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Analysing Air Quality and Health Risks in Indian Cities

Saikumar Chityala[1], T. Malathi [2]

[1,] P.G. Research Scholar, Department of MCA-Data Science, Aurora Deemed To Be University, Hyderabad, India
[2]Assistant Professor, Department of MCA, Aurora Deemed To Be University, Hyderabad, Telangana, India
Email: [1]chityalasaikumar204@gmail.com, [2] malathi@aurora.edu.in

ABSTRACT :

This project, "Analysing Air Quality and Health Risks," analyses how air pollution impacts Indian city public health and the workload of hospitals in cities like Chennai and Hyderabad. We collected data on Air Quality Index (AQI), stress levels at hospitals, and health risk scores. We developed interactive visual narratives like area charts, bar charts, and dual-axis charts in Tableau so that any user, ranging from students to city planners, can clearly understand the trends. Our research indicated that when air quality worsens (high AQI), there is indeed an increase in health risk along with higher hospital stress, especially in certain months or years. For example, hospital stress is worst during poor air months in Chennai. Similarly, in Hyderabad, high AQI years also experience higher health risks. These findings irrefutably demonstrate that pollution not only harms the environment but human health as well and imposes extra strain on healthcare. Our dashboards allow users to simply view where in the months, years, or cities effort is required more, so city councils and hospitals can prepare in advance. Our visualizations provide an easy data story that is easier for all to access, that is, when and why air is most dangerous. This project emphasizes the importance of regular tracking of air quality. In a bid not to further worsen the environment, we believe there must be increased public knowledge, regular monitoring, clean fuel, and more planning based on actual facts. Displaying data using tools turns hard data into data that can save public health and enhance the living standard in our cities.

Keywords: Air Quality Index, Hospital Stress, Health Risk Score, Air Pollution, Data Visualization, Tableau, Indian Cities, Public Health, Chennai, Hyderabad, Urban Pollution, Environmental Health, Hospital Capacity, Health Analytics, Pollution Monitoring.

Introduction

Air pollution has emerged as the most serious and urgent problem of Indian cities today. Millions of people breathe in air filled with dust, smoke, and toxic gases on a daily basis. It does not just turn the sky grey or irritate people; it causes real health problems like asthma, cough, allergy, and even heart problems. Because of this, many people end up spending additional hospital days. The health care industry is also subject to additional strain on days or during months when pollution rises. Thus, it is very important to research in detail how air quality relates to health risk and hospital workload in India.

Our paper, "Analysing Air Quality and Health Risks," tries to understand this relationship in greater detail. We were interested to know whether or not there is a clear and direct relationship between the qualities of air that individuals breathe in and whether they are likely to fall sick or need hospitalization. We selected two major cities, Chennai and Hyderabad, for our research. We chose these cities because they are growing fast and face all of the same problems as the rest of India's cities, including traffic, factories, and changing weather.

We first started our research by collecting information about Air Quality Index (AQI). AQI is a number which allows people to understand the quality of air on a specific day. We also learned about hospital stress ratios (whether hospitals are full or not), and health risk scores (informing us about the likelihood of people falling ill due to pollution).

After collecting the data, we observed that standard tables and long lists of numbers are very hard to understand for the majority. So, we used Tableau, a popular data visualization tool, to make our analysis easy and understandable. Using Tableau, we built many different kinds of charts like area charts, bar graphs, dual-axis charts, and dashboards. These graphics enable all—students and average citizens, physicians and politicians—to see the patterns and trends at a glance, without technical expertise.

The main purpose was to ascertain if periods of high AQI (unhealthy air) also measured higher readings for hospital stress and health hazard. For example, is there a particular month when the air over Chennai is horrendously bad and, coincidentally, hospitals fill up and health problems on the increase? Similarly, are there years in Hyderabad when pollution is high and also the health hazards? These were the questions we wanted to find out.

In our study, the interactive dashboards and visual stories that we created helped us better visualize the trends. We were able to mark which years or months are most dangerous, and where, in what city. We also understood that pollution problems are not uniformly distributed—some regions or months have severe problems. This kind of information is exceedingly useful to physicians, hospitals, urban planners, and even families, in order that they may plan when to take added precautions.

This project also describes how simple graphics and frequent monitoring of AQI can bring about a significant difference. If individuals are conscious of the risks, and hospitals can prepare for peak-risk periods, numerous issues could be minimized. Our expectation is that such a study will make everyone more aware of pollution issues, promote measures to maintain clean air, and make our cities cleaner places to reside.

Literature Review

Urban air pollution has been a significant public health threat, impacting millions of people across the globe. Studies have confirmed that high levels of air pollutants have been correlated with serious respiratory and cardiovascular disease, proving a clear health risk through compromised air quality [1]. Combining air quality data with health analytics can actually evaluate the effect of pollution on human health in urban environments [2].

Land use and urban activities significantly determine the air quality in urban areas. Urban areas with heavy traffic and industrialization have higher concentrations of airborne particles in their air, which increase the health risks when exposed [3]. Advanced tools like Tableau data visualization have been used in India to analyze air quality trends, providing policy-makers and urban planners with actionable insights from pollution and health trends [4].

Air pollution is a major cause of death and disease burden in India. From 1990 to 2016, life expectancy decreased in Indian states due to air pollution, emphasizing the need for monitoring and mitigation [5]. The main sources of pollution in Indian cities are vehicle emissions, industrial production, and burning of biomass, which require total management measures [6].

Specific research in Indian cities has validated the health hazard caused by pollution. In Delhi, long-term exposure to particulate matter and noxious gases makes respiratory and cardiovascular diseases much higher [7]. Mitigation of household emissions can lead to meeting national ambient air quality standards, proving that source-specific reduction can make a concrete difference to public health [8].

Current events also reflect the correlation of human activity with air quality. The Indian lockdown of COVID-19 led to limited emissions and an improvement in air quality, which reflects directly on the human activity's influence on pollution levels [9]. Indian city trend analysis has also demonstrated a positive relationship between air quality index highs and elevated health risks, with the importance highlighted that monitoring and visualization of air quality can inform effective preventive strategies [10].

