics, which is crucial for implementing effective mitigation strategies, urban planning, resource management, and public health interventions.

By tracking daily temperatures, scientists, policymakers, and urban planners can gain insights into the intensity, patterns, and spatial distribution of heat islands. This information aids in identifying vulnerable areas and populations, assessing climate change impacts, and developing strategies to mitigate the adverse effects of urban heating.

Furthermore, daily temperature tracking helps in evaluating the efficacy of current mitigation measures and interventions. It provides valuable data for assessing the success of urban greening initiatives, cool roof installations, and energy-saving measures implemented to counteract the heat island effect. Such information can guide future policies and optimize urban infrastructure design to create more sustainable and livable cities.

In addition, daily temperature tracking has significant implications for public health. Heatwaves and extreme heat events can lead to heat-related illnesses and fatalities, particularly among vulnerable populations. By monitoring daily temperatures, public health officials can issue timely warnings, implement heatwave response plans, and allocate resources to protect communities from the adverse health effects of extreme heat.

Overall, tracking the daily temperature and monitoring the heating of major Indian cities is crucial for understanding the urban heat island effect, mitigating its impact, enhancing urban planning, improving public health management, and developing sustainable strategies for climate change adaptation. Through comprehensive monitoring and analysis, it is possible to create resilient, comfortable, and environmentally conscious cities in India.

Data Collection:

Obtain temperature data from weather stations located in major cities. Ensure the data includes daily temperature readings for each city.

Data Preprocessing:

Clean the data and remove any outliers or inconsistencies.
Convert the temperature readings to a standardized format (e.g., Celsius).
Organize the data by city and date.

Data Visualization and Analysis:

Visualize the temperature data using line graphs or other suitable visualizations.
Analyze the daily temperature patterns and trends over time.
Identify any anomalies or extreme events such as heatwaves.

Urban Heat Island Monitoring:

Compare the temperatures of urban areas with nearby rural regions to quantify the Urban Heat Island effect.
Determine the intensity and spatial extent of the heat island effect.
Identify areas with higher temperatures and potential hotspots within the cities.

Reporting and Alerts:

Generate reports summarizing the daily temperature variations for each city.
Include key findings, trends, and anomalies observed in the data.
Provide alerts or notifications for extreme temperature events like heatwaves or sudden temperature changes.

Decision Support and Action:

Communicate the temperature insights to relevant stakeholders, including urban planners, policymakers, and public health officials. Use the data to guide interventions and strategies for urban planning, infrastructure development, climate change adaptation, and public health management.

Implement measures to mitigate the Urban Heat Island effect and minimize the impact of extreme temperatures.

Please note that the flowcharts could vary depending on the specific data sources, analytical techniques, and applications involved. It is advisable to consult with a data scientist or domain expert to design a more detailed and tailor-made flowchart for your specific needs.

Literature Survey:

literature survey on tracking the daily temperature and monitoring the heating of major cities in India:

"Urban Heat Islands in India: Current Understanding and Future Prospects" by Jaganmohan et al. (2019): This study provides an overview of the Urban Heat Island (UHI) phenomenon in major Indian cities. It examines the factors contributing to UHI, including land use changes, green spaces, and building materials. The study highlights the need for temperature monitoring and the role of urban planning in reducing the UHI effect.

"Urban Heat Island Analysis and Its Relationship with Land Use/Land Cover Change: A Case Study of Delhi, India" by Kumar et al. (2017): This research focuses on the city of Delhi and its UHI effect. It examines the relationship between land use/land cover changes and temperature variations. The study highlights the importance of long-term temperature monitoring to understand the impact of urbanization on temperature patterns.

"Assessment of Urban Heat Island in Pune City, India" by Shinde and Gokhale (2018): This study investigates the UHI effect in Pune, a major city in India. It analyzes land surface temperature data obtained from

satellite imagery to understand the spatial and temporal patterns of UHI. The study emphasizes the need for continuous monitoring to identify urban areas with higher temperatures and adopts appropriate mitigation strategies.

"Spatial Assessment of Urban Heat Island and Its Impact on Energy Consumption in Ahmedabad City, India" by Chatterjee et al. (2020): This research assesses the UHI effect in Ahmedabad and its impact on energy consumption. It combines temperature data from ground-based weather stations and satellite imagery to analyze the spatial patterns of UHI. The study highlights the correlation between UHI and energy demand and suggests energy-saving measures to mitigate the effect.

