

DSCI 5360 – Data Visualization

Meteorological Data Analysis with Tableau

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Rohit Akilaysh Vanne



Introduction

This study employs Tableau visualizations to analyze a meteorological dataset, focusing on the relationship between humidity levels and precipitation types across diverse regions. The dataset was extracted from Kaggle as an excel file and later imported into Tableau to commence visualization. The objective is to discern patterns and correlations that may contribute to a nuanced understanding of weather phenomena (Sadegh & Alizadeh, 2021).

Dataset

<https://www.kaggle.com/datasets/saurabhsuven/meteorological-data>

The meteorological dataset under consideration spans a specific time period, offering a comprehensive view of atmospheric conditions and weather-related variables. The dataset encompasses a range of meteorological parameters, with a focus on key elements such as humidity, precipitation types, visibility, apparent temperature, and atmospheric pressure. Embarking on the journey of visualizing meteorological data is akin to peering through a cosmic kaleidoscope of nature's whims. The choice of this dataset wasn't a mere selection; it was a quest for deciphering the intricate dance of the elements.

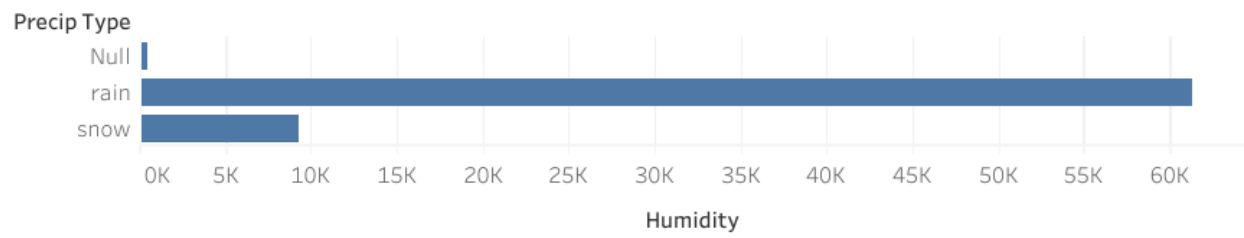
Each entry in the dataset is timestamped, providing temporal information that facilitates the analysis of hourly and daily variations in these meteorological factors. The humidity values within the dataset are expressed as a relative scale, ranging from 0.26 to 1.0, indicating the level of atmospheric moisture during the recorded time intervals. Precipitation types, a critical aspect of weather patterns, are categorized and observed in relation to varying humidity levels. Visibility data is incorporated, shedding light on the range of atmospheric clarity in response to different weather summaries.

Apparent temperature, a measure that combines actual temperature with the impact of factors like humidity and wind, is included in the dataset. Additionally, atmospheric pressure, a key determinant of weather conditions, is presented in millibars. The dataset is not only diversified in terms of the meteorological parameters it covers but also captures variations over time. The dataset provides an hourly breakdown, allowing for the exploration of diurnal patterns, daily trends, and potential anomalies in the recorded meteorological data. This temporal dimension enhances the dataset's utility for in-depth analyses, making it a valuable resource for understanding the dynamic interplay of atmospheric variables during the specified time period.

Humidity against precipitation.

The initial visualization under consideration juxtaposes the cumulative humidity levels (SUM of humidity) against precipitation types in different regions. The column section represents variations in humidity, a critical parameter in atmospheric conditions. Concurrently, the rows delineate distinct precipitation types observed in response to these humidity fluctuations.

