

Developing a Binational Citizen Science Platform for Water Quality Monitoring

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Keywords: Citizen Science, Rio Grande Water Quality, Binational Collaboration, Application Development

Introduction

The Rio Grande-Rio Bravo is a critical, yet highly stressed, water source that remains one of the 10 Most Endangered Rivers in the world (American Rivers, 2025; WWF, n.d.). This status is driven by a complex mix of climate change, over-allocation, and chronic water scarcity (American Rivers, 2025; WWF, n.d.). For 15 years, the Rio Grande International Study Center (RGISC), an environmental advocacy group, has promoted stewardship through the Rio Research Round Up (RRR), a binational water testing event (Rio Grande International Study Center, n.d.). The RRR engages 50 to 60 student teams across multiple basins, from Colorado to Mexico and the Gulf Coast, to collect vital water quality data (Rio Grande International Study Center, n.d.). The data, including parameters like pH, nitrates, and dissolved oxygen, are crucial for identifying local sources of contamination and building public engagement (Conrad & Hilchey, 2011; WWF, n.d.). However, the program has historically lacked a centralized, accessible digital platform to consolidate, visualize, and share this extensive, multi-year dataset with the public and partner schools. Modernizing this program through a digital tool provides a key application of citizen science, which is recognized for generating large amounts of data for environmental management and raising public awareness of pollutant effects (Capdevila et al., 2020; Jollymore et al., 2017).

Purpose and Objectives

The purpose of this REEU application and development project was to transform the archival data collected by the Research Round Up into an operational, public-facing Citizen Science Platform (mobile application and web portal). This directly aligns with the RGISC mission to protect the Rio Grande through awareness, research, and bi-national collaboration (Rio Grande International Study Center, n.d.). The key objectives were to develop a mobile application module to allow student teams (citizen scientists) to easily perform CRUD (Create, Read, Update, Delete) operations for water quality data collected in the field; design and deploy a public-facing web data analytics portal that displays the collected data, statistics, and graphical representations, open to the public for maximum transparency and educational use; integrate four years of historical, binational RRR data (US and Mexico) into the system, establishing a robust baseline for ongoing river health monitoring and analysis; and enhance the mobile application's User Interface and User Experience (UI/UX) using Flutter to ensure a professional, intuitive, and highly functional tool that can fully support the program's cross-border operations.

Methods or Procedures

The project was executed using an Agile milestone-based approach to manage the technical complexity of full-stack development.

- **Platform Stack:** The system utilizes a Flutter foundation for the mobile app, with data securely stored and managed via a Firebase database. The public web portal was deployed using Vercel.
- **Data Integration:** Approximately four years of RRR data were collected from RGISC files, manually validated, and programmatically ingested into the database. The system was structured to support both US and Mexican RRR regional classifications (e.g., ALTA CUENCA, BAJA CUENCA) as requested by RGISC staff.
- **UX/UI Overhaul:** A critical step was dedicating a phase to the complete User Interface and User Experience enhancement using Flutter. This ensures the app meets modern standards for usability, which is a key factor in the sustained success and accuracy of citizen science projects (Capdevila et al., 2020).
- **Web Portal Design:** The portal's architecture prioritizes user-friendly access, including interactive map previews, comparison tools, and educational guides for interpreting water quality data, all of which support the Rio Research Round Up educational and outreach goals.

Results

The project successfully delivered the core infrastructure and is currently in the final stages of the UX overhaul before the beta launch. The public-facing analytical web portal is operational and accessible at <https://citizen-science-site.vercel.app/>. Furthermore, the system successfully consolidated and made accessible four years of binational water quality data, providing a reliable dataset for student research and comparison. On the mobile front, the core CRUD functionality for water data is fully implemented and is connected to the live database. The app is currently undergoing the UI/UX enhancement phase, positioning it for immediate beta testing and official submission to the Apple and Google app stores.

Implications and Application

This project successfully leveraged technology to transform the RGISC's RRR into a robust digital platform. This has significant implications for environmental education, data collection efficiency, and bi-national cooperation. By providing students with an easy-to-use mobile tool and a public web portal, the project fosters a sense of ownership and strengthens public participation in water quality data production (Capdevila et al., 2020). The readily available, visualized data creates an evidence-based tool for RGISC to advocate for water security and environmental justice along the US-Mexico border (Rio Grande International Study Center, n.d.). Moreover, this internship has provided hands-on experience in end-to-end technical project management, including translating complex research needs into viable software features (Flutter development, Firebase database structuring), which is invaluable for a future career in Environmental Technology or Data Science. The next steps are to complete the UX/UI overhaul, launch the mobile app beta, and implement the planned Spanish language capability on both the app and website to ensure maximum inclusivity and accessibility for the Rio Research Round Up's bi-national participants.

References

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