Comparison of Key Techniques

Paper (Year)	Technique	Purpose	Strengths	Limitations
Junaid et al., 2025	Tableau Data Visualization	Interactive dashboards to present AQI, hospital stress, and health risk	Makes complex data accessible; supports multiple visualization types	Visualization accuracy depends on data quality; may oversimplify trends
Sahu et al., 2021	AQI & Health Risk Trend Analysis	Correlates AQI with health risks over time in Indian cities	Helps identify high-risk periods; supports preventive planning	Depends on long-term, accurate data; seasonal variability may affect results
Sharma et al., 2020	Temporal Trend Analysis (Lockdown Study)	Measures air quality improvements during restricted emissions	Shows direct impact of human activity on pollution; temporal insights	Short-term data; may not reflect long-term trends
Chowdhury et al., 2019	Source-specific Mitigation Analysis	Evaluates effects of reducing household emissions	Actionable policy insights; shows potential to meet air quality standards	Implementation may be challenging; requires detailed emission data
Balakrishnan et al., 2019	Disease Burden & Life Expectancy Analysis	Quantifies national-level health impacts of air pollution	Provides large-scale evidence of health impact; helps policymakers prioritize interventions	May not reflect city-level variations; uses modeled data
Mateos et al., 2018	Land Use & Air Quality Analysis	Evaluates impact of urban land use on air quality and human health	Links pollution exposure to urban planning; quantitative health risk evaluation	May not capture temporal trends; data may not be widely available
Nagpure et al., 2016	Human Health Risk Assessment	Assesses health risks in Delhi due to air pollution	Provides city-specific risk assessment; supports healthcare planning	Focused on one city; relies on accurate hospital data

Fotopoulou et al., 2016	Linked Data Analytics	Connects air pollution data with health outcomes using interdisciplinary approach	Allows comprehensive health risk analysis; supports data-driven decision-making	Requires integration of multiple datasets; complex methodology
Guttikunda et al., 2014	Emission Source Analysis	Identifies main sources of pollution in Indian cities	Helps target mitigation strategies; highlights contribution of traffic, industry, biomass burning	Data-intensive; may not capture seasonal variations
Ilyas et al., 2009	AQI Measurement & Air Pollution Assessment	Evaluates air pollution levels in urban areas and their impact on human health	Provides baseline data for health risk analysis; standard method for pollution evaluation	Limited to one city; may not account for all pollutants

Methodology

1. Data Collection and Preparation

First off, wrangling the data. I rounded up all the juicy bits about air quality and health stats for Indian cities, but the spotlight was mostly on Chennai and Hyderabad. We're talking.

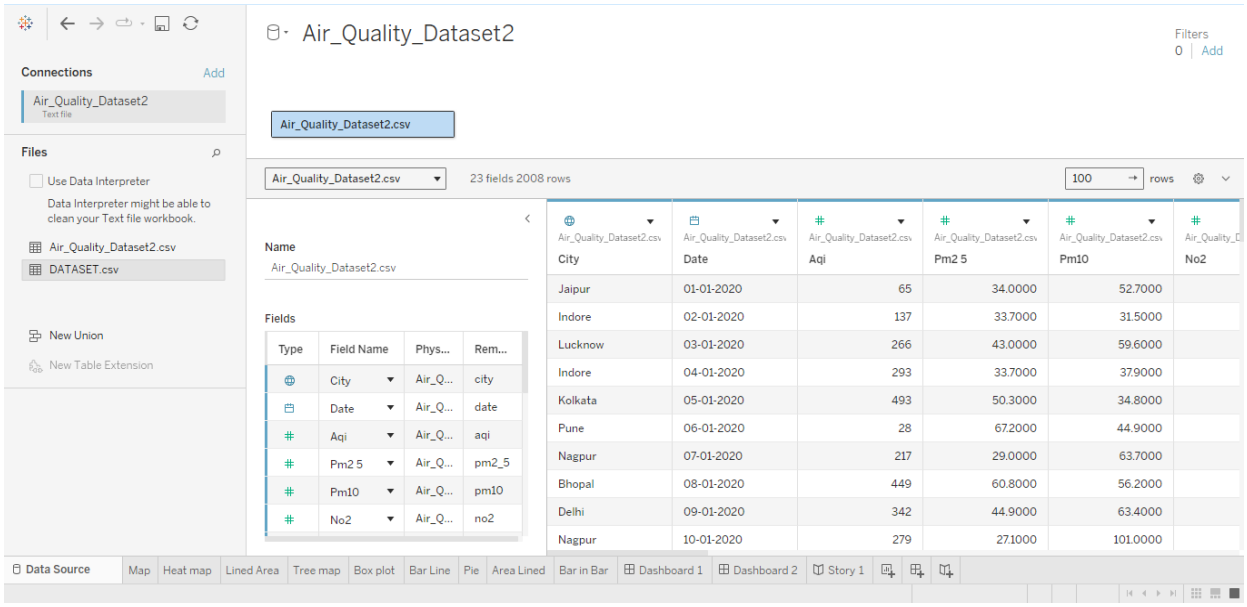
- Air Quality Index(AQI): for the pollution scoop,
- hospital stress ratios (because, let's face it, hospitals are always under the pump), and health risk scores to see just how much the air is messing with people's lungs.
- Threw in extras like which pollutants were winning the "most annoying" contest, what kind of area we're looking at (city, 'burbs, or out in the sticks), plus the usual suspects: temp, humidity, weather stuff.