Sheet 1



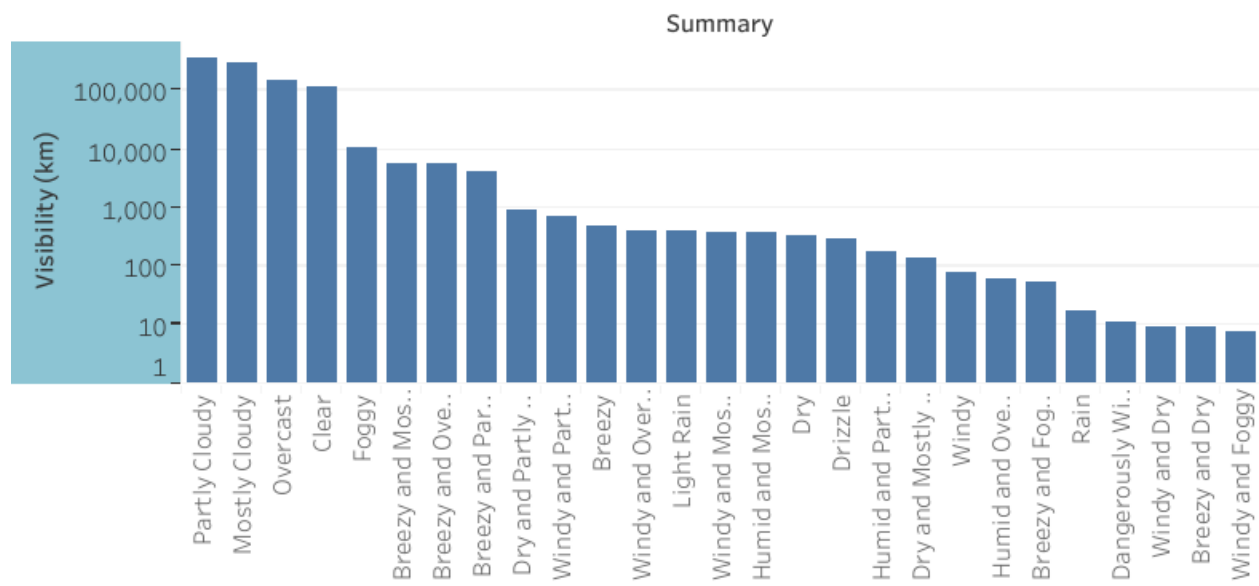
A discernible trend becomes evident upon examination. Regions characterized by elevated humidity levels demonstrate a notable prevalence of rainy conditions. This observation aligns with meteorological principles, as heightened humidity generally indicates an increased potential for moisture condensation and subsequent rainfall.

Conversely, regions with lower humidity levels display a distinctive prevalence of snow. The diminished atmospheric moisture content in these areas contributes to the formation of snowfall, particularly under suitable temperature conditions.

Visibility and weather conditions.

The Second visualization depicts the level of visibility in comparison with the weather summary.

Sheet 2



Upon a closer examination of the dataset and the above graph, it becomes evident that visibility is intricately tied to various weather conditions, providing valuable insights into the influence of climate changes on atmospheric clarity. The data presents a range of weather summaries, each paired with corresponding visibility values in kilometers. When the weather is characterized as

"Windy and foggy," the visibility is recorded at 7.62 kilometers. Similarly, "Breezy and foggy" conditions exhibit a visibility of 56.77 kilometers.

A compelling pattern emerges as we explore the impact of different weather summaries on visibility. Instances of windy and foggy weather conditions correspond to lower visibility values, suggesting that the presence of both wind and fog contributes to reduced atmospheric clarity. Conversely, weather summaries denoted as "Partly cloudy" and "Mostly cloudy" exhibit significantly higher visibility values. For instance, "Dangerously windy and partly cloudy" is associated with a visibility of 11.45 kilometers, and "Humid and mostly cloudy" records a visibility value of 389.31 kilometers.