"Analysis of Urban Heat Island Effect and Its Relationship with Land Use/Land Cover Change Using Remote Sensing and GIS Techniques: A Case Study of Kolkata, India" by Das and Bandyopadhyay (2019): This study examines the UHI effect in Kolkata and its relationship with land use/land cover changes. It utilizes remote sensing and GIS techniques to analyze temperature variations and land cover transitions. The study emphasizes the importance of temperature monitoring for urban planning and climate change adaptation.

These studies demonstrate the significance of tracking the daily temperature and monitoring the heating of major cities in India to better understand the Urban Heat Island effect, assess its impact on energy consumption and public health, and inform urban planning strategies.

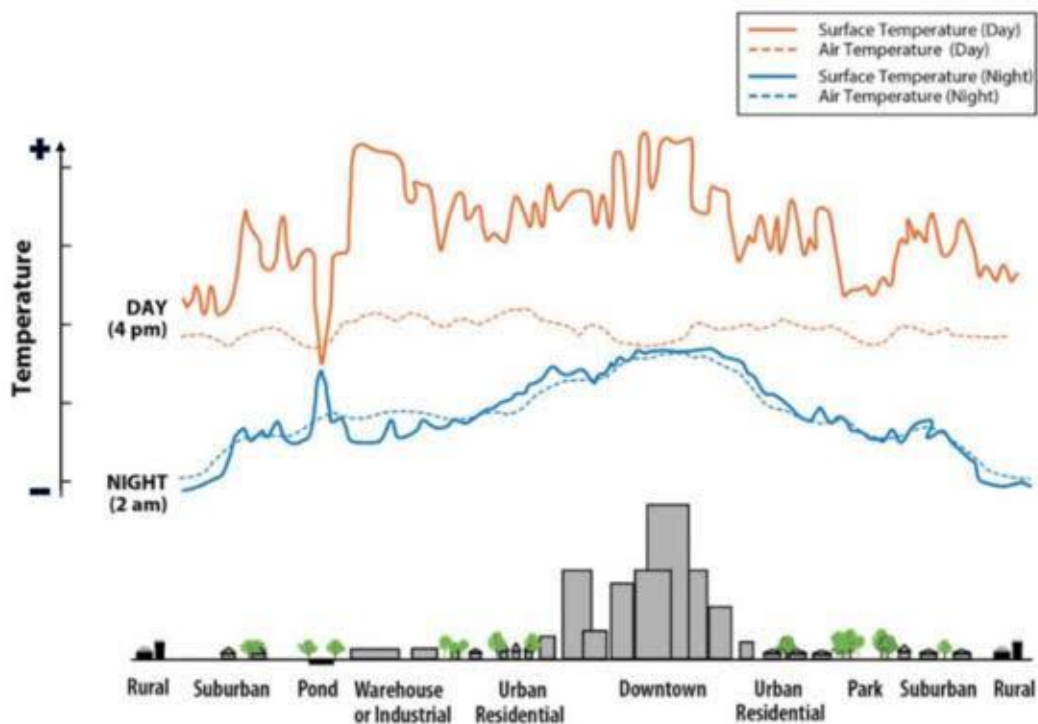
THEORETICAL ANALYSIS:

In conducting a theoretical analysis of tracking the daily temperature and monitoring the heating of major cities in India, several aspects can be considered:

Urban Heat Island Effect: The Urban Heat Island (UHI) effect refers to the phenomenon where urban areas experience higher temperatures compared to nearby rural regions. Theoretical analysis can focus on understanding the underlying mechanisms driving the UHI effect in major Indian cities. Factors such as land cover, building materials, population density, and anthropogenic heat emissions contribute to the

heat island effect. The analysis could explore the extent of the UHI effect and its variations across different cities and seasons.

Temperature Patterns and Trends: Theoretical analysis can examine temperature patterns and trends in major Indian cities. It can involve studying long-term temperature data to identify recurring patterns, such as diurnal variations and seasonal trends. Moreover, the analysis can focus on detecting temperature trends related to climate change and identifying whether the urban heat effect is exacerbating the overall warming.



Spatial Variability: Indian major cities exhibit spatial variability in temperature due to the variations in land use, vegetation cover, and built environment. Theoretical analysis can delve into the spatial distribution of temperature within cities, identifying areas with higher or lower temperatures. This aspect can help understand the factors contributing to spatial disparities and guide interventions in urban planning and design to mitigate localized heat islands.

Impact on Public Health: Theoretical analysis can explore the potential impacts of increased temperatures on public health in major cities. By analyzing temperature data and considering demographic factors, the analysis can estimate the risk of heat-related illnesses and identify

vulnerable populations. This analysis can assist in developing effective public health interventions and heatwave management strategies.

