Abstract:

Drinking water quality is important for the well-being of the general public. The crisis of potable water in most developing countries is already creating public health emergencies of staggering proportions. While water is important for life, indicating the features that may affect its quality and the relationship between those impacted features and the potability of the water is necessary for the professionals, the community water suppliers, and consumers. That was the main reason we wanted to work with a dataset related to water potability. In this project, we created some visualizations (scatter plot, histogram, pie chart, boxplot) representing the distribution of some features that affect the water quality and the relationship between them, and mostly focus on answering these questions: what type of relationship between Hardness and Solids in different pH scales? What is the distribution of Conductivity, pH scale, and potability in the water dataset? And what is the relationship between the Turbidity, pH, and Potability category?

Dataset Description:

We are using a dataset about drinking water's potability in different areas from Kaggle. There are 10 variables and 3,276 observations. The dataset provides data about the potability of water in different areas over years. Variables included in the dataset to decide if the water is potable include pH, hardness, solids, chloramines, sulfate, conductivity, organic carbon, trihalomethanes, turbidity, and potability. The content was taken from various websites like data.world, kaggle and some features are updated from those sites. The variables we are going to use with their statistical descriptions are: pH is numerical and mean is 7.081, hardness is numerical and mean is 196.37, solids is numerical and mean is 22,014.1, chloramines is numerical and mean is 7.122, sulfate is numerical and mean is 333.8, conductivity is numerical and mean is 426.2, organic carbon is numerical and mean is 14.28, trihalomethanes is numerical and mean is 66.396, turbidity is numerical and mean is 3.967, and lastly potability is binary.

We believe visualizing and analyzing the potability of the drinking water may interest water quality testers, community water suppliers, and the consumers themselves. We think the water quality testers are the ones who are most familiar with this topic because their daily job is to assess the quality of water at its source. They will be familiar with all the attributes used to test water quality such as pH, hardness, solid particles, sulfate particles, and more. They may know the standards to judge whether the water is good to drink, potable. However, they may not know the relationships between those water testing attributes. They may be interested in the relationship between those attributes, such as higher pH, how low the hardness is in the water, or they may also be interested in the comparisons of water potability in different pH scales, in different hardness elements, etc.

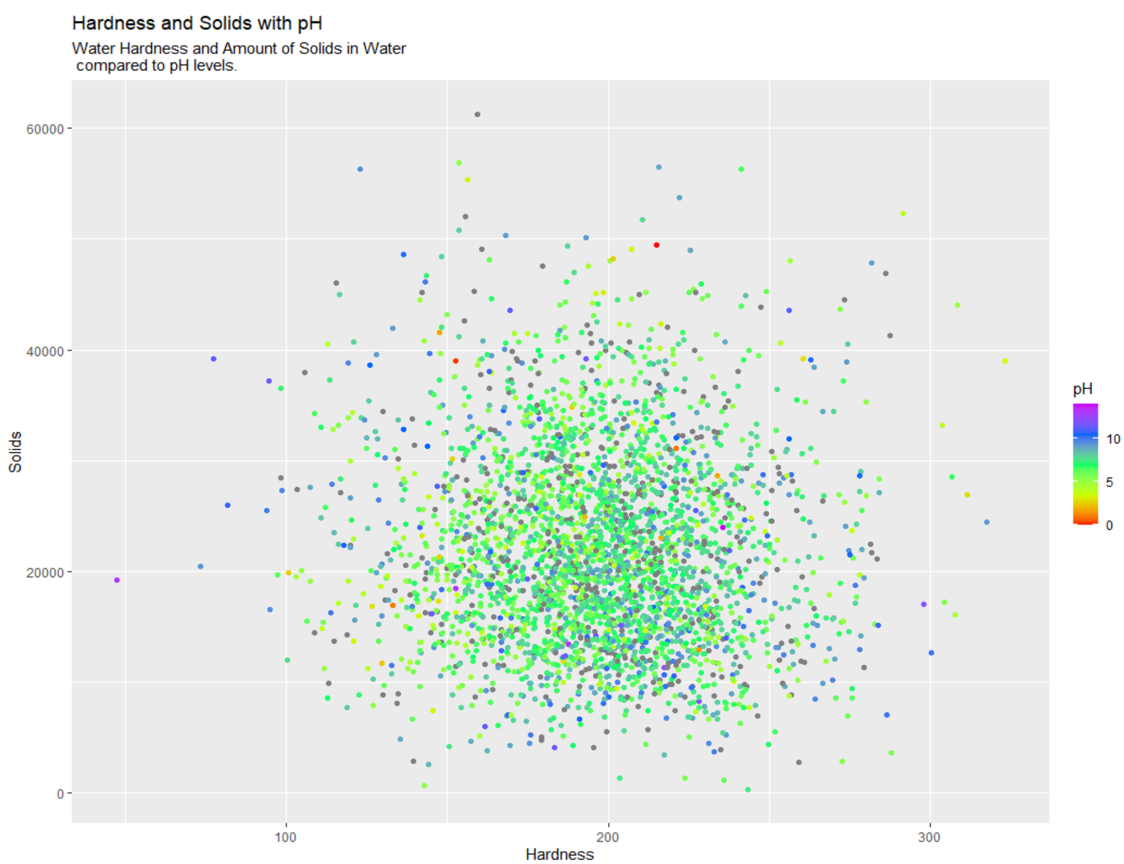
Community water suppliers may acknowledge different attributes used to qualify the drinking water. They may know the required standards for making water safe to drink. However, like the water quality testers, the community water suppliers may not acknowledge the relationships between the water testing attributes or the potability of the drinking water in different pH scales, in different hardness elements, and more.