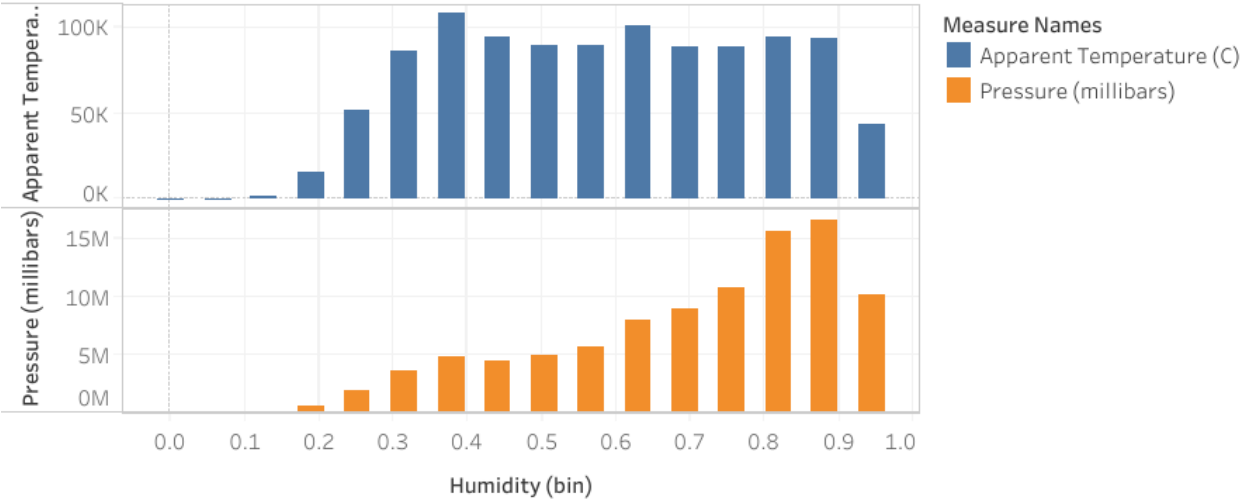
These findings underscore the correlation between visibility and specific weather conditions. Partly cloudy weather appears to offer more reasonable visibility, while conditions involving fog and wind are associated with decreased visibility. This information holds considerable significance for various sectors, including transportation, where clear visibility is paramount for safety. For instance, this data could inform the development of more adaptive traffic management systems or guide pilots in making informed decisions during adverse weather conditions. Overall, the dataset offers a nuanced understanding of the impact of climate changes on visibility, opening avenues for strategic planning and decision-making in response to varying weather scenarios.

Pressure against humidity.

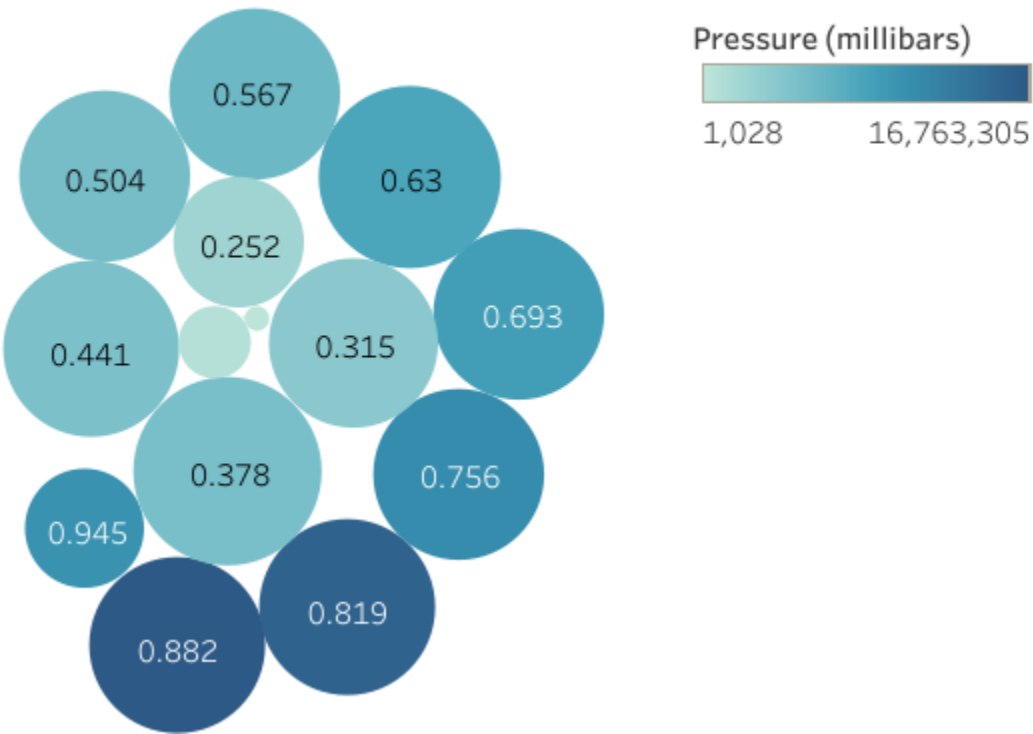
This dataset presents a combination of meteorological variables, including humidity, apparent temperature, and atmospheric pressure. The data is organized with a binary categorization for humidity (0 and 1) and two distinct measure names, namely Apparent temperature (C) and Pressure (millibars).

