Exploring Environmental Impacts on Public Health

An R Shiny Dashboard for Informed Decision-Making

Submitted by

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Abstract

This report outlines the creation and execution of an interactive R Shiny dashboard intended to investigate the connection between environmental factors and public health. By integrating data on air quality, water availability, sanitation, and health results, the dashboard seeks to provide policymakers, researchers, and organizations with practical insights to enhance global health and environmental conditions.

Introduction

The relationship between environmental concerns and public health is currently one of the most significant topics of concern. Access to clean water, sanitary facilities, and air quality are examples of environmental factors that significantly affect health outcomes in communities and nations. Poor water and sanitation systems increase the risk of waterborne infections and child mortality, while air pollution can cause respiratory problems. Since these problems are a reflection of global trends and disparities rather than being unique, they require immediate response. The amount of information on these topics is vast, yet a lot of it is dispersed and in difficult-to-understand formats. This hinders the ability of researchers, decision-makers, and health organizations to develop intelligible conclusions or take focused action.

This project's main goal is to close this gap by utilizing R Shiny to create an interactive dashboard that compiles important environmental and public health data into a single, easily accessible platform. The dashboard attempts to make the investigation of intricate linkages easier by combining statistics from more than 100 nations, covering years of data on pollution levels, sanitation, water access, and health consequences. Through visual tools like heatmaps, time series graphs, and comparison analysis features, users will be able to investigate trends, patterns, and important data. The objective is to enable stakeholders to comprehend the urgent environmental health issues that their areas face, efficiently allocate resources, and put policies into action that have a real impact.

By offering a single resource for researching environmental and health trends, the dashboard benefits academic research in addition to politicians and health groups. The project's goal is to close the gap between unprocessed data and useful insights, facilitating regional and international initiatives to enhance public health and environmental sustainability. This initiative aims to be a catalyst for positive change in communities throughout the world by transforming data into a meaningful story.

Motivation

Public health is greatly impacted by environmental variables such as clean water, adequate sanitation, and air pollution. For instance, respiratory issues can be brought on by poor air quality, and severe infections and even more child fatalities can result from a lack of clean water and proper sanitation. In underdeveloped regions, where resources are scarce and environmental health concerns receive little attention, these challenges are particularly acute.

The dispersed nature of the data is a significant obstacle to tackling these issues. Data on sanitation, pollution, water availability, and health consequences frequently originate from disparate sources and are difficult to relate to or comprehend. Because of this, it is challenging for academics and decision-makers to see the whole picture and develop answers.

The purpose of this initiative was to address that issue. We want to compile all of this data into a single location by creating a straightforward, interactive dashboard. Making it simple for people to recognize patterns and trends can help them concentrate on the areas that most require attention. The dashboard will help researchers, health executives, and policymakers organize resources more efficiently, make smarter judgments, and develop policies that have a significant impact.

The main idea behind this project is that understanding the problem is the first step toward fixing it. By making this data clear and easy to use, we hope to help communities improve their health and create a healthier, more sustainable future.

Intended Users

This dashboard is designed for people and groups who work to improve public health and the environment. One key group is policymakers. They can use this tool to understand problems like pollution and water access better and create smarter laws and policies to tackle these issues. Public health leaders will also find the dashboard helpful for identifying areas with the most urgent needs, so they can plan and act more effectively.

The dashboard can be used by government agencies and non-governmental organizations (NGOs) to determine how best to use their resources and where to concentrate their efforts. Researchers and academics are yet another significant group that will gain from the dashboard. It gives students a chance to research the links between environmental problems and public health, which may result in fresh perspectives and answers.

Overall, the dashboard is meant for anyone who wants to understand how the environment affects people’s health and who wants to make informed decisions to create healthier and safer communities.