	city	date	aqi	pm2_5	pm10	no2	o3	emperatur	humidity	pital_admiss	ulation_der	pital_capa	latitude	longitude	egion_type	qi_categor	inant_pollu	ther_condi	ient_indica	kdown_per	ay_of_wee	aqi_moving_avg_7d
2	Jaipur	01-01-2020	65	34	52.7	2.2	38.5	33.5	33	5	Rural	1337	29.53525	95.5487	Rural	Satisfacto	pm10	Sunny	Yes	No	Wednesd	65
3	Indore	02-01-2020	137	33.7	31.5	36.7	27.5	-1.6	32	4	Urban	1545	31.12873	124.2617	Urban	Moderate	no2	Sunny	No	No	Thursday	101
4	Lucknow	03-01-2020	266	43	59.6	30.4	57.3	36.4	25	10	Suburban	1539	36.09208	101.517	Suburban	Poor	pm10	Sunny	Yes	No	Friday	156
5	Indore	04-01-2020	293	33.7	37.9	12.3	42.7	-1	67	10	Urban	552	25.01202	72.2039	Urban	Poor	o3	Rainy	Yes	No	Saturday	190.25
6	Kolkata	05-01-2020	493	50.3	34.8	31.2	35.6	33.5	72	9	Suburban	1631	38.23908	92.74203	Suburban	Severe	pm2_5	Cloudy	Yes	Yes	Sunday	250.8
7	Pune	06-01-2020	28	67.2	44.9	41.9	47.8	7.9	89	11	Urban	1291	38.24906	126.5998	Urban	Good	pm2_5	Windy	No	Yes	Monday	213.6666667
8	Nagpur	07-01-2020	217	29	63.7	22.3	56	27.7	22	8	Urban	1852	30.21008	109.0097	Urban	Poor	pm10	Windy	No	Yes	Tuesday	214.1428571
9	Bhopal	08-01-2020	449	60.8	56.2	40	18.1	26.3	46	14	Urban	350	24.50309	128.8687	Urban	Severe	pm2_5	Sunny	No	No	Wednesd	269
10	Delhi	09-01-2020	342	44.9	63.4	31	34.9	28	34	7	Urban	878	20.4644	72.88061	Urban	Very Poor	pm10	Cloudy	No	No	Thursday	298.2857143
11	Nagpur	10-01-2020	279	27.1	101	47.8	42.2	-2.1	24	8	Urban	179	31.31827	101.6387	Urban	Poor	pm10	Windy	Yes	No	Friday	300.1428571
12	Lucknow	11-01-2020	484	56.6	46.3	33.2	27.3	27.9	62	9	Urban	600	24.845	79.13736	Urban	Severe	pm2_5	Cloudy	Yes	Yes	Saturday	327.4285714
13	Visakhap	12-01-2020	472	44.7	56.6	35.1	31.1	9.4	26	5	Suburban	154	23.54695	79.58241	Suburban	Severe	pm10	Windy	Yes	No	Sunday	324.4285714
14	Ludhiana	13-01-2020	276	46.3	50.5	32.8	52.6	24.7	53	11	Rural	1042	39.73065	96.85282	Rural	Poor	o3	Cloudy	No	No	Monday	359.8571429
15	Agra	14-01-2020	290	0.4	43	25.3	55.8	8.8	33	3	Urban	989	25.38188	80.98463	Urban	Poor	o3	Windy	No	Yes	Tuesday	370.2857143
16	Chennai	15-01-2020	475	45	47.6	38.5	54.6	10.4	76	6	Urban	1461	39.88811	118.1516	Urban	Severe	o3	Sunny	No	Yes	Wednesd	374
17	Patna	16-01-2020	423	34.2	31.4	36.1	32.8	24.7	70	5	Urban	1472	38.74168	101.5648	Urban	Severe	no2	Sunny	Yes	No	Thursday	385.5714286
18	Indore	17-01-2020	269	41.3	46	22.9	39.7	-4.7	74	10	Urban	1337	36.86396	84.99308	Urban	Poor	pm10	Windy	No	No	Friday	384.1428571
19	Chennai	18-01-2020	475	44.4	34.8	41.4	67.2	25.4	27	10	Suburban	1374	29.37545	120.7728	Suburban	Severe	o3	Cloudy	Yes	Yes	Saturday	382.8571429
20	Visakhap	19-01-2020	34	41.5	17.3	40.3	44.4	2.5	35	8	Urban	893	27.7063	99.67174	Urban	Good	o3	Sunny	No	Yes	Sunday	320.2857143
21	Nagpur	20-01-2020	234	42.3	47.3	17.2	43.7	34.4	36	11	Urban	1508	29.09464	86.43779	Urban	Poor	pm10	Windy	Yes	Yes	Monday	314.2857143
22	Pune	21-01-2020	402	47	13.8	29.2	30.8	30.3	84	8	Rural	1785	39.44866	74.11826	Rural	Severe	pm2_5	Cloudy	No	No	Tuesday	330.2857143
23	Lucknow	22-01-2020	164	31.1	66.1	20.2	31.9	5.1	69	8	Suburban	1500	34.32058	128.8559	Suburban	Moderate	pm10	Sunny	Yes	No	Wednesd	285.8571429
24	Chennai	23-01-2020	429	61.3	43.2	30.1	37.8	35.3	28	8	Urban	1041	28.87495	114.9955	Urban	Severe	pm2_5	Windy	Yes	Yes	Thursday	286.7142857
25	Agra	24-01-2020	161	44.4	51.6	25.3	15	28.5	86	7	Urban	89	33.17752	76.37245	Urban	Moderate	pm10	Windy	Yes	No	Friday	271.2857143
26	Visakhap	25-01-2020	385	24	31.5	28.1	29.6	-2.6	23	3	Urban	1187	24.81153	103.8944	Urban	Very Poor	pm10	Sunny	Yes	Yes	Saturday	258.4285714
27	Bangalor	26-01-2020	184	40.3	57.1	15.6	45.1	6.6	36	8	Urban	59	39.87717	124.1074	Urban	Moderate	pm10	Rainy	Yes	Yes	Sunday	279.8571429

Before doing anything fun, I had to clean up the mess—ditched duplicates, patched up missing blanks, got everything lined up neat by month and year. You know, the boring-but-necessary bits so we don't end up comparing apples to, like, Saturn.

2. Connecting Data to Tableau

The resulting dataset was then loaded in Tableau. Fields were city, date, year, and category in Tableau. Filters and controls were placed for the data to be easily explored, compared between cities in different time periods, and filtered.