In the graph below, humidity (bin) is the categorical variable in the column section, and 'Measure names' differentiating between 'Apparent temperature (C)' and 'Pressure (millibars)' in the rows. The corresponding numerical values represent the aggregated data for each combination.

Sheet 3



Sheet 3



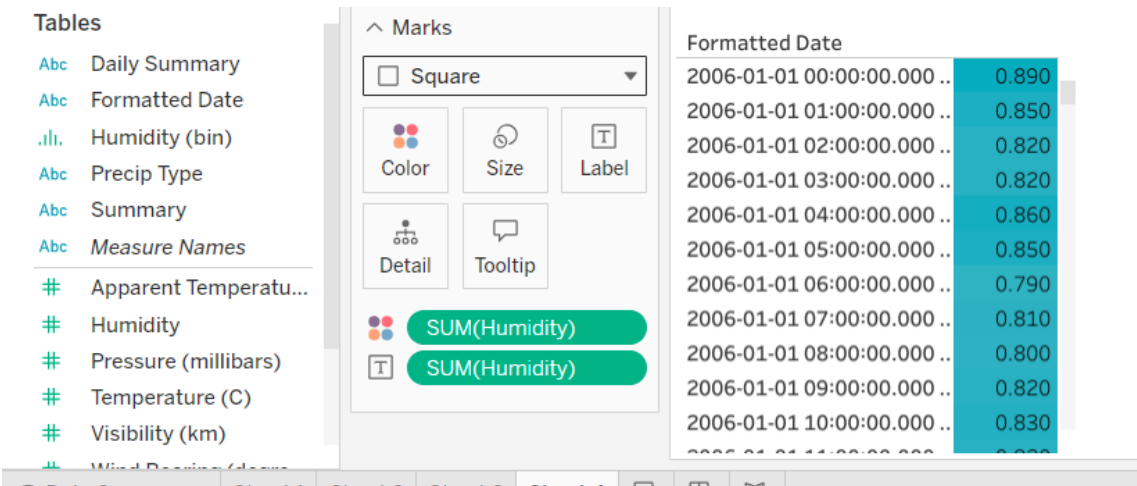
Extreme values in apparent temperature, such as 43,076.08 and -387.78, stand out as anomalies requiring further investigation. These outliers may stem from data entry errors or signify specific, noteworthy weather events that necessitate serious examination for accurate interpretation. The data set hints at a potential correlation between humidity, apparent temperature, and pressure. Delving into the relationships among these variables could offer

valuable insights into the dynamic interplay between changes in humidity levels and the corresponding variations in apparent temperature and atmospheric pressure.

A detailed examination of hourly variations in humidity reveals several noteworthy observations. The recorded humidity values exhibit a range from 0.26 to 1.0, suggesting a relative scale rather than a percentage.

Hourly fluctuations of humidity.

As we explore the hourly fluctuations, a discernible pattern emerges, showcasing the dynamic nature of humidity throughout the recorded hours. Notably, humidity tends to increase during the night hours, as exemplified by the reading at 2013-07-29 21:00:00 (0.59), and conversely decreases during the day, as evidenced by the measurement at 2013-07-03 14:00:00 (0.32).