Air Quality Dashboard Features

An in-depth and interactive method of analyzing global air quality measurements is offered by the Air Quality Dashboard. The global average PM2.5 concentration, which shows the amount of fine particulate matter in the air, is one of the important summary data that readers can examine at the top. It also shows the average PM10 concentration worldwide, which indicates higher particulate pollution, and the most polluted nation, Saudi Arabia. These numbers provide users with a concise and understandable summary of global air quality conditions.

The dashboard includes multiple tabs to enable a deeper exploration of air quality data. The Air Quality Map visualizes PM2.5 concentrations across countries using a color-coded system. Cooler tones represent regions with better air quality, while warmer tones (yellow, orange, and red) highlight areas with higher pollution levels. This map allows users to hover over individual countries to access specific metrics or click on them for further details, helping to quickly identify problem areas.

A line chart showing the evolution of PM2.5 concentrations over time can be seen on the Air Quality Trends tab. Users can use this visualization to comprehend patterns and trends, such as whether the air quality in a given area is getting better, becoming worse, or staying the same. Researchers and policymakers working on air quality management and intervention measures can benefit greatly from such knowledge.

The Country Rankings Table tab ranks countries based on their PM2.5 concentrations, providing a sortable and searchable table for easy comparison. This table enables users to identify the most and least polluted countries, helping stakeholders focus their efforts on regions that require urgent attention or recognize areas making progress.

To further customize their analysis, users can apply filters to narrow the data by region, specific countries, or years. Additionally, a PM2.5 concentration range slider allows for targeted exploration of countries within specific pollution thresholds. For convenience, a Download Data button is available, enabling users to export datasets for offline use and further analysis. The dashboard also includes a helpful guide to ensure all users, regardless of technical expertise, can navigate the platform effectively.

With its combination of interactive maps, historical trends, and rankings, the Air Quality Dashboard serves as a comprehensive and user-friendly tool for understanding global air pollution trends and identifying regions requiring immediate action.