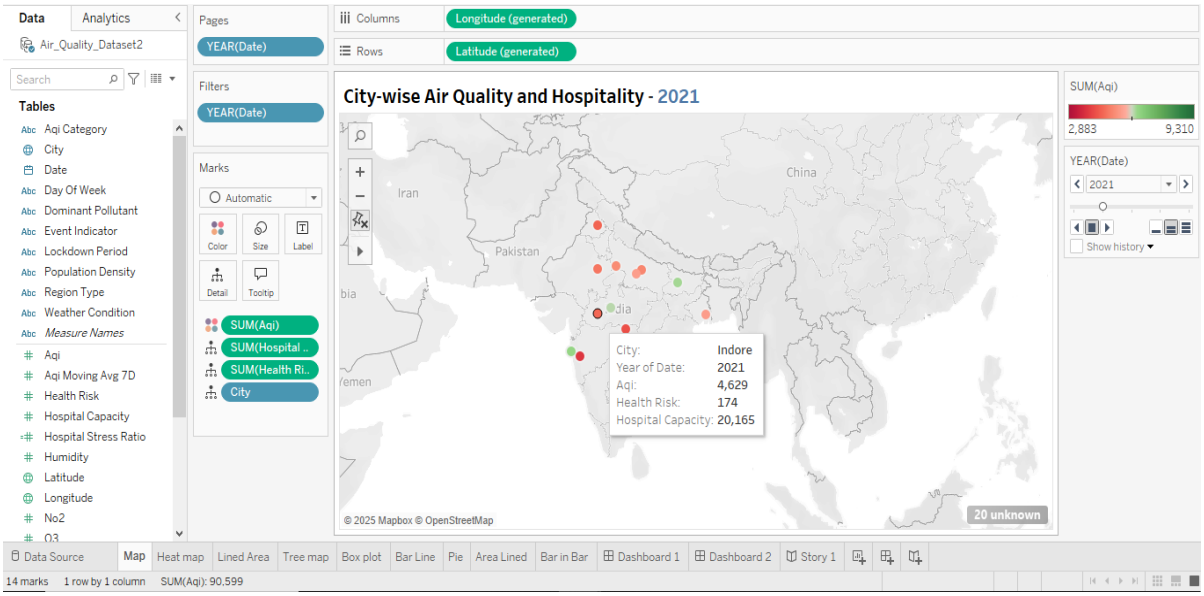


3. Creating Visualizations (8 Charts)

- **Counter-pro forma statements:** Eight individual pro formas were developed, one for each role:
- **Map Chart** – Visualize AQI, health risk, and hospital capacity by city on the Indian Map.
  Heat Map – Depicts how hospital capacity differs in cities under different AQI categories.
  Area Chart with Average Line – The 7-day AQI average and score graphed side-by-side to show historic trends.
- **Tree Map** – Displays the most significant pollutants, source areas and associated health effects.
  Blox Plot – Differs between weather, humidity-temperature and AQI categories.
- **Bar and Line Chart** – Trends of AQI across weekdays in the context of health implications.
  Area and Line Chart – Describes the impact of monthly AQI variations on hospital stress ratios.
- **Bar-in-Bar Chart** - Presents the health risks scores against the yearly AQI values for a qualitative view of long-term effects.
- Every chart showed another piece of the analysis, and the story grew more complete.

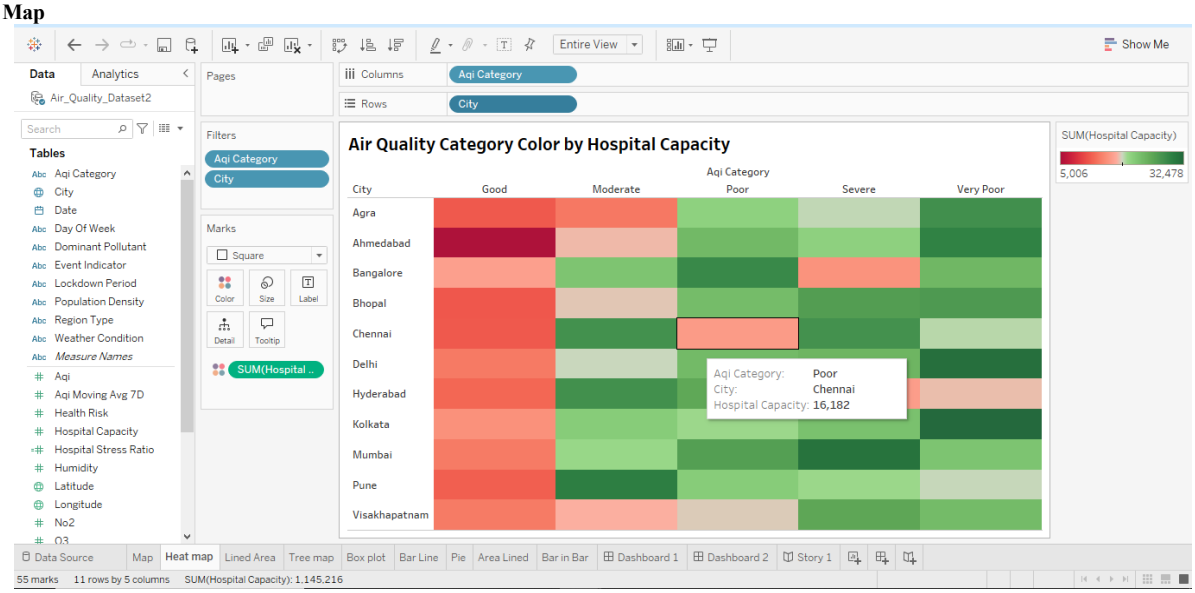
Results:

Map Chart



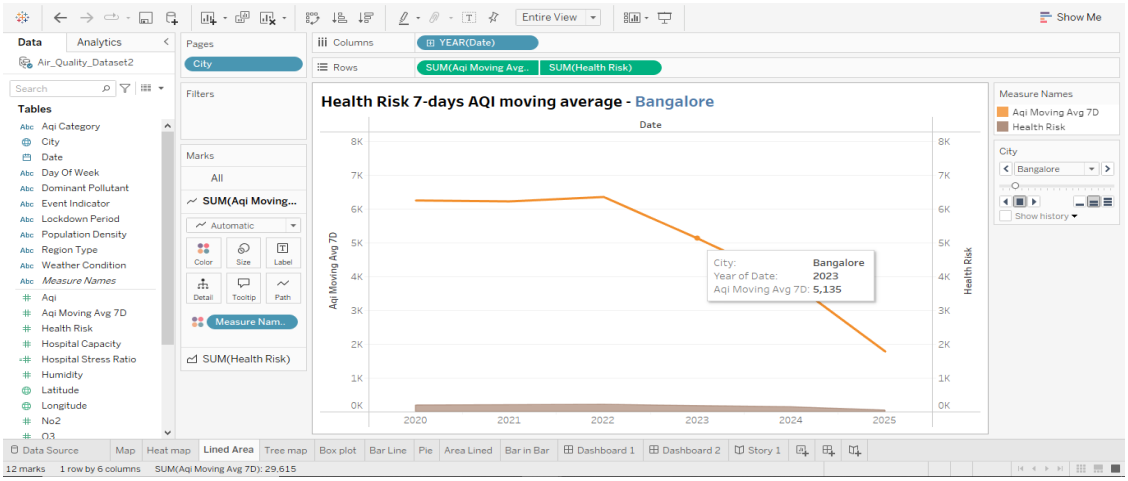
This map shows AQI levels across Indian cities in Years, with redder dots indicating worse air quality. Cities face high pollution and rising health risks despite strong hospital capacity.

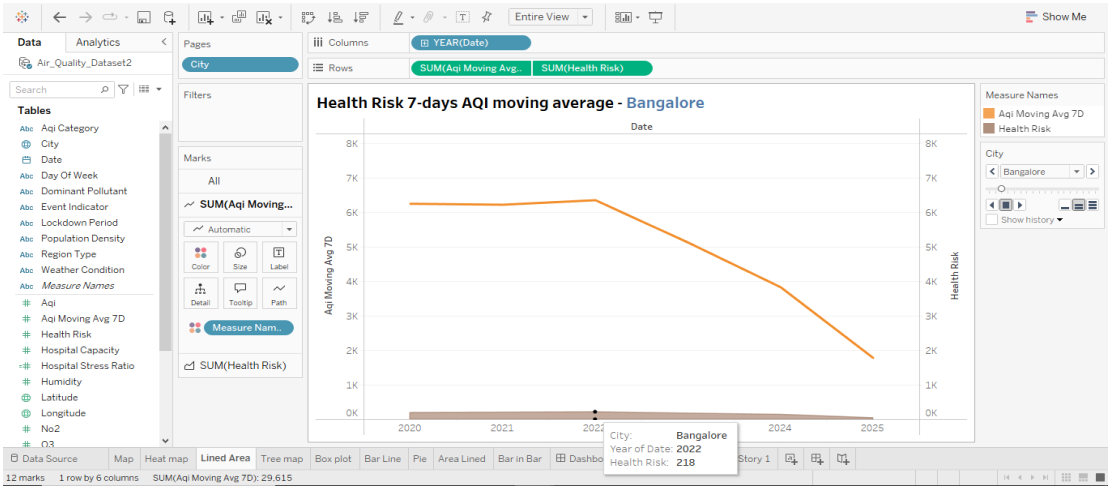
Heat Map



This heat map shows the relationship between air quality categories and hospital capacity across cities. Darker green cells indicate higher hospital capacity in poor air conditions, while red suggests limited resources.