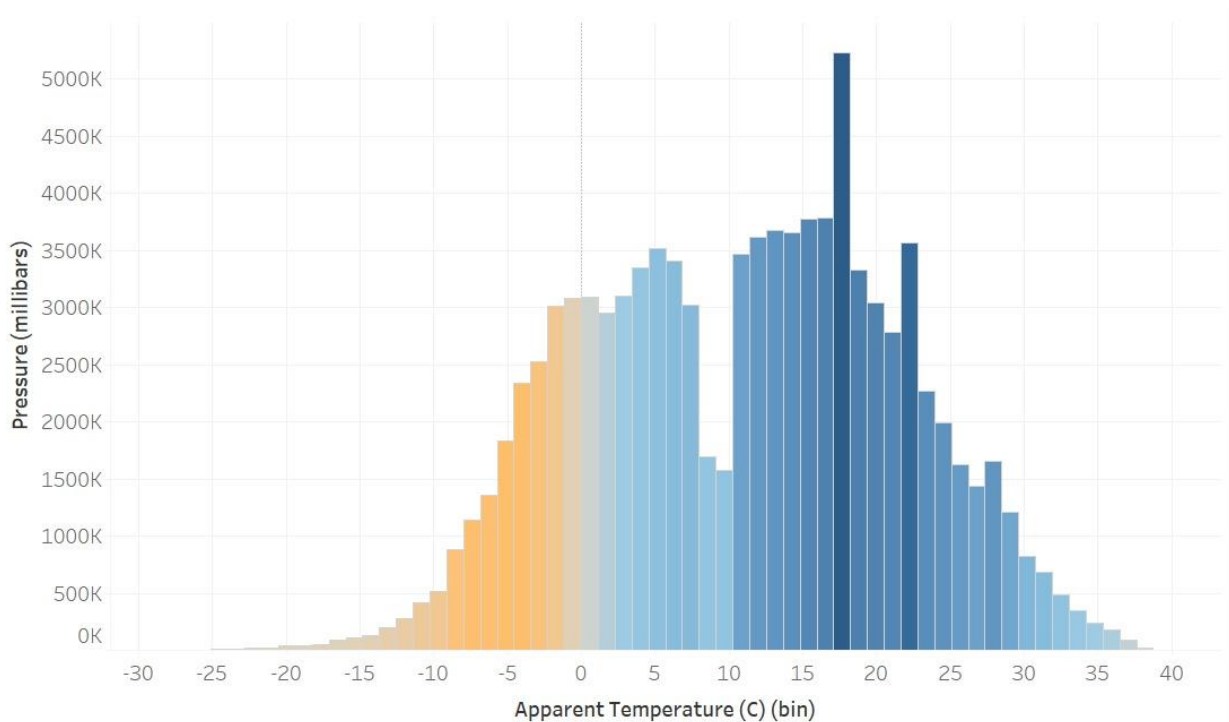
Further analysis uncovers a clear daily pattern in humidity, with higher levels prevalent during the night and early morning, followed by a decline during the day. The dataset highlights a peak humidity reading around 2013-07-03 02:00:00 (0.97), while the lowest values occur around midday. Day-to-day variations in humidity are also evident, with certain days consistently exhibiting higher or lower humidity levels. For instance, on July 29, 2013, humidity remains relatively high, reaching 0.71, whereas on July 30, 2013, it drops to 0.38.

Apparent Temperature vs. Pressure:

Understanding how apparent temperature and pressure relate to one another can help one understand how variations in atmospheric pressure may affect perceived temperature.

pressure on the y-axis and perceived temperature on the x-axis. A particular measurement is represented by each point in this representation, which can be used to spot any noticeable patterns or trends.

This can assist in identifying differences between the apparent temperature-pressure connection at various pressure levels. Observing the graph, one can see that pressure is excessively high between 15 and 20 degrees Celsius, while excessively low or high temperatures indicate that pressure is too low.