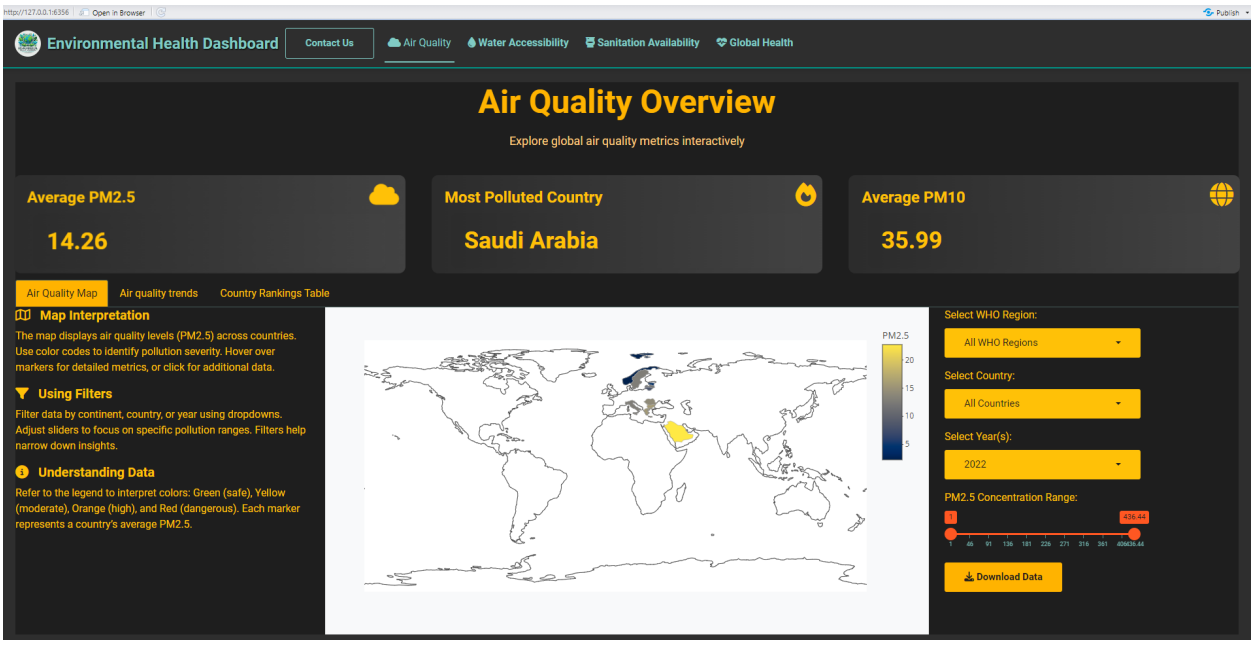

Fig 1. Air quality dashboard

Water Access Dashboard Features

The Water Access Dashboard is designed to provide a comprehensive view of global water access metrics in an interactive and user-friendly format. The top section displays key summary statistics, including the global average percentage of people with access to basic water services, which stands at 76.67%. Additionally, it highlights Latvia as the most improved country and DR Congo as the least improved country, offering a quick overview of progress and persistent challenges.

The dashboard features multiple tabs for in-depth exploration. The Water Access Map visualizes water access data across countries using a gradient of blue colors, where darker shades indicate higher access levels and lighter shades represent lower access. This map allows users to hover over countries to view specific data points or click on them for detailed information, enabling easy identification of regional disparities.

The Trends tab provides a line chart illustrating changes in global water access over time. This feature is particularly valuable for understanding historical progress and long-term patterns. For instance, the chart highlights a steady improvement in water access percentages over the years, which can help stakeholders assess the effectiveness of policies and interventions.

In addition, the Country Rankings Table ranks nations by their water access percentages, providing a clear and sortable comparison of performance across countries. This table helps users identify leaders and laggards in water access, offering insights into where resources and attention are most needed.

To enhance usability, the dashboard includes customizable filters, allowing users to narrow their analysis by region, country, or year. An adjustable slider further refines results by focusing on specific water access thresholds, such as countries with less than 50% access. A "Download Data" button enables users to export datasets for offline use, supporting researchers and policymakers in conducting further analysis. To ensure accessibility, the dashboard also features a guidance section that explains how to interpret visualizations and use the filtering tools effectively.

The Water Access Dashboard is a potent tool for comprehending global trends in water access, assessing advancements, and pinpointing locations that require focused interventions by combining these components, which include the map, trends, and rankings table.

