Water is life: A Visual Analysis of Nigerian Waterpoint Geospatial Patterns

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Introduction

In rural Africa, access to clean and safe water can be a challenge. Thousands of water points have been installed over the past decade but they are of poor quality or are not well maintained causing them to become non-functional. This can cause waterborne diseases which can destroy lives and livelihoods. One country in West Africa which faces this issue is Nigeria. More than 38 percent of all improved water points in Nigeria are non-functional.

The aim is to make the data more accessible and easier to interpret by having interactive charts showing both high-level patterns and low-level details, such as water access by the district. This will potentially help the Nigerian government, community planners and researchers make informed policy decisions, decide where to allocate their resources optimally to fix or maintain water points and eventually improve the quality of lives of the people living in Nigeria.

Data

The data is focused on the water points in Nigeria. It will make use of two data sets:

1.The first data set is about Nigeria level 2 administrative boundaries which contains GIS data for polygon feature. The data is obtained from https://data.humdata.org/dataset/nigeria-admin-level-0-1-and-2-administrative-boundaries
2.The second data set is about water point related data such as water source and technology deployed etc. The data is obtained from https://data.waterpointdata.org/dataset/Water-Point-Data-Exchange-Plus-WPdx-/eqje-vguj/data.

Methodology

Using various R packages such as ggplot2, ggplot2 extensions and tidyverse packages, the team will extract, analyse, and visualize geospatial patterns of functional and non-functional water points and build an interactive R Shiny application with visual analytics techniques.

It will be split into 3 sections:

1. Overview of High-level Patterns
2. Visual Inferential Analysis
3. Geographical Segmentation

R Shiny Visualization

Section 1: Overview: Users can an overview revealing high-level patterns. It can display locations of functional, non-functional and unknown water points in terms of country-level or district-level throughout Nigeria. The intention is to help the users visualise which region in the country has higher functioning/non-functioning water points at a glance. There will be a few filtering options for the users, such as water points status, technology deployed in water points and performance of water points.

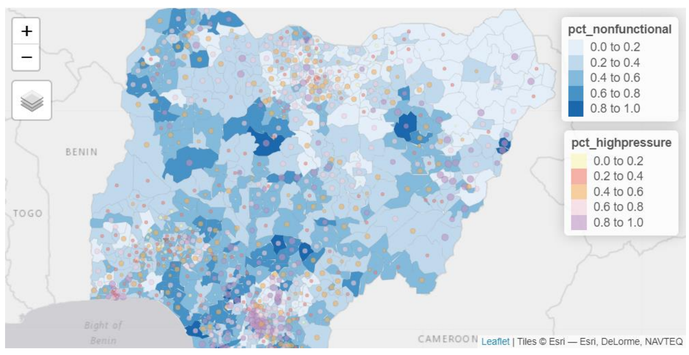


Figure 1. Choropleth map of Nigeria

Section 2: Visual Inferential Analysis: Users can make use of analytics approach for knowledge discovery. Graphs include boxplots for Anova analysis, correlation matrices, scatter plots. This will help users identify relationships or correlations between different features, such as technology used, pressure score and number of non-functional water points. It may also allow users to compare statistics across different districts through one-way ANOVA tests. There will be filtering options for users to choose features they want to understand more.

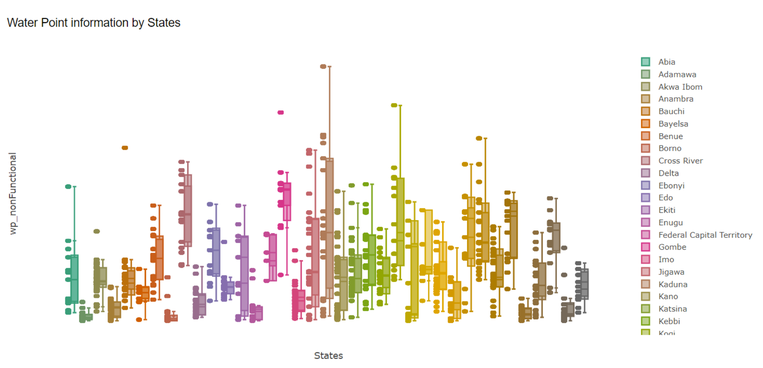


Figure 2. Boxplots of feature by states

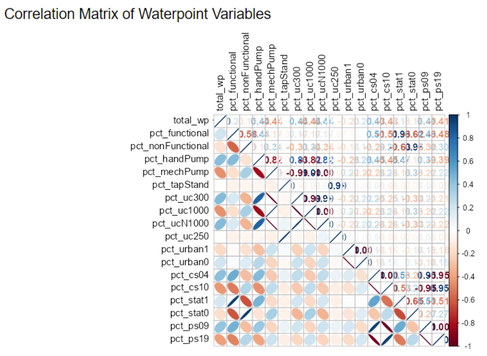
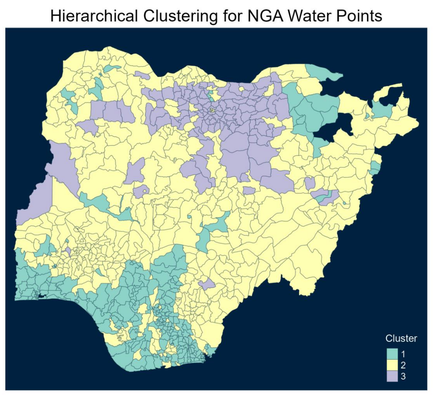
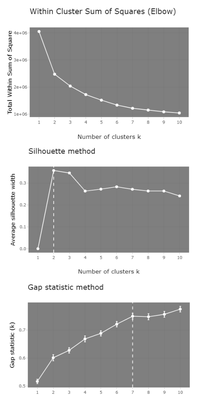


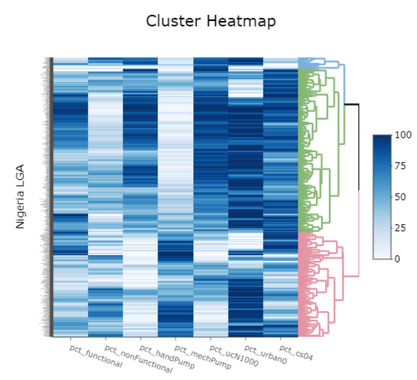
Figure 3. Correlation Matrix of features

Section 3: Geographical Segmentation Users can visualise geographical segmentation by grouping the water points according to their statistical attributes and spatial location.

There will be a user interface panel that allows users to select which method to identify the number of optimal cluster (including silhouette, elbow) , heatmap and clustering analysis (including hierarchical clustering method)







Insights

1. From the overview, most of functional waterpoints are located at the north-east region while most of non-functional waterpoints are located at south-west region. Most of the regions are free of unknown waterpoints.
2. We can see that not all mean number of non-functional waterpoints are the same across the different states. There is a statistically significant difference in number of non-functional waters points between different states.
3. There doesn't seem to be strong correlation between non-functional waterpoints and other features.
4. Geographical segmentation: Joseph

Future work and Conclusion

The R Shiny app can potentially be expanded and adapted for other countries as well, not just Nigeria. We can also adapt it for other applications and domains, including visualization of geographical distribution and patterns of different resources, such as food and energy. The app should serve the same purpose of helping any user self-help in understanding patterns and trends and yet be flexible enough to be adapted for any topic of interest.

In conclusion, visual analysis is very important in helping different users such governments, non-governmental organizations or researchers in understanding patterns, distributions and relationships of certain features. This can help users make informed policy and business decisions, helping them achieve their objectives in a quick and effective way.