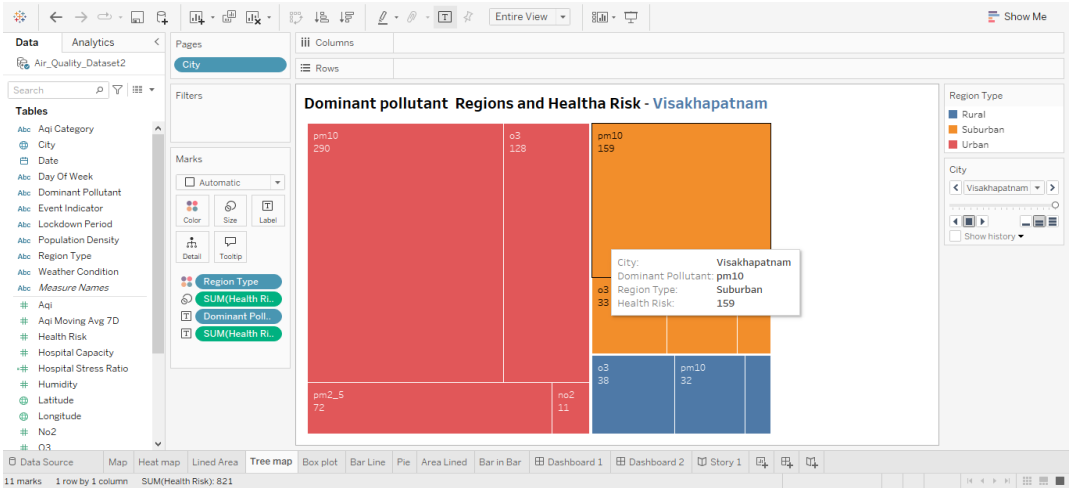
Lined Area Chart





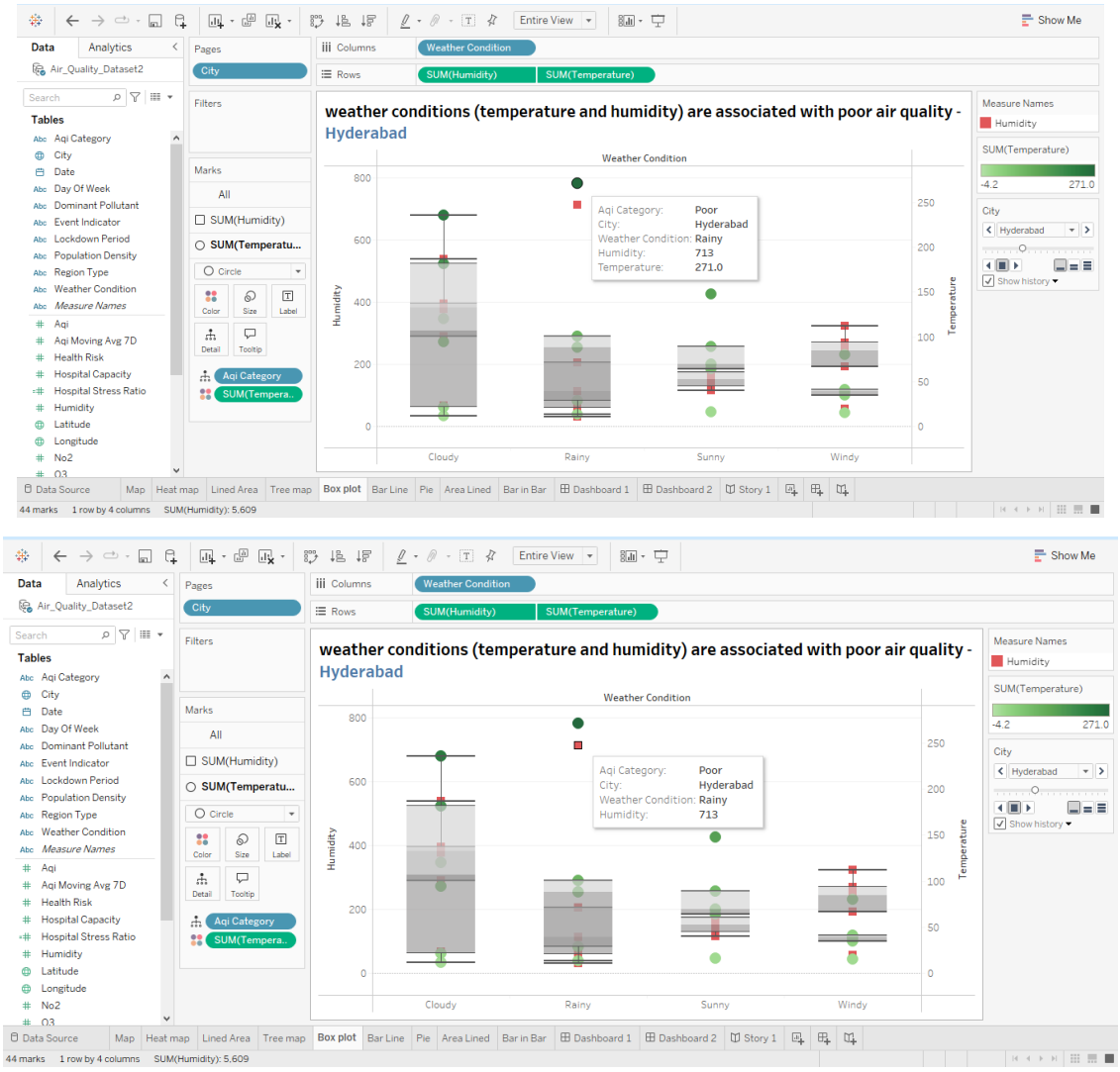
This chart illustrates the 7-day AQI moving average and associated health risks in City from 2020 to 2025.As AQI levels decline over the years, a corresponding drop in health risks is also observed, indicating a positive trend.