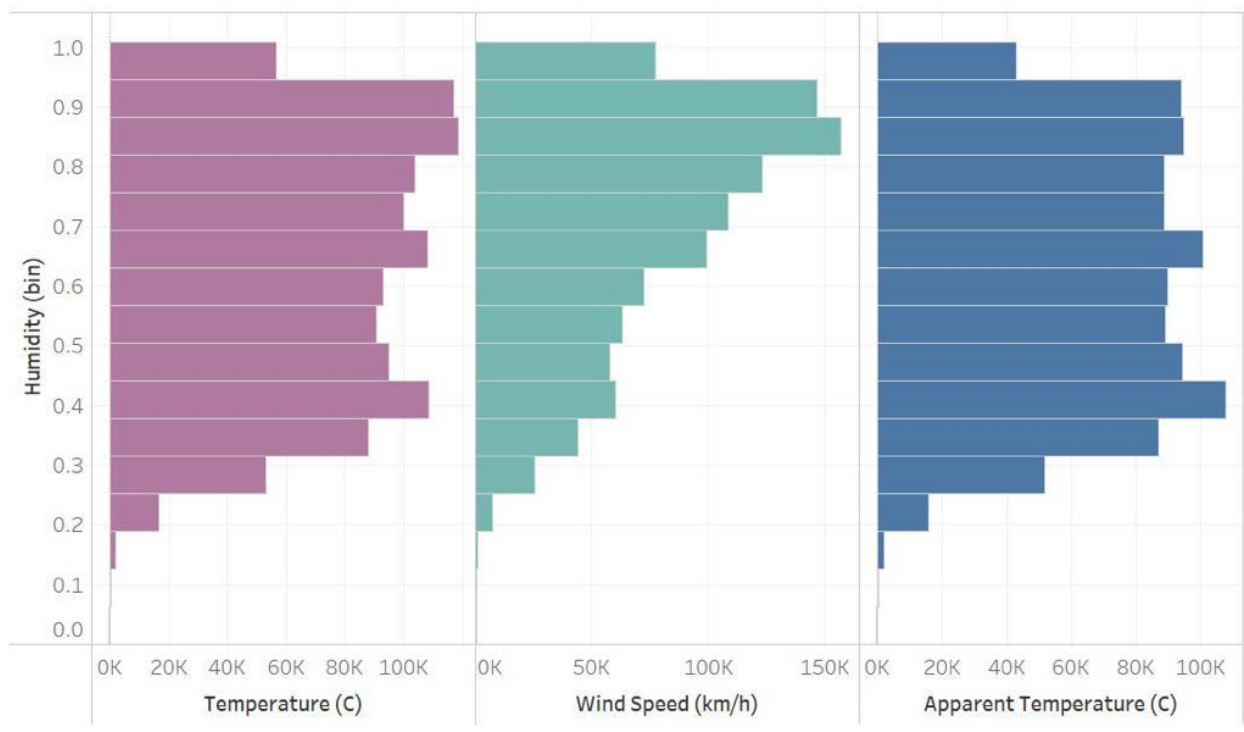


Correlation Analysis:

Examining the statistical link between two or more variables is the goal of correlation analysis. Examining the correlation between different meteorological variables in the context of meteorological data might reveal how these elements interact. This is a synopsis of what you may observe when you plot the association between apparent temperature, wind speed, humidity, and temperature.

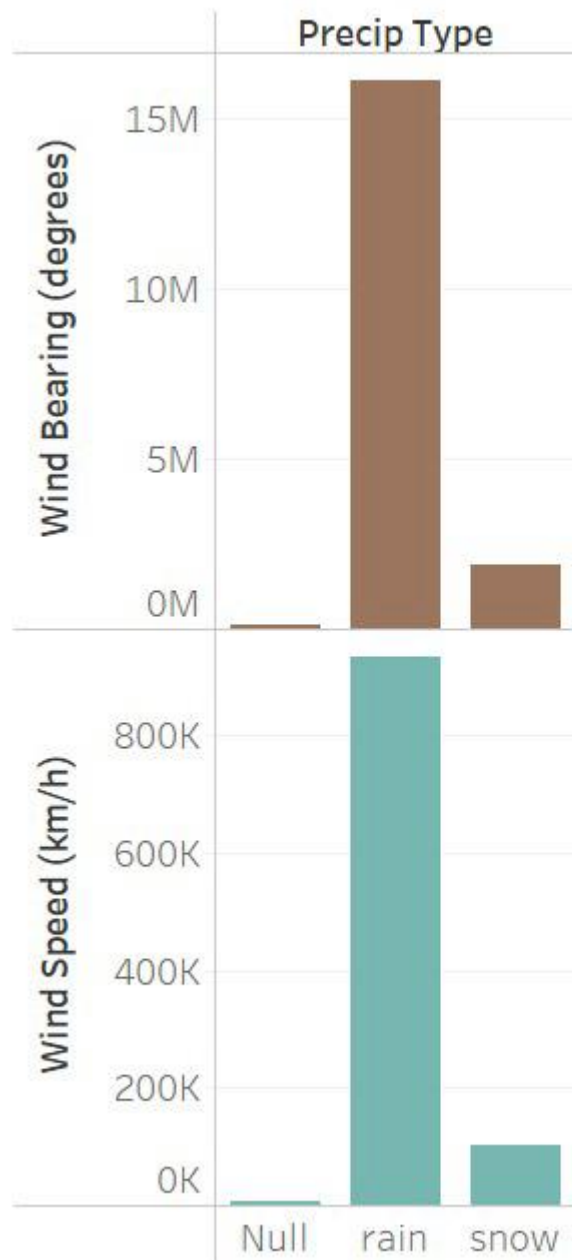
Temperature versus Visible Temperature, wind speed, and temperature:

Understanding the correlations between humidity and these three meteorological variables might help us understand how humidity affects felt temperature and how these variables interact. The humidity patterns are not consistent when compared with temperature and apparent temperature while the wind speed had a constant growth with increasing humidity.

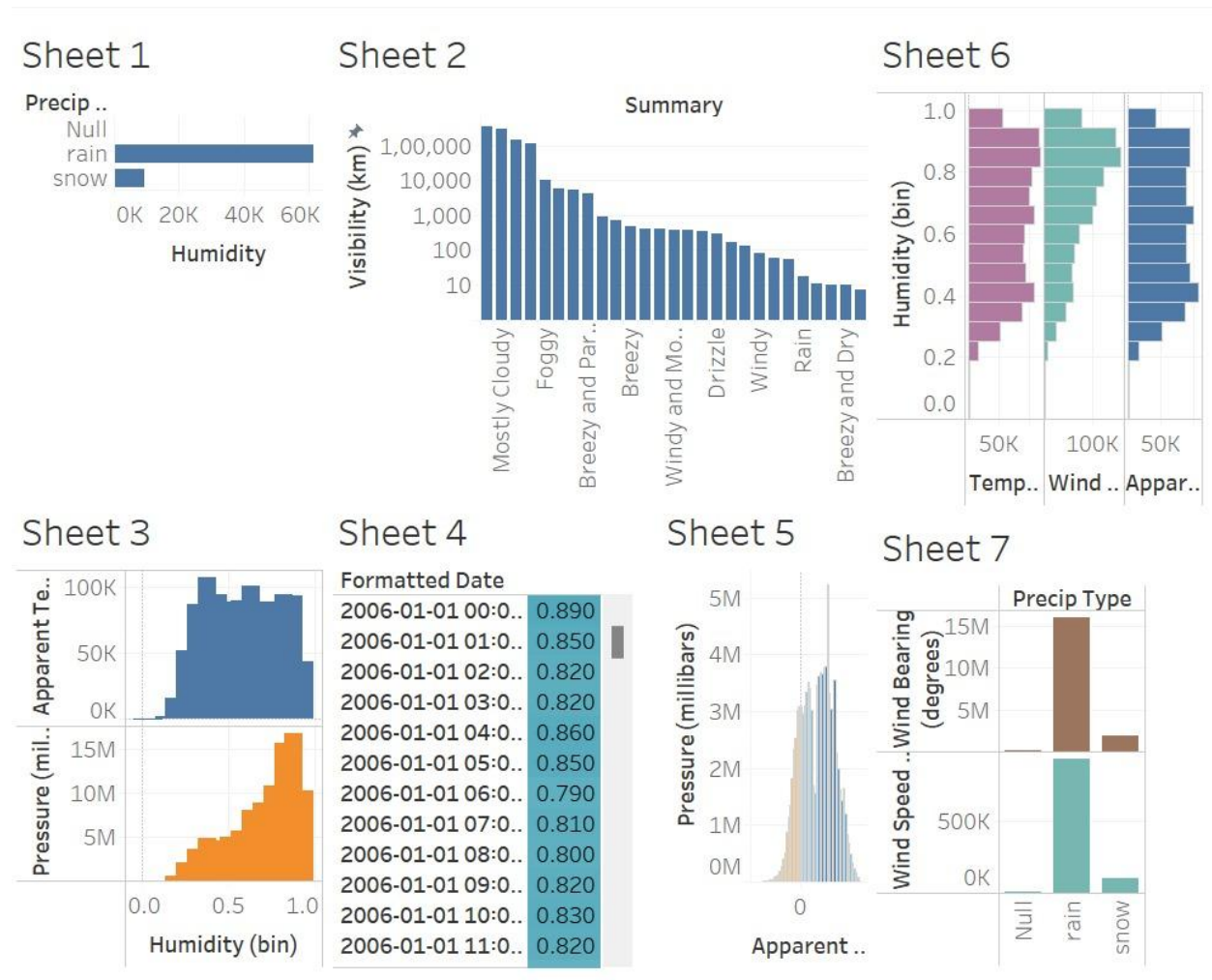


Precip Type vs Wind speed and wind bearings

To find patterns and trends in the relationship between wind bearings, precipitation type, and wind speed, you can make a variety of charts. The range of wind speeds for every kind of precipitation. To see differences in wind speed across different wind directions, you can make separate box plots for each wind bearing. Wind Bearing and Wind speed is more during rain



DASHBOARD



Story Point

The visual exploration of meteorological data using Tableau has unveiled critical insights with significant managerial implications and actionable business takeaways. Understanding the correlations between humidity levels, precipitation types, and visibility is not only vital for meteorological forecasting but also holds relevance for various industries impacted by weather conditions.

Managerial implications.

1. Operational planning:

Managers in industries sensitive to weather conditions, such as agriculture, construction, and transportation, can use these insights to enhance operational planning. For instance, adjusting

construction schedules based on expected precipitation or optimizing transportation routes considering visibility patterns.

2. Inventory management:

Retailers and supply chain managers can leverage precipitation forecasts to optimize inventory management. Anticipating rainy conditions can inform decisions on stock levels for weather-dependent products like umbrellas, raincoats, or seasonal apparel.

Specific actions and decisions that can be made with the results.

To enhance the organization's readiness and resilience in the face of variable weather conditions, a series of specific actions have been identified. First and foremost, a systematic approach should be established to seamlessly integrate real-time weather data into the decision-making processes. This involves leveraging Application Programming Interfaces (APIs) or weather forecasting services to ensure that up-to-date meteorological information is readily available for strategic decision-makers. By adopting this approach, the organization can make informed and timely decisions that account for the dynamic nature of weather patterns.