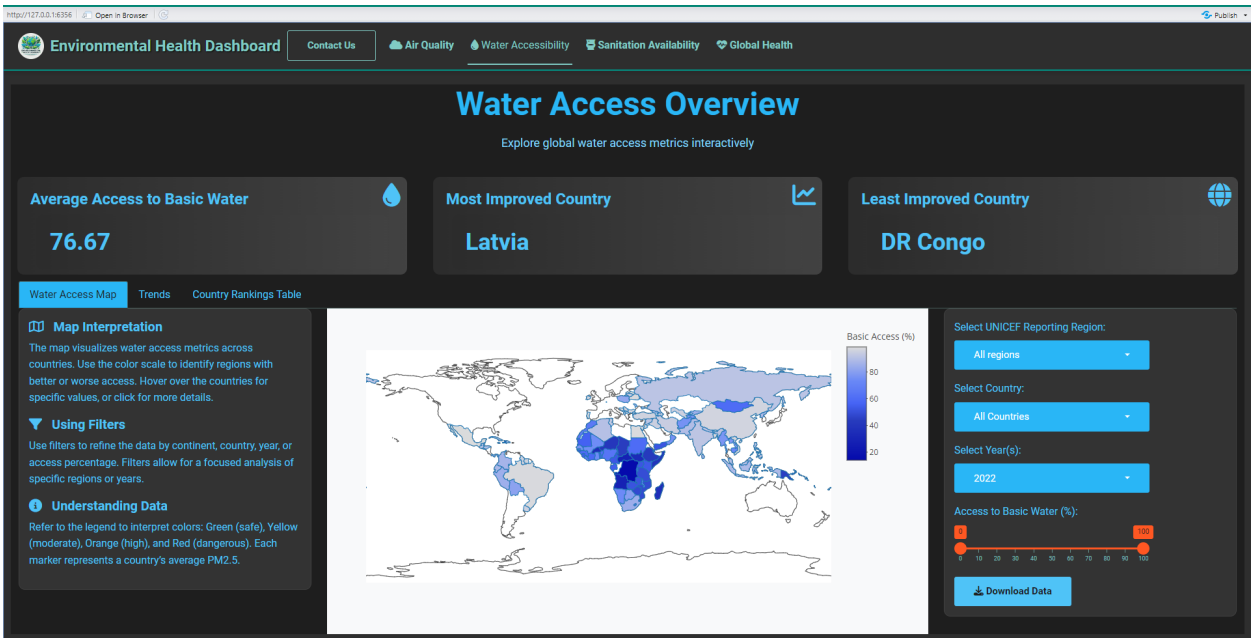

Fig 2. Water Access Dashboard

Sanitation Access Dashboard Features

The Sanitation Access Dashboard provides an interactive platform to analyze global access to basic sanitation services. At the top of the dashboard, key summary statistics are displayed, including the global average percentage of sanitation access, which is currently 71.94%. The dashboard also highlights North Macedonia as the most improved country and reports data from a total of 230 countries, offering a comprehensive view of global trends.

The dashboard consists of multiple tabs for detailed exploration. The Sanitation Access Map provides a visual representation of sanitation access percentages across countries

using a gradient of blue colors. Darker shades indicate higher access levels, while lighter shades highlight regions with lower sanitation coverage. This map allows users to hover over countries to view specific sanitation data and click for additional details, helping to identify disparities and progress at a glance.

The Trends tab includes a line chart that illustrates how sanitation access has evolved over time. This feature enables users to assess historical improvements and track patterns across different years, providing valuable insights into the impact of global sanitation policies and interventions.

The Country Rankings Table ranks countries based on their average sanitation access percentages. Users can easily identify the top-performing countries, like North Macedonia, and compare them with those showing lower sanitation coverage. This sortable and searchable table ensures that stakeholders can analyze performance across regions and pinpoint areas requiring immediate attention.

The dashboard also includes customizable filters, allowing users to refine their analysis by continent, specific countries, or year. An adjustable slider further narrows the data to focus on countries within specific sanitation access ranges, such as those with less than 50% coverage. For added convenience, the dashboard provides a Download Data button, enabling users to export filtered datasets for offline use and deeper analysis. To ensure accessibility, the platform includes a guidance section that explains how to interpret visualizations and use filtering tools effectively.

By combining these features, including the map, trends, and rankings table, the Sanitation Access Dashboard is an essential resource for understanding global sanitation challenges and evaluating progress toward improved sanitation access worldwide.