Consumers usually do not know or care much about what makes the water safe to drink. As long as the community water suppliers and experts say it is safe to drink, the consumers will assume it is safe. However, consumers are directly affected if the water is not safe to drink. Thus, we think the comparisons of potability of the drinking water in different pH scales or different chemical elements amounts will interest them. Although consumers can receive an annual report from their community water supplier on their local drinking water quality, we believe that the story can be conveyed to them in a much easier and more interesting way with visualization.

Visualizations:

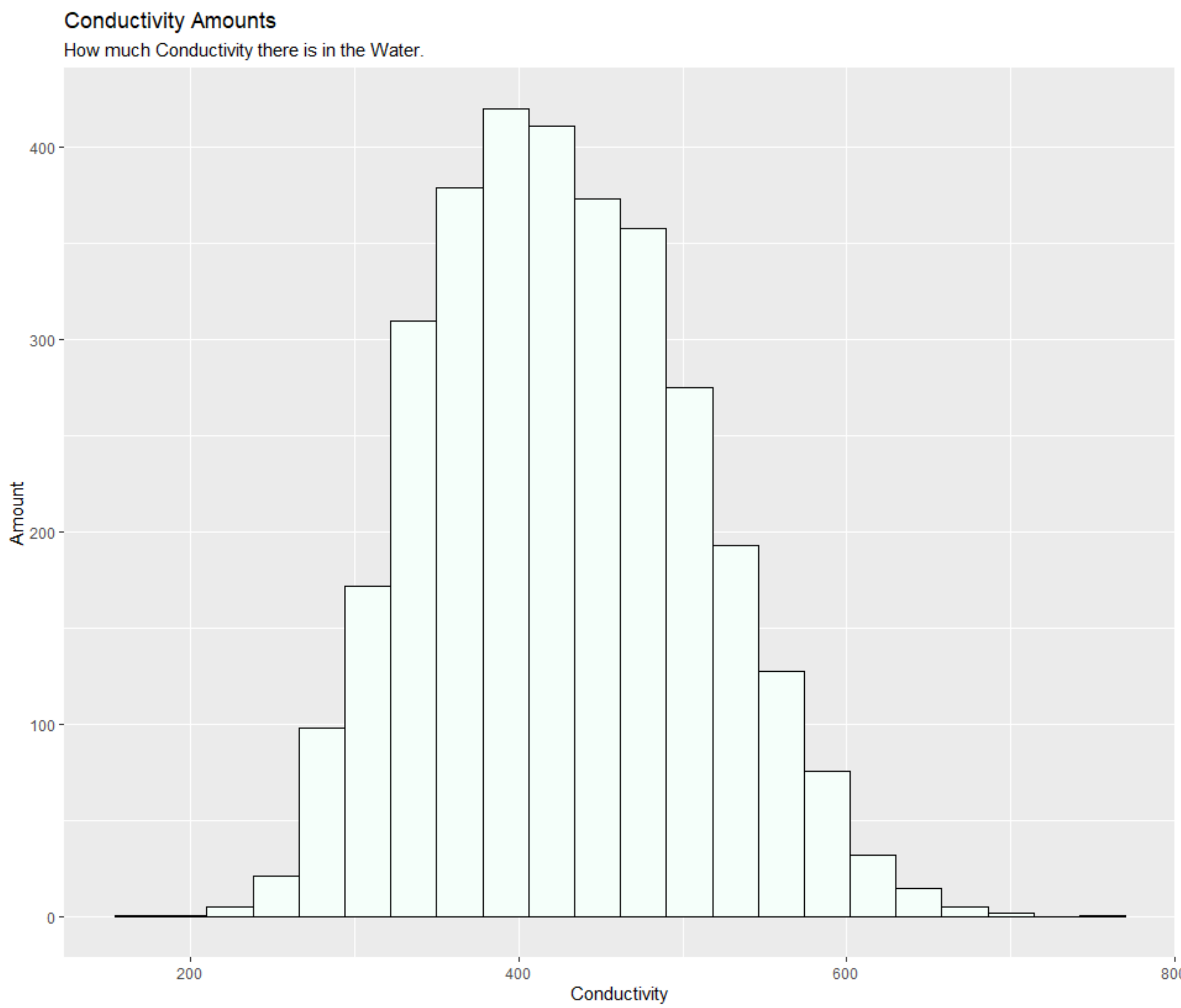
All visualizations were made in Rstudio. The visualizations are two scatter plots, a histogram, a pie chart, and a boxplot.