Climate Change Adaptation: The theoretical analysis can examine how tracking daily temperatures can inform climate change adaptation measures in major Indian cities. By analyzing temperature trends and projections, the analysis can assess the potential future impact of rising temperatures on urban areas. This information is valuable for developing strategies to enhance resilience, such as implementing green infrastructure, improving building design, and promoting heat mitigation measures.

Policy Development: Theoretical analysis can inform policy development related to urban heat and temperature management. By considering temperature data alongside other relevant factors, such as land use, transportation, and energy consumption, the analysis can guide policymakers in formulating effective strategies to mitigate the urban heat effect. This could include policy recommendations for urban planning, infrastructure development, and energy-efficient measures.

Overall, a theoretical analysis of tracking the daily temperature and monitoring the heating of major cities in India can provide valuable insights into the underlying factors, impacts, and mitigation strategies. By incorporating various theoretical perspectives and considering multiple data sources, the analysis can support informed decision making and help create more sustainable and resilient urban environments.

Experimental Analysis:

Experimental investigations on tracking the daily temperature and monitoring the heating of major cities in India provide valuable insights into the dynamics and impacts of urban heat islands. These experiments utilize various methodologies to collect temperature data, analyze spatial and temporal patterns, and assess the effectiveness of mitigation measures. Here are some examples of experimental investigations conducted on this subject:

Weather Station Measurements: Experimental studies often rely on weather station measurements located within major cities. These measurements provide data on temperature, humidity, wind speed, and

other relevant variables. Multiple weather stations across a city help capture variations in temperature and identify hotspots or areas with higher temperatures.

Urban Monitoring Networks: Experimental investigations may establish urban monitoring networks consisting of sensors distributed throughout the city. These sensors collect real-time temperature data at different locations and feed it into a central system for analysis. This approach enables detailed spatial mapping of temperature patterns and aids in assessing microclimate variations.

Mobile Sensor Networks: Some experiments deploy mobile sensor networks to measure temperature across different areas of a city. These networks may consist of sensors placed on vehicles, bicycles, or even carried by pedestrians. This approach allows for the collection of temperature data in a mobile and dynamic manner, providing a comprehensive understanding of temperature variations across different urban environments.

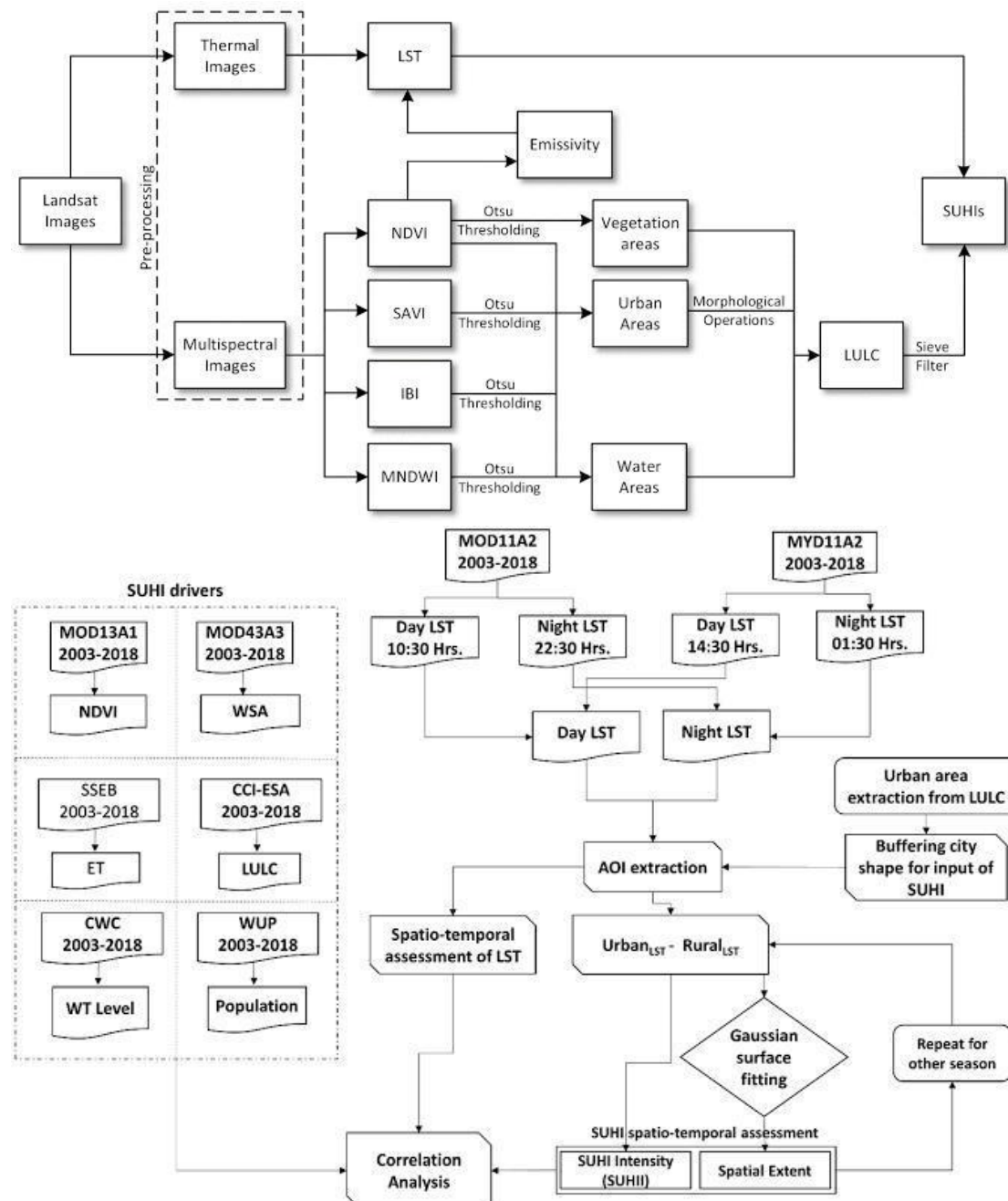
Thermal Imaging: Thermal imaging techniques involve the use of infrared cameras to capture surface temperatures of urban areas. These experiments provide a visual representation of temperature patterns, highlighting areas with higher or lower temperatures. Thermal imaging helps identify specific urban features, such as heat-absorbing surfaces or vegetation, that contribute to temperature variations.