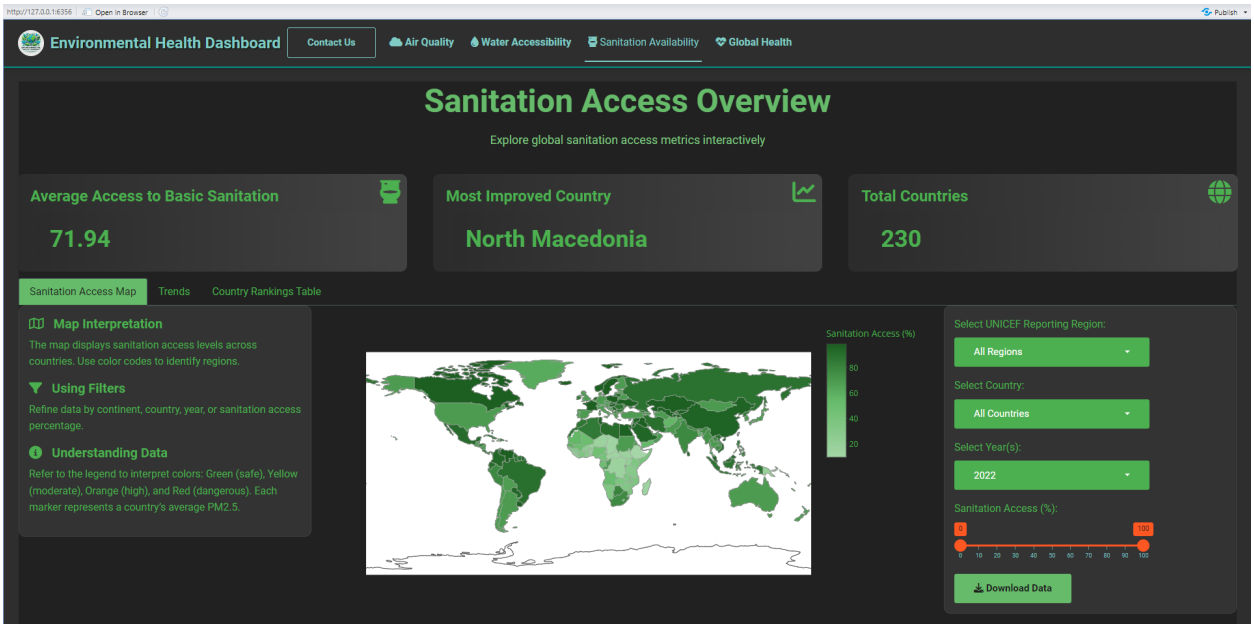

Fig 3. Sanitation Access Dashboard

Global Health Dashboard Features

The purpose of the Global Health Dashboard is to investigate global health indicators and comprehend the effects of non-communicable diseases in various nations and areas. Users are shown important information at the top, such as the current total of 66,502,878 fatalities from non-communicable diseases. The dashboard gives a thorough picture of global health trends by reporting data from 183 nations and highlighting the Western Pacific, which is the most affected region.

The dashboard consists of multiple tabs to enable detailed exploration. The Global Health Map visually represents death rates from non-communicable diseases across countries using a gradient color scheme. Darker shades of blue indicate higher death counts, while lighter shades represent lower counts. This visualization allows users to hover over countries to view specific data and click for additional insights, helping to identify regions with the most significant health burdens.

The Trends tab features a line chart that shows how deaths from non-communicable diseases have changed over time. This visualization enables users to assess historical patterns and monitor long-term changes in mortality rates, offering insights into the effectiveness of global health policies and interventions.

The Country Rankings Table ranks countries based on their total deaths from non-communicable diseases. This sortable and searchable table provides a clear comparison of health burdens across countries, helping stakeholders identify regions requiring urgent attention or those that have made progress in reducing mortality.

To refine the analysis, users can apply filters by continent, specific countries, or years. A health indicator range slider further customizes the exploration, allowing users to narrow their focus to specific thresholds of death counts. The dashboard also provides a Download Data button, enabling users to export datasets for offline analysis. Additionally, a guidance section ensures that all users, regardless of technical expertise, can interpret the visualizations and utilize the filtering tools effectively.

By combining interactive maps, trends, and rankings, the Global Health Dashboard serves as a vital resource for addressing global health challenges and reducing the burden of non-communicable diseases worldwide.

Fig 4. Global Health Dashboard

Additional Features

The dashboard includes a dedicated "Contact Us" feature to ensure that users can easily reach out for assistance or provide feedback. By clicking the "Contact Us" button in the navigation bar, users can access a pop-up window displaying the email address and phone number for support. This feature ensures that users can report issues, request additional features, or seek clarification about the dashboard's functionality.

The inclusion of this feature demonstrates the commitment to user-centric design, ensuring that the platform is not only interactive but also responsive to user needs. This level of accessibility and support enhances the overall user experience, making the dashboard a reliable and trustworthy resource.