1. **Scatter plot of the Hardness and Solids with pH**



This scatter plot represents the water hardness against the number of solids in different pH levels. Looking at the plot, we can see that there are many points located at the center where the value of the Hardness is in the range 150 to 250 and the value for Solids in the range 1000 to 3000. The color of each point represents its pH level. The hotter the color (red, orange) the lower the pH, the more acidic the water is, and vice versa, the cooler the color (blue, purple), the higher the pH level, and the more alkaline the water is. The green range represents pH in range 6-7. Most of our points are green meaning most of our data points have pH in the range 6-7.

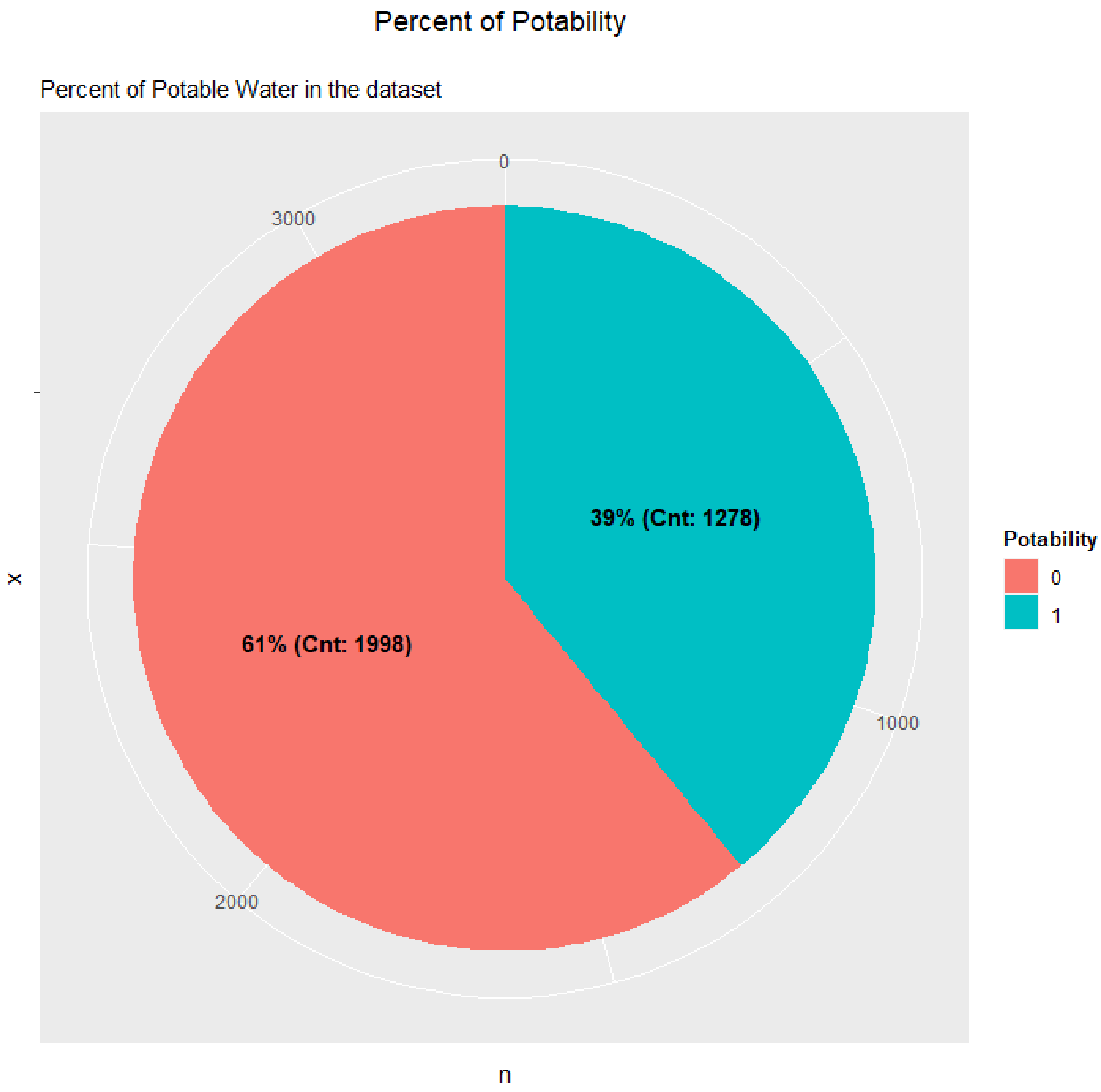
2. Histogram for the Conductivity Amounts