Tree Map



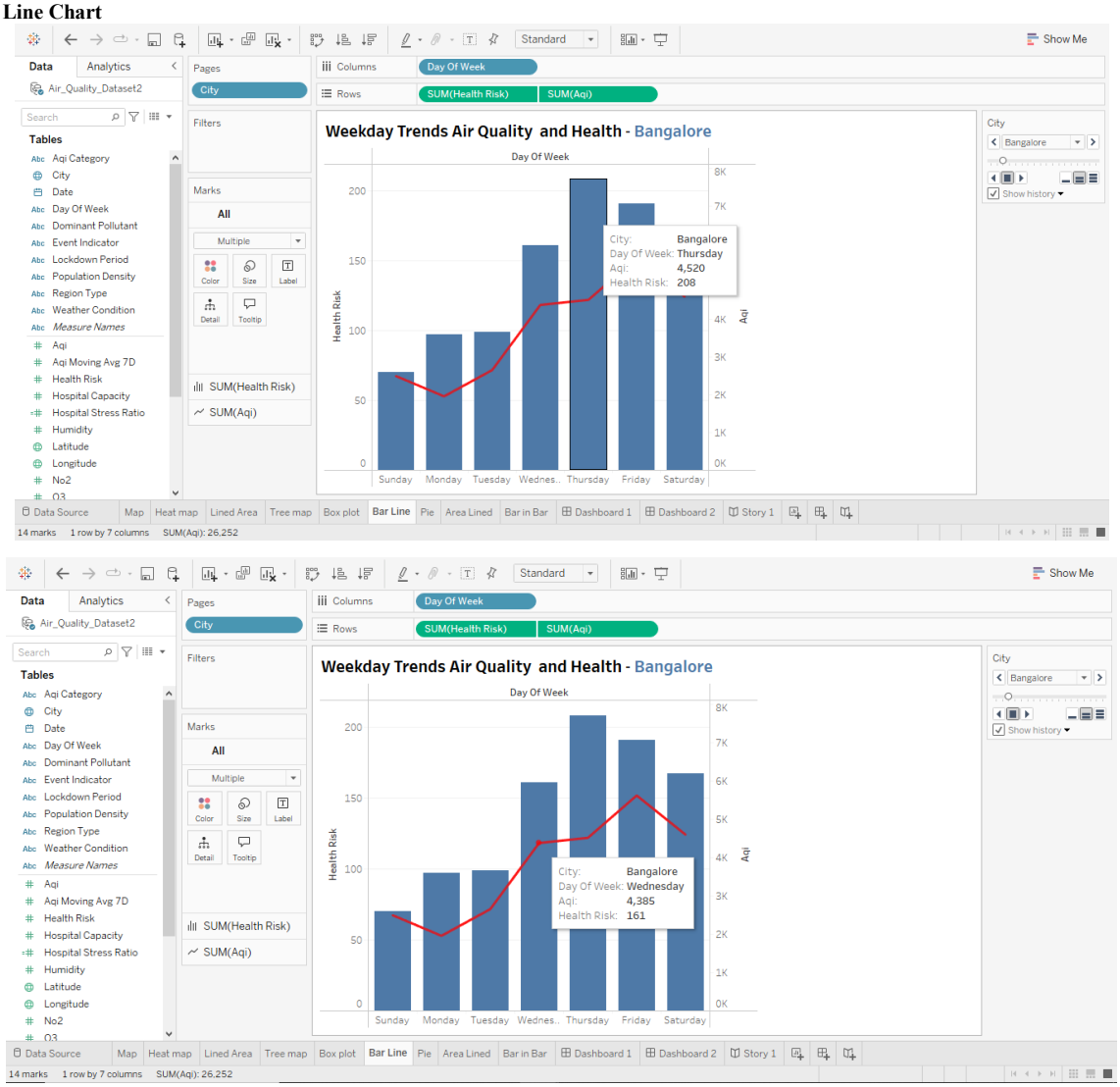
This tree map highlights dominant pollutants across urban, suburban, and rural regions of City. PM10 is the leading pollutant in both urban and suburban zones, contributing significantly to health risks.

Box Plot



This visualization explores how temperature and humidity levels influence air quality. This highlights the need to monitor weather conditions closely to predict air pollution spikes.