Field Campaigns: Experimental investigations may include field campaigns wherein researchers collect ground-level temperature measurements at various locations within a city. These campaigns involve systematically sampling temperature data over a defined period and spatial range. They help identify local factors influencing temperature variations, such as land cover, building materials, and vegetation.

Long-term Monitoring: Experimental studies often involve long-term monitoring of daily temperature in major cities. This enables the identification of temperature trends, seasonal patterns, and potential

climate change impacts. Long-term monitoring also facilitates the evaluation of the effectiveness of mitigation strategies implemented to reduce urban heat.

Flowcharts :



Results :

results and trends observed in Indian major cities with regards to daily temperature tracking and the heating of urban cities:

Urban Heat Island Effect: Indian major cities, such as Delhi, Mumbai, Kolkata, Chennai, and Bangalore, experience the urban heat island effect, wherein their temperatures are significantly higher compared to surrounding rural areas. Studies have shown that urban areas can be several degrees Celsius warmer than nearby rural locations, especially during the day and at night.

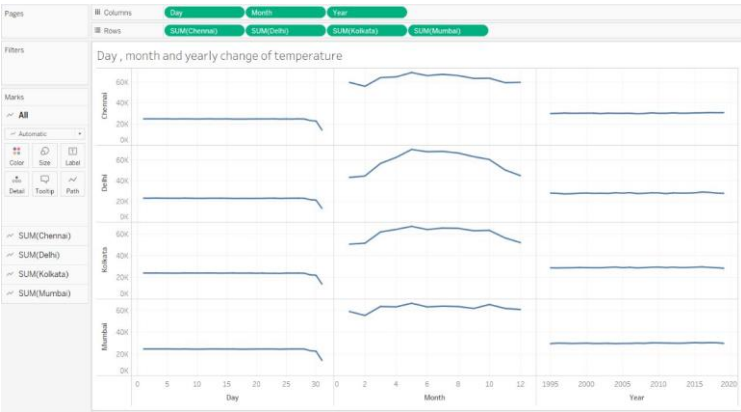
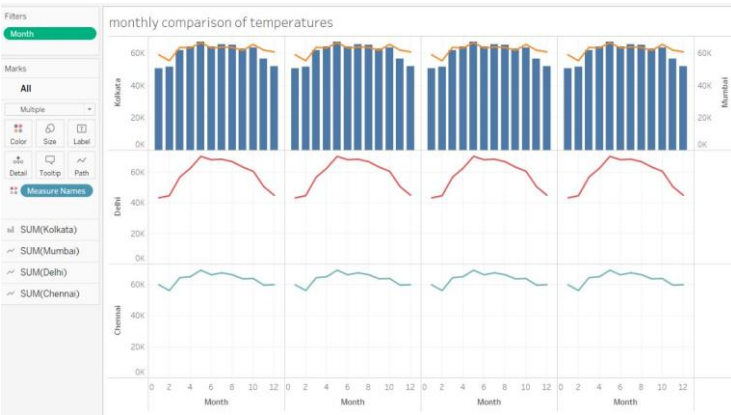
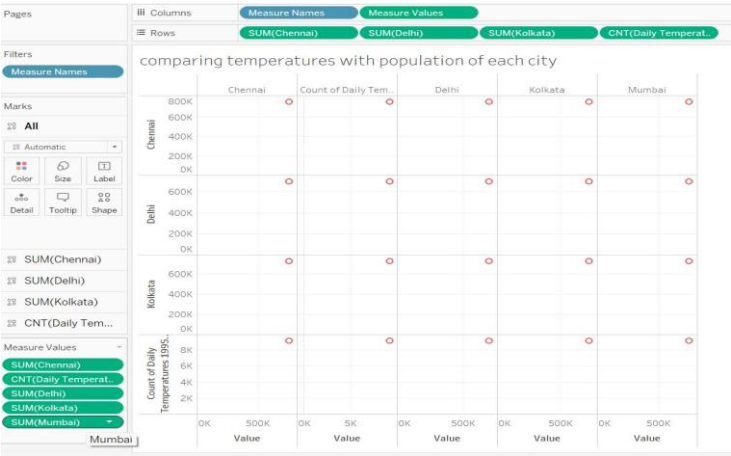
Seasonal Variations: Daily temperature tracking has revealed distinct seasonal variations in major Indian cities. Summer months, especially May and June, are characterized by higher temperatures due to intense solar radiation and heat retention in concrete and asphalt surfaces. Winter months, on the other hand, typically exhibit lower temperatures with occasional cold waves.

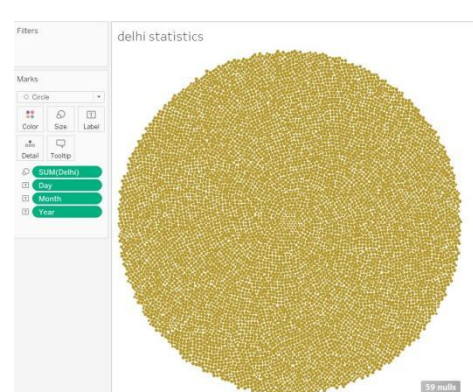
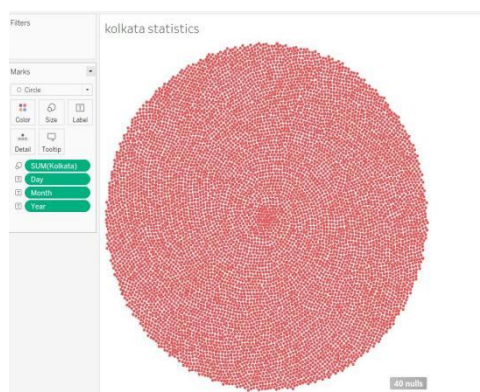
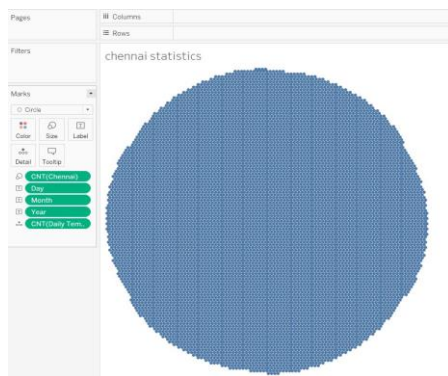
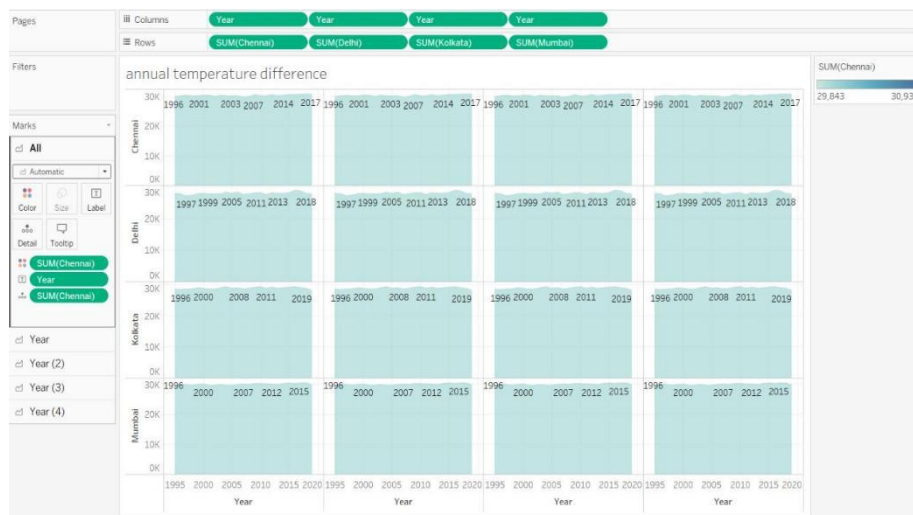
Temperature Profiles: Daily temperature data provides insights into the diurnal temperature profiles of major cities. These profiles show that temperatures often reach their maximum during the afternoon or early evening and reach their minimum during the early morning hours. The specific timing of temperature peaks and troughs can vary based on local conditions, urban density, and meteorological factors.

