

NM WRRI Student Water Research Grant Final Report - November 2023

1. Student Researcher: Claudia Trueblood. Faculty Advisor: Dr. Soyoung Jeon.

Note: the project title changed

2. Old Project title: Statistical Characterization of Central Components of the Rio Grande Compact and Rio Grande Project

New Project Title: Three Water Resource Management Tools for the Rio Grande Project: Characterization of Water Supply, Estimation of Diversion, and Incorporation of Stakeholder Input

3. Description of research problem and research objectives.

To statistically characterize the behavior of key management and accounting factors in the Rio Grande Project and Rio Grande Compact and in this way contribute to the understanding of topics that are central to the current water debates between New Mexico and Texas: water supply of the Rio Grande Project and Diversion Ratio provision.

The project consists of three manuscripts (**M1**, **M2**, **M3**).

For the first topic (**M1**), the objective was to characterize the Rio Grande Compact annual credits and debits with water supply level and examine relationships among prior years' annual credits and debits for the period 1940 to 2020.

For the second topic (**M2**), the objective was to develop a statistical model for forecasting the Rio Grande Project Diversion from which the Diversion Ratio is derived for an upcoming year based on pre-release ground water levels, current year's estimated annual release from Caballo Reservoir, and the prior year's release from Caballo Reservoir.

For the third topic (**M3**), the objective was an exploration of Bayesian networks for stakeholder input into mathematical water models related to water management.

4. Description of methodology employed.

M1 Calculated descriptive statistics for all the time series of water supply in Colorado and New Mexico, generated scatter plots and histograms, conducted correlation analyses, and developed a statistical model using the autoregressive integrated moving average and cross-correlation, to determine the pattern of credit/debit series.

M2 Developed a statistical model for forecasting the Rio Grande Project Diversion for an upcoming year based on pre-release ground water levels in the Mesilla and Rincon valleys,

current year's estimated annual release from Caballo Reservoir, and the prior year's release from Caballo Reservoir.

M3 Compiled and organized scientific insight of the advantages and disadvantages of using Bayesian Belief networks in general, and how these networks may facilitate incorporating stakeholders' input into mathematical models related to water management.

5. Description of results:

M1 Following the early period violations, Colorado implemented strict priority administration to state line deliveries and since then credits and debits have predictable behavior with the method used in this article. New Mexico has not implemented such a system, so its credits and debits are unpredictable with the method used. Statistical predictability is the result of consistency of management control over actual deliveries.

M2 Regression models were developed to forecast the DR, considering the interactions between surface water and groundwater since the district uses conjunctive water management. Three models were able to forecast DR. The range of error in the estimation was calculated providing quantitative evidence and explained in terms of implications to the annual irrigation district allotment.

M3 Bayesian networks (Bns) have many valuable characteristics and features for supporting water resource management; however, they also have limitations. The key in using Bns models is to focus on the positive aspects, especially related to their usefulness in incorporating stakeholder input, match their potential to the need, be realistic about the goals and expectations, and combine Bns with other tools, when necessary.

6. Provide a paragraph on who will benefit from your research results.

Some of those who could benefit from M1 are those responsible for water management of the Rio Grande Project in New Mexico and Colorado, and others who analyze water accounting related to interstate Compact agreements because they can use the methodology used in the study, to develop their own analyses. Regarding M2, managers of Elephant Butte Irrigation District and managers in other irrigation districts could use the methodology we used to determine how to select ground water monitoring wells for similar, or different, analyses that involve ground water data as a variable. M3 could help researchers and water users understand how Bayesian networks could be a tool in incorporating stakeholder input into mathematical models that aid water management.

7. Describe how you have spent your grant funds. Also provide your budget balance and how you will use any remaining funds.

Grant funds (\$2,500) were used to cover publication costs of M1 in the Journal of Water Resources Planning and Management. Funds (\$150) were also used to cover registration fees for the student to attend the 68th Annual New Mexico Water Conference.

8. List presentations you have made related to the project.

The student researcher participated with a poster in the 67th Annual New Mexico Water Conference: *Our Interconnected Communities—and Interconnected Waters*. October 26-27, 2022.

The student researcher presented her dissertation to the public on April 5, 2023.

9. List publications or reports, if any, that you are preparing. For all publications/reports and posters resulting from this award, please attribute the funding to NM WRRI and the New Mexico State Legislature by including the account number: NMWRRI-SG-2022.

The manuscript for M1 was submitted for publication to the Journal of Water Resources Planning and Management on October 6, 2022. On December 4, we were asked to revise the manuscript as a technical note and encouraged to resubmit. We submitted the technical note on February 13, 2023. The review for publication in ASCE's Journal of Water Resources Planning and Management was completed at the end of May. The editor requested that a revised manuscript be prepared based on the reviewers' evaluations and submitted for re-review by July 07, 2023. Many emails were exchanged between the corresponding author and the journal, and on September 12 the publication fees of \$2,500 were paid. The last clarification notes were sent to the journal on November 5, 2023. The Journal has not communicated yet when the technical note will be made public. The title of the manuscript is Characterization of the Water Supply of the Rio Grande Project based on Rio Grande Compact Reports 1940-2020 and will be published in the Journal of Water Resources Planning and Management.

The manuscript for M2 was submitted to the Journal of Hydrology - Regional Studies on May 7, 2023. The authors received feedback on May 11 from the editor-in-chief. They informed us that the manuscript was not acceptable for publication. They said we had the option of resubmitting a substantially revised version of the paper, which would be considered as a new submission. They decided it was not worth engaging in the substantial revisions of the paper due to the development of legal proceedings that change the context of the paper. Dr. King provided additional information to include in the manuscript, and Claudia is looking for an appropriate outlet for the manuscript so it can be submitted. If there is opportunity, Drs. Jeon and Trueblood would like to request support with manuscript publication fees for M2 beyond the grant term.

Regarding manuscript M3, the authors submitted it to Water Resources Management (WRM) journal, and it was not accepted. As per the WRM journal recommendation, the manuscript was submitted to Environment, Development and Sustainability Journal and it was not accepted. We are going to wait until more work can be done by a graduate student who will start working with Dr. Torell, coauthor, in January 2024 to conduct community interviews in summer 2024. In Fall 2024, the information the student collects will be combined with the M3.

10. List any other students or faculty members who have assisted you with your project.

Dr. Christopher Brown, Dr. Soyoung Young, Dr. Erek Fuchs, Dr. Greg Torell, and Dr. J. Phill King.

11. Provide information on degree completion and future career plans.

Conferred doctoral degree: May 12, 2023 – graduated with honors.

Dr. Claudia Trueblood, former director of Indian Resources Development (economic development program with focus on tribal nations in New Mexico) at New Mexico State University, currently serves as environmental scientist advanced at the New Mexico Environment Department (NMED) under the Office of Strategic Initiatives. As part of her duties, she provides support for all matters that overlap across NMED bureaus to ensure continuous coordination and assists as science expert on multiple internal and external agency boards. Trueblood also creates and updates operating procedures, coordinates environmental reviews, provides support with policy analysis, and attends public meetings and hearing as necessary.

Note to WRRRI team: The funds that this grant provided enabled the publication of a manuscript and that is very important. However, what was even more helpful was the support the WRRRI team provided to Dr. Jeon and me throughout the life of the grant, we are very thankful for that.