Bar and Line Chart

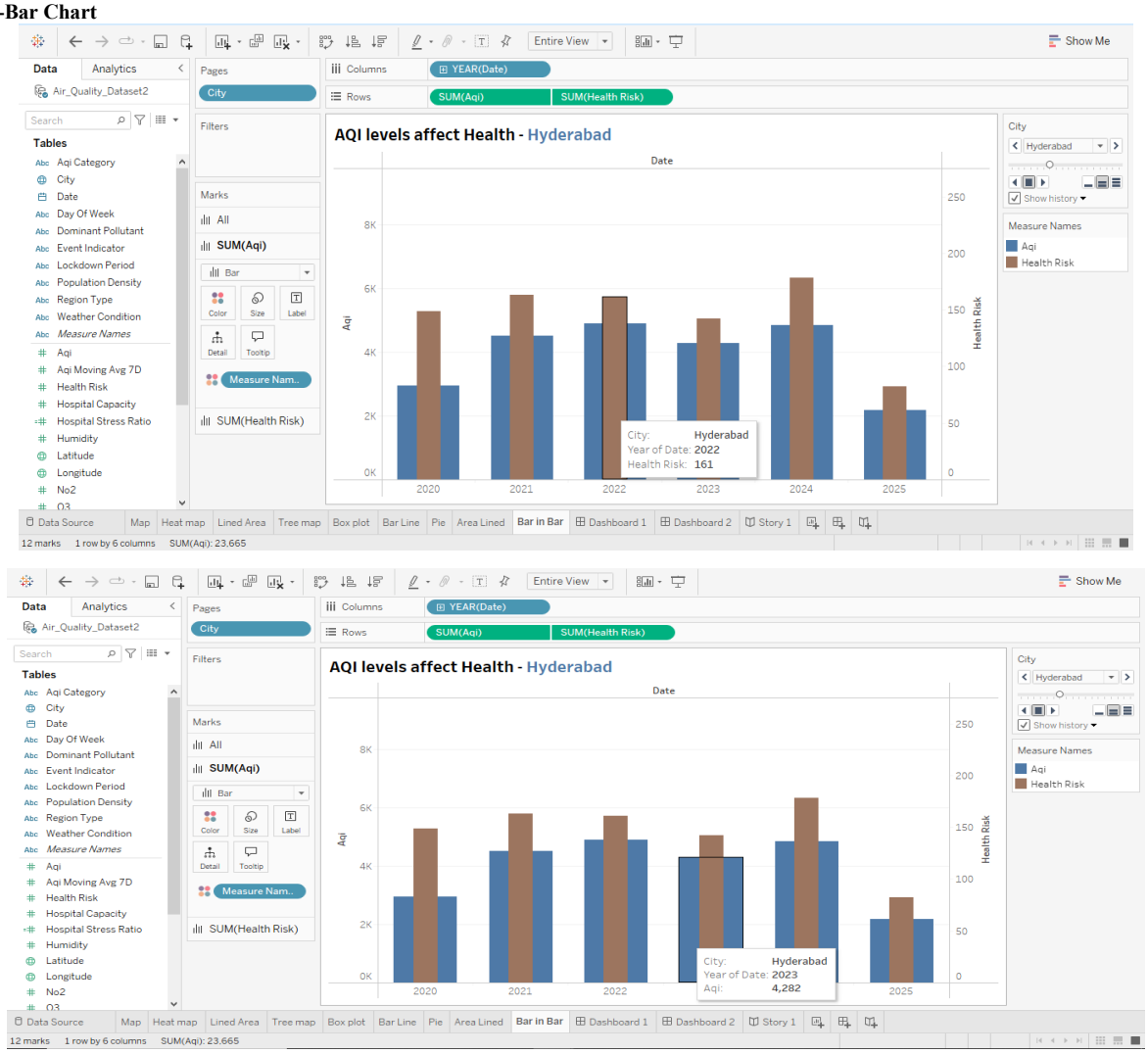


This visualization explore Weekday analysis shows AQI, followed by high health risk. Air quality worsens mid-week, suggesting weekday activity may impact pollution.

Area and Line Chart

In Cities, hospital stress during months of higher air pollution. This shows how worsening air quality directly increases pressure on healthcare systems.

Bar-in-Bar Chart

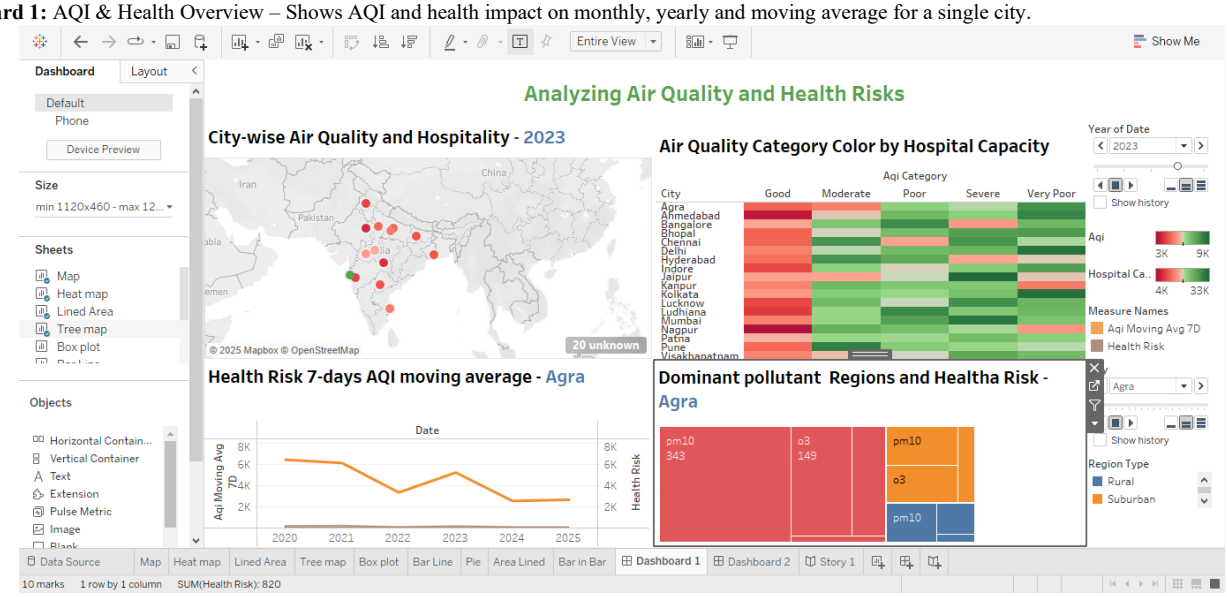


In Cities, higher AQI levels clearly relate to increased health risks over the years. This highlights how air pollution trends directly impact public health.

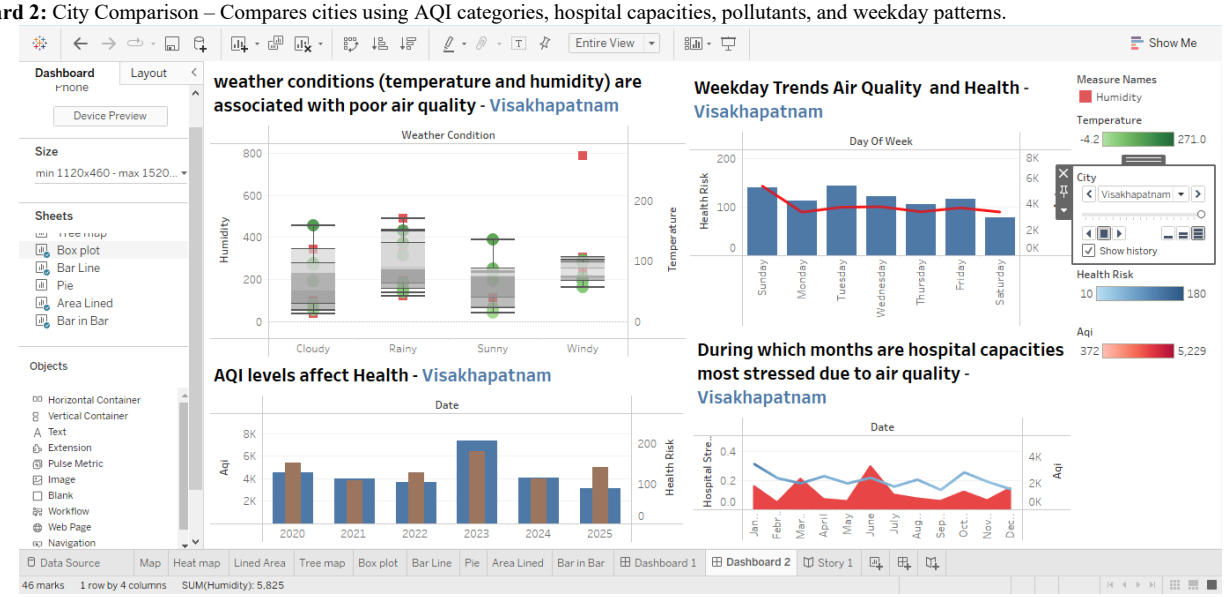
Building Dashboards.