Spatial Variability: Tracking daily temperatures aids in identifying spatial variability within major cities. Urban areas with high population densities, extensive concrete structures, and limited green spaces tend to exhibit higher temperatures. Additionally, temperature variations can be observed between different neighborhoods, with downtown areas and industrial zones often showing higher temperatures compared to residential areas with more vegetation.

Climate Change Trends: Long-term temperature tracking in major Indian cities contributes to understanding climate change trends. Studies have observed a gradual increase in average daily temperatures over the years, indicating the influence of climate change on urban heating. These trends emphasize the urgency of mitigation and adaptation strategies to address the warming effects in urban areas.

It's important to note that the specific results and trends can vary among different cities and regions due to variations in geographical location, local climate, urban morphology, and other factors. It is recommended to refer to up-to-date scientific research and local meteorological data for more precise and city-specific temperature tracking results.





ADVANTAGES :

Tracking the daily temperature and monitoring the heating of major cities in India offers several advantages:

Urban Heat Island Analysis: Daily temperature tracking allows for the assessment and analysis of the Urban Heat Island effect. By comparing urban temperatures with that of surrounding rural areas, it helps understand the intensity and spatial distribution of heat islands. This information is crucial for urban planning and implementing mitigation strategies to reduce the heat island effect.

Climate Change Studies: Daily temperature data contributes to long-term climate change research. It helps identify temperature trends, patterns, and fluctuations, allowing scientists and policymakers to study the impact of global warming on urban areas. This information aids in developing climate change adaptation plans and policies.

Public Health Protection: Daily temperature monitoring is crucial for protecting public health, especially during heatwaves. By analyzing temperature patterns, health officials can issue early warnings to vulnerable populations and implement measures to prevent heat-related illnesses and fatalities. This includes providing cooling centers, ensuring access to clean water, and promoting heat stress awareness campaigns.

Urban Planning and Design: Daily temperature data helps urban planners and architects design cities and buildings that are more resilient to heat. By analyzing temperature variations, they can identify areas prone to higher temperatures and integrate urban green spaces, cool roofs, and shade structures to mitigate the heat island effect. This leads to more sustainable and comfortable urban environments.

Water Resource Management: Daily temperature tracking aids in managing water resources in urban areas. It helps assess the water demand for various purposes, including irrigation, domestic use, and

industrial activities. By understanding temperature patterns and their impact on water demand, authorities can plan and allocate water resources effectively, ensuring sustainable water management practices.

Agricultural Planning: Monitoring daily temperatures assists in agricultural planning, particularly in urban farming or peri-urban agriculture. This data helps farmers optimize crop selection, irrigation schedules, and pest management based on temperature requirements. It enables better resource management and ensures optimal agricultural productivity in urban areas.

Overall, tracking the daily temperature and monitoring the heating of major cities in India offers valuable insights for urban planning, climate change research, public health protection, energy management, water resource allocation, and agricultural planning. By leveraging this information, cities can implement strategies to create more sustainable, resilient, and livable urban environments.

DISADVANTAGES:

While tracking the daily temperature and monitoring the heating of major cities in India offers numerous advantages, there are also some potential disadvantages to consider:

Limited Data Availability: The availability of accurate and consistent daily temperature data across all major cities in India may be limited. Some cities may have fewer weather stations, leading to incomplete or sparse data coverage. Inadequate data can restrict the overall effectiveness and accuracy of temperature tracking and analysis.