Additionally, the development of weather-responsive protocols is crucial. Collaboration with cross-functional teams is necessary to craft protocols that delineate specific actions based on weather forecasts. These protocols should serve as comprehensive guides, informing operational adjustments, shaping marketing strategies, and influencing supply chain decisions in response to changing weather conditions. This collaborative effort ensures a unified and coordinated response across various departments, aligning the organization's activities with anticipated weather events.

The analysis of the dataset provides insightful observations that carry significant implications for decision-making in various domains. Extreme outliers in apparent temperature, such as 43,076.08 and -387.78, prompt the need for robust quality control measures, including data validation and potential removal of erroneous data points. Additionally, the discerned correlation between humidity, apparent temperature, and pressure offers valuable insights for meteorological agencies to enhance forecasting models. This understanding can empower weather-sensitive industries to strategically plan operations based on temporal patterns and seasonal variations. The findings also impact decisions related to infrastructure maintenance, energy resource allocation, and public communication strategies, contributing to improved safety, efficiency, and public awareness. The results thus serve as a foundation for informed decision-making, enabling stakeholders to proactively address challenges presented by dynamic meteorological conditions.

Conclusion

In conclusion, the Tableau visualizations have proven to be effective tools for exploring and presenting complex meteorological data. The insights gained from these visualizations contribute to a nuanced understanding of the relationships between humidity, precipitation types, visibility, and atmospheric conditions over different temporal scales. This study not only reaffirms established meteorological principles but also unveils intricate patterns and variations that enhance our comprehension of regional weather dynamics. Moving forward, such visual analytics can serve as a powerful resource for meteorologists and researchers seeking to unravel the complexities of weather phenomena and improve forecasting accuracy. The integration of multiple variables in the analysis further underscores the interconnected nature of meteorological factors, emphasizing the need for a holistic approach in studying and interpreting weather patterns.

References

(Voas and Ambler *The relationship between behavior in a stress situation and later separation from flight training with expressed anxiety toward flying*)