Two dashboards were developed by organizing series of charts:

Dashboard 1: AQI & Health Overview – Shows AQI and health impact on monthly, yearly and moving average for a single city.



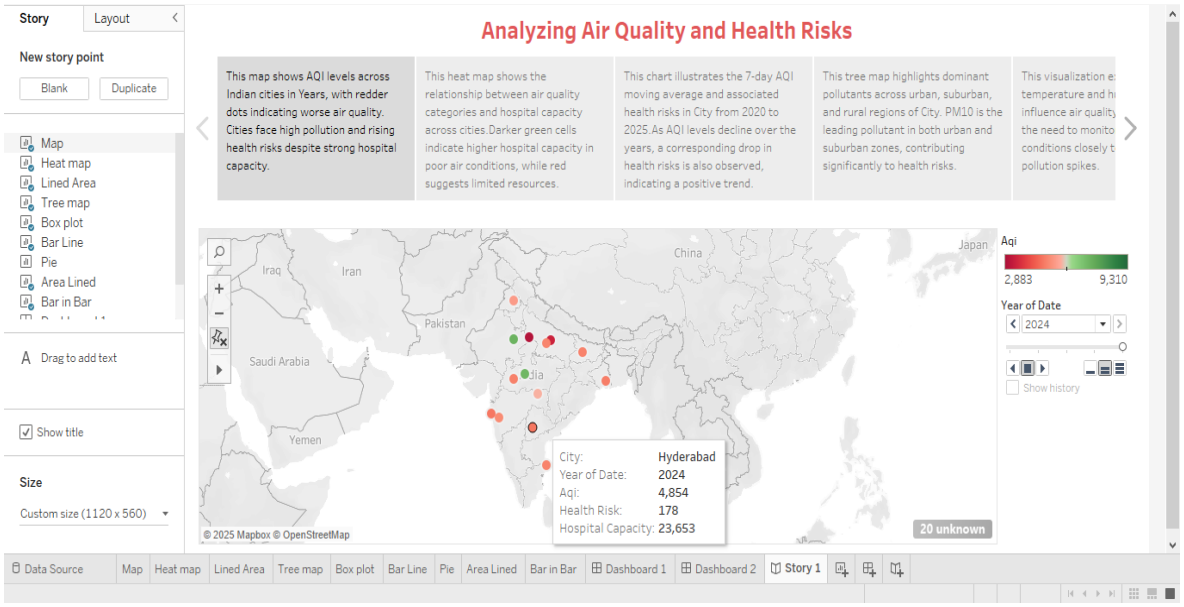
Dashboard 2: City Comparison – Compares cities using AQI categories, hospital capacities, pollutants, and weekday patterns.



Dashboards included filters (by city, year, or category) and interactive actions so users could explore data themselves.

Creating a Tableau Story

The charts and dashboards were next merged into a step-by-step story in Tableau. Each slide of the story features a main point, for example, “Hospital stress rises in high AQI months” or “Health risks increase in polluted years.” This storytelling method made the project accessible to those without technical skills.



Testing and Refining

Finally, all the charts and dashboards had been verified for their accuracy and clarity. The colors (red for high AQI, green for better conditions) were selected very carefully, labels and tooltips were added for an explanation, and filters were checked to ensure a smooth interaction. The adjustments made the story more professional and user-friendly.

Discussion

Through this project, we became familiar with the connection between air pollution and health risks, as well as the pressure on hospitals in Indian cities like Chennai and Hyderabad. By applying Tableau, we transformed the complicated datasets into understandable and interactive visualizations. Such a transformation allowed us to discover the crucial trends which might not be easily figured out by numbers alone.

What we uncover is that an increment in the Air Quality Index (AQI) which may go to the level months or years, is very likely to be accompanied by the rise of hospital stress and health risk scores. Just to illustrate, in Chennai, during the time the AQI reaches its peak, hospital stress gets increasing rapidly. Likewise, the periods when the air is the dirtiest are those that witness a high number of health risk cases. These changes in the disease risks reflect the proximity of public health to the environment.

Health officials can draw upon the dashboards and charts made in Tableau to understand the situation better than before. It does not stop here because through these visualizations, the issue of air pollution is presented as a cause of health problems and not merely an environmental challenge. Raising awareness as one of its key roles in the debate of this project, the visualization of the data becomes the very vehicle of the message.

Our project, by visibly displaying the impact of pollution on health, helps to put across the message and encourages more efficient planning. This is particularly the case in cities where pollution continues to be a growing challenge and where their populations are in need of protection.

COMMUNITY IMPACT

Better Public Awareness: The project educates people about the relationship between the quality of air, health risks, and hospital stress. Visual and engaging public stories allow every community member to monitor the environmental situation, detect the degree of pollution, and also comprehend the whole issue of pollution.

Support for Hospitals and Health Planning: Our data-driven insights help hospitals to realize in advance the schedule of pollution peaks during the year. Planning the time of hospital stress is the point from which they can anticipate adding more personnel, increasing the number of beds, or stocking up medicines.

Data-Driven Decisions: These visualizations of the environmental data allow officials and urban planners to follow the path of pollution in different places over time. It instils with them the obligation to develop these or other measures, for example, regulating traffic, promoting public transportation, or planting more trees in areas where the quality of air is the poorest and people are at the highest risk.

Student learning and Research: Besides, the project is a source and tool of knowledge for young learners and future scientists. The project depicts the journey of data visualization transforming complex, environmental data into clear insights that can affect the decisions of the real world.

Encouraging Cleaner Living: The project, by linking pollution with real health impacts, inspires people to clean, install more efficient technologies, and reduce the number of vehicles on the streets, and be more conscious of the environment as part of their daily activities.

Conclusion

This project emphasized the negative impacts of air pollution on people's health and hospital stress in Indian cities like Chennai and Hyderabad. To visually present the variations of data through different charts and dashboards, we activated Tableau. Our health risk and hospital stress score investigation demonstrate that, on the whole, lower air quality results in higher scores of these metrics. In other words, pollution is no longer a mere environmental issue but a serious health threat that has an impact on people daily lives. By the use of data visualization, we made it easier for everyone-from students and families to city planners and doctors-to see when pollution is most harmful and take action. The project is a very nice introduction to the effectiveness of visual storytelling for showing the connection between the numbers and the provision of public health protection measures. Their effort is simultaneously a very strong call for both continuous air quality monitoring and public health readiness. This helps the locals in predicting the time when the dangers are going to escalate, the planners being more strategic in allocating the resources, and people getting motivated to be more watchful with the air quality. At the very end, the project argues that the cleaner the air, the healthier are the lives of people

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