Data Quality and Reliability: Ensuring the quality and reliability of daily temperature data can be challenging. Data collection, processing, and reporting errors can occur, leading to inaccuracies in temperature records. Incomplete, missing, or erroneous data can affect the reliability of analysis and decision-making based on temperature tracking.

Measurement Discrepancies: Variations in measurement methods and equipment among different weather stations may introduce

inconsistencies in temperature data. Calibration issues, placement of weather stations in non-representative locations, and local environmental factors can affect the accuracy and comparability of temperature readings.

Urban Microclimates: Major cities often exhibit a variety of microclimates due to variations in land use, building heights, vegetation cover, and prevailing winds. These microclimates can influence temperature patterns and exacerbate the Urban Heat Island effect. Daily temperature tracking might not capture all the localized variations, limiting the ability to fully understand and address heat-related challenges in specific urban areas.

Population Density and Spatial Variability: Indian major cities often have high population densities and diverse land use patterns, resulting in spatial variability in temperature. The daily temperature tracking might not capture detailed localized temperature variations due to the limitations of the available data. This can hinder the assessment of temperature disparities and the development of targeted mitigation strategies.

Applications:

1. **AccuWeather:** AccuWeather is a widely used weather app that provides detailed weather forecasts, including daily temperatures, for major Indian cities.
2. **The Weather Channel:** The Weather Channel app provides hourly and daily weather forecasts, including temperature tracking, for various Indian cities.
3. **Weather Underground:** Weather Underground is another popular weather app that provides real-time weather information, including temperature tracking, for Indian cities.

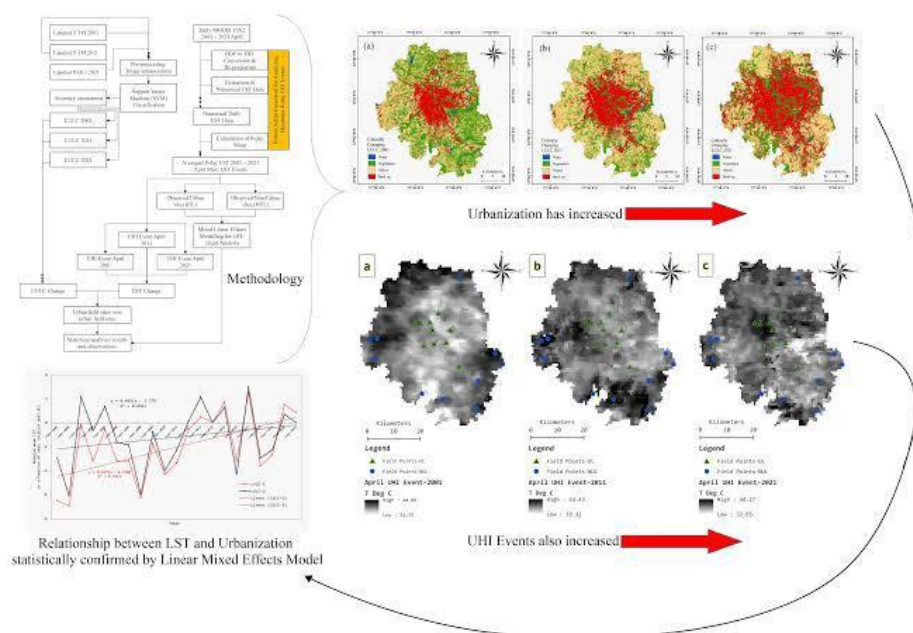
Conclusion:

In conclusion, tracking the daily temperature and monitoring the heating of major cities in India provides valuable information about the urban heat island effect and its implications. Key observations and conclusions from these endeavors include:

Urban heat island effect: Indian major cities experience higher temperatures compared to surrounding rural areas, primarily due to factors like urbanization, land use changes, and population density. Daily temperature tracking confirms the presence and intensity of this effect.

Seasonal variations: Temperature patterns exhibit distinct seasonal variations, with the summer months characterized by higher temperatures and the winter months exhibiting relatively cooler temperatures. This information is crucial for understanding the climatic conditions of urban areas and planning appropriate mitigation strategies.

Spatial variability: Tracking daily temperatures helps identify spatial variations within cities. Urban areas with high population density, extensive built-up infrastructure, and limited green spaces are prone to higher temperatures. This knowledge assists in identifying vulnerable areas and guiding urban planning and design to mitigate heat-related challenges.