Fig 5. Contact us Feature

Limitations of the Dashboard

While the Environmental Dashboard provides valuable insights into global environmental and health metrics, it has certain limitations that must be acknowledged. One significant limitation is the reliance on historical datasets, which means the dashboard does not include real-time updates. This limits its utility for monitoring ongoing events, such as sudden air quality changes or emerging health crises.

Another limitation lies in the quality and availability of data. Some regions, especially low-income or conflict-affected areas, may lack comprehensive or reliable data, leading to gaps in the analysis. These gaps could skew the overall insights and underrepresent the challenges faced by certain populations. Additionally, the dashboard simplifies complex relationships between environmental factors and health outcomes into visualizations, which might not fully capture the nuanced interdependencies or causations.

The usability of the dashboard may also pose challenges for certain users. While the platform includes guides and explanatory sections, non-technical users or individuals unfamiliar with data interpretation may find it overwhelming to navigate or draw actionable conclusions. Furthermore, internet access and a capable device are prerequisites for using the dashboard, potentially excluding users in underserved regions who could benefit from such insights the most.

Despite these limitations, the Environmental Dashboard is a robust tool that provides a solid foundation for understanding global trends. Addressing these challenges in future

iterations could make it an even more effective resource for decision-makers and researchers.

Potential Improvements

While the Environmental Dashboard is a powerful tool, there are several realistic improvements that could enhance its functionality and impact. One major improvement would be the integration of real-time data sources through APIs. This would enable the dashboard to provide up-to-date information, making it more useful for monitoring ongoing environmental and health events, such as pollution spikes or disease outbreaks.

Another improvement could focus on expanding the dataset coverage, particularly for underrepresented regions. Collaborating with local governments and organizations could help fill data gaps, ensuring a more comprehensive and accurate analysis. Adding more variables, such as socioeconomic and policy factors, could also enrich the insights provided by the dashboard and allow for a deeper understanding of environmental health challenges.

To make the dashboard more accessible, a simplified mobile version could be developed. This would extend its reach to users who rely on mobile devices, especially in low-resource settings. Additionally, multilingual support could be incorporated, enabling non-English speaking users to interact with the dashboard effectively.

Advanced analytical tools could also be integrated into the platform. For example, predictive analytics powered by machine learning could forecast trends in air quality, water access, sanitation, or health outcomes based on historical data. This would provide stakeholders with actionable foresight to plan better interventions.

Finally, improving the user interface and experience would make the dashboard more inclusive for non-technical users. Adding more guided tutorials, user-friendly visualizations, and customizable dashboards could empower a broader audience to use the tool effectively. By implementing these improvements, the Environmental Dashboard could become an even more impactful resource for global environmental and public health decision-making

Conclusion

The Environmental Dashboard is a significant step forward in understanding the intricate relationship between environmental factors and public health. By integrating datasets on air quality, water access, sanitation, and health outcomes, it provides a centralized and interactive platform for analyzing global trends and disparities. The dashboard serves as a vital tool for policymakers, researchers, and organizations to identify high-risk areas, monitor progress, and design targeted interventions to improve health and environmental conditions.

Despite its current limitations, such as reliance on historical data and underrepresentation of certain regions, the dashboard offers a robust foundation for future developments. Its user-friendly design and interactive features make it accessible to a diverse audience, while proposed improvements like real-time data integration, predictive analytics, and expanded datasets have the potential to significantly enhance its impact.

Ultimately, this project demonstrates the power of data-driven insights in addressing complex global challenges. By translating fragmented datasets into actionable knowledge, the Environmental Dashboard empowers stakeholders to make informed decisions and work toward creating healthier, more sustainable communities worldwide. With ongoing refinements and support, the dashboard can continue to play a crucial role in shaping evidence-based policies and fostering global collaboration on environmental and public health issues.