This is a histogram graph representing the conductivity in water that is affected by the presence of inorganic dissolved solids such as chloride, nitrate, sulfated, and phosphate anions. It is a measurement of the water. To pass the electrical current and a higher conductivity value means more chemicals dissolved in the water that's the reason it is important in the water dataset.

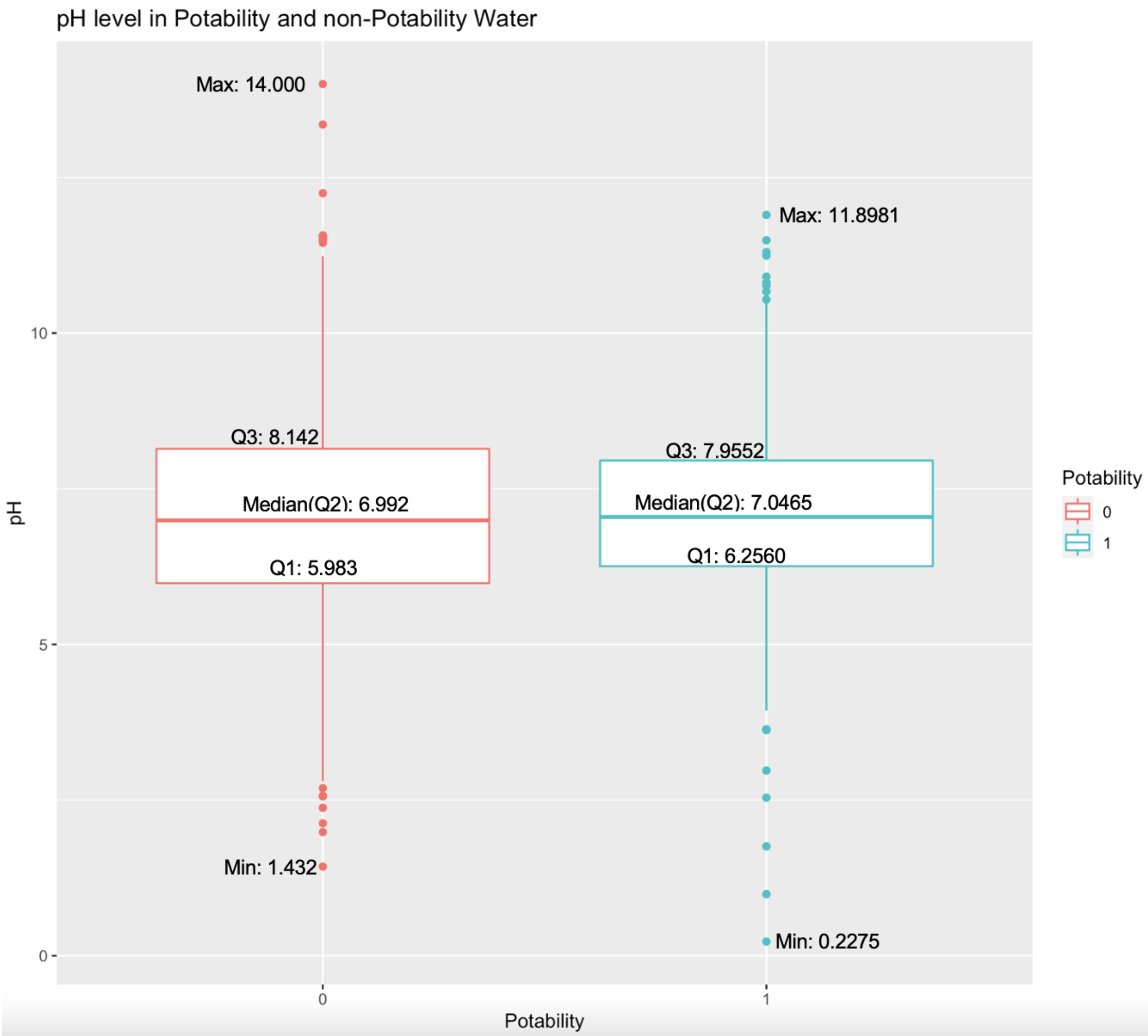
Regular drinking water contains 200 to 800 µS/cm which tells us the dataset we have is safe/good for drinking water.