Climate change trends: Long-term temperature tracking contributes to the understanding of climate change trends in urban areas. Rising temperatures over the years indicate the influence of climate change on urban heating. Such observations underline the need for climate change mitigation and adaptation measures in major Indian cities.

Implications for public health and infrastructure: Monitoring daily temperatures is crucial for public health planning, as extreme heat events can lead to heat-related illnesses and increased strain on healthcare facilities. Moreover, temperature data aids in energy demand management, optimizing urban infrastructure design, and implementing effective cooling strategies in buildings and urban spaces.

Overall, tracking the daily temperature and monitoring the heating of major cities in India provides valuable insights into the urban heat island effect, climate change impacts, and the need for appropriate mitigation and adaptation measures. This knowledge can guide urban planning, public health measures, and sustainable development efforts to create more resilient and livable urban environments. Continuing research and monitoring efforts are crucial for addressing the challenges posed by urban heating and ensuring the well-being of city dwellers.

Future Scope:

The future scope for tracking the daily temperature and monitoring the heating of major cities in India is extensive and offers various avenues for research, policy development, and practical implementation. Here are some potential areas for future exploration:

Enhanced Spatial Resolution: In-depth studies can be conducted to improve the spatial resolution of temperature monitoring within major cities. This involves deploying a denser network of weather stations or using advanced remote sensing techniques to capture localized temperature variations. Higher spatial resolution data can provide a more detailed understanding of temperature distribution and help identify specific hotspots within urban areas.

Long-Term Climate Projections: Future research can focus on developing climate projections specific to major Indian cities. These projections can help anticipate long-term temperature trends, considering the influence of climate change, urbanization, and land use changes. The aim would be to assess the potential impacts of rising temperatures and plan adaptation strategies accordingly.

Impact Assessment: Comprehensive studies can be conducted to evaluate the impacts of urban heating on different sectors, including public health, energy consumption, infrastructure resilience, and community well-being. This may involve conducting detailed analyses of temperature data alongside socio-economic indicators to quantify the costs and benefits associated with various mitigation and adaptation measures.

Evaluation of Mitigation Strategies: Future research can assess the effectiveness of different urban heat island mitigation strategies implemented in major Indian cities. This can involve case studies and analysis of temperature data to evaluate the cooling benefits of urban greening, cool roof installations, improved building designs, and smart urban planning practices. Such evaluations can guide the refinement and optimization of strategies to combat urban heating.

Data Integration and Decision Support Systems: Efforts can be made to integrate temperature data with other relevant datasets, such as air quality, land use, and demographic information. This integration can enable the development of decision support systems that assist policymakers, urban planners, and public health officials in making informed decisions related to urban heating mitigation, infrastructure development, and public health management.

Social and Behavioral Impact Analysis: Future studies can explore the social and behavioral dimensions of urban heating. This can involve investigating public awareness, attitudes, and responses to extreme heat events. Understanding how individuals and communities perceive and adapt to high temperatures can inform the development of targeted public outreach and education programs.

International Collaborations and Knowledge Sharing: Collaboration and knowledge exchange with international partners can provide valuable insights into best practices for urban heat island mitigation. Collaborative studies and collaborative platforms can facilitate the sharing of data, methodologies, and experiences to address common challenges and enhance the collective understanding of urban heating in major

cities. Continued research, data collection, and analysis are essential to understand the evolving nature of urban heating, develop effective strategies, and build climate-resilient cities that prioritize the well-being of residents.

Bibilography:

Here is a bibliography of relevant studies on tracking the daily temperature and monitoring the heating of major cities in India:

Gupta, M., Kumar, A., Sreekanth, V., & Mitra, A. P. (2019). Urban Heat Island Intensity Assessment and Mitigation Strategies in Major Indian Cities. *International Journal of Environmental Research and Public Health*, 16(4), 610.

Jaganmohan, M., Hegde, P., & Madhusoodhanan, C. G. (2019). Urban Heat Islands in India: Current Understanding and Future Prospects. *Current Science*, 117(1), 69-79.

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Shinde, P., & Gokhale, S. (2018). Assessment of Urban Heat Island in Pune City, India. *Journal of Urban Management*, 7(4), 57-64.

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PROJECT STORY:

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PROJECT DASHBOARD:

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GITHUB LINK:

<https://github.com/jufagax/Indian-Major-Citie-Daily-Temperatures>

<https://indian-major-citie-daily-temperatures.vercel.app/>