3. **Pie chart of Potability Percentages**



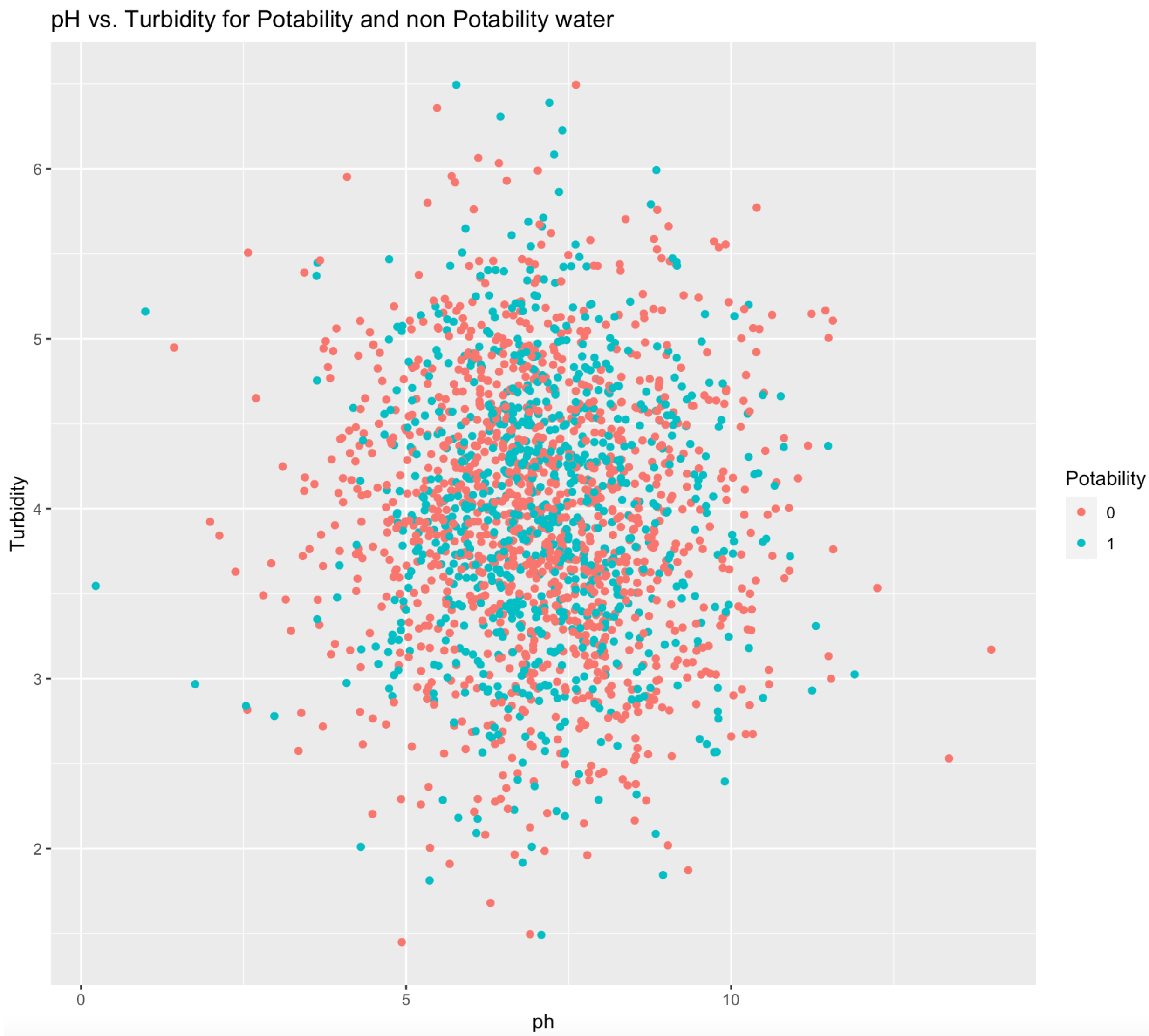
This pie chart graph represents the percentage of potability in the dataset divided into two categories: 0, which means the water is not potable, and 1, which is potable. From the chart, we can see that 61% of the dataset showing that the water is not potable to drink, only 39% of the dataset showing that the water is potable for drinking. The 'Cnt' represents the number of data in each category. There are 1998 data points belonging to the not potable group (group 0) corresponding to 61%, and there are 1278 data points belonging to the potable group (group 1) corresponding to 39%.

4. Boxplot of pH levels and Potability



This graph represents the distribution of pH for different potability of water. Potability 0 means the water is not potable, and 1, means the water is potable. According to the graph, there is not too much difference in the pH distribution for the 'potable' and the 'non-potable' groups. The median of the pH is the same between the two groups. The box of the 'potable' group (potability = 1) is narrower, meaning the pH distribution of this group is more condensed than non-potable water. Other than that, the pH scale for the 'potable' and 'non-potable' groups is quite similar in this dataset. It is understandable since water potability depends not only on the pH level but also on other factors such as hardness, solids, turbidity, etc.

5. Scatter plot of pH Levels and Turbidity compared to Potability



This scatter plot shows the pH levels compared to turbidity for each observation. Along with that, the color of the point shows whether or not it is potable. The blue point represents that the water is potable. The peach color point represents that the water is not potable. This graph has more peach color points than blue which means that most of the water tested for potability is not safe to drink. The higher the turbidity is the more cloudy the water is, and based on this graph most of the data points average to around 4, which would mean that the water needed to be filtered before it is safe to drink. For water to be safe to drink based on pH levels, it would be around 7 and most of the data observances are around 7 which means the pH levels are mostly neutralized.

Conclusion & Evaluation:

It is not easy to look at the distribution of a feature without visualizing it. Our histogram, pie chart, and boxplot helped us simplify and answer questions about the distribution of conductivity, pH, and potability of water. The boxplot provided us with some statistical values like median, minimum, and maximum. A scatter plot is perfect for representing the relationship between numerical features and in our dataset there is a strong association between solids and hardness, or pH and turbidity, at the center of our two scatter plots. However, the correlation and the trends were not as clear as we would have liked. So, the scatter plot was not the best to help us figure the relationship between the water testing elements in this scenario.

Besides research questions mentioned earlier in the abstract, we wanted to address a couple more interesting questions in this project: How high should the pH be to make the water safe to drink? This question can be addressed by looking at our boxplot. According to our boxplot, the pH from 6.256 to 7.95 is safe for drinking water. Another question is what the permissible range of pH and turbidity for the potable water should be? This question can be addressed from our last scatter plot. The water has turbidity in the range 3-4, and pH in the range 5-7 is primarily potable for drinking.

Overall our visualizations in this project, the two scatter plots, histogram, pie chart, and the box plot, did a good job in helping us convey the story to the audience. They addressed most of our research questions and made the answers easier for the audience to understand.

Works Cited

Kadiwal, Aditya. “Water Quality.” *Kaggle*, 25 Apr. 2021, https://www.kaggle.com/adityakadiwal/water-potability