NM WRRI Student Water Research Grant Progress Report Form

Progress Report due October 1, 2020
Draft Final Report due April 17, 2021
Final Report due May 17, 2021

1. Student Researcher: Victoria Blumenberg
   Faculty Advisor: Dr. Michaela Buenemann

2. Project title: Determine the Usefulness of Surface Water as a Proxy for Precipitation in a Semi-Arid, Mountainous Environment

3. Description of research problem and research objectives.

Stable isotopes in modern precipitation are often used for several applications, including identifying paleowater in aquifers, determining the relative contributions of groundwater and precipitation to streams, and determining the water source for flora and fauna (Kendall and Coplen, 2001). Despite the usefulness of stable isotope datasets, collecting precipitation can be costly and difficult, especially in semi-arid, arid, and remote locations. In an attempt to circumvent such problems, several studies have attempted to use surface water as a proxy for precipitation because it is so much easier to collect (Kendall and Coplen, 2001). These studies have relied on the existing Global Network of Isotopes in Precipitation (GNIP), the existing USGS National Stream Quality Accounting Network (NASQAN), and the temporary United States Network of Isotopes in Precipitation (USNIP) to estimate the reliability of surface water as a proxy. Unfortunately, these networks are not uniformly distributed and often have a surface water sampling location far from the nearest precipitation sampling location, which results in large errors in Northeast New Mexico (Kendall and Coplen, 2001; Dutton et al., 2005).

We established a precipitation study in Northeast New Mexico with funding support from the Judith McBean Foundation and the High Plains Grasslands Alliance. That study aims to investigate the isotopic composition of modern precipitation in a semi-arid, remote region. Our 10 sampling locations were specifically chosen to investigate elevation and latitude, the two most influential variables on isotopic composition in modern precipitation (Dutton et al., 2005). Although data from that study will help reduce errors in precipitation models, it does not seek to improve our understanding of surface waters. The objective of this study is to create a surface water sampling program that is coupled with the precipitation study to reduce errors in previous analysis and determine if surface water can be used as a proxy for precipitation in a semi-arid, mountainous region.

4. Description of methodology employed.

Although there are 10 precipitation sampling locations, only 8 had surface water available to sample in close proximity at a similar elevation and latitude. Previous studies have shown that seasonal variability in the isotopic composition of precipitation is higher than that of rivers (Kendall and Coplen, 2001). For this reason, all 10 precipitation locations were sampled monthly while the 8 paired surface water locations were sampled at least once in the summer, fall, winter, and spring.

Precipitation was collected in a Palmex tube-dip-in style collector at the end of each month. Total volume was measured and samples were collected in 12mL or 20mL borosilicate glass vials with conical lids and no headspace. Due to varying field conditions such as low velocity, dry streambeds, frozen streams, and dangerously high velocities, discharge was not

measured at the surface water sampling locations. Instead, grab samples were collected by rinsing a 20mL borosilicate glass vial three times and filling it in the middle of the stream, at roughly half of the total depth. All sample vials were sealed with paraffin film and refrigerated until analysis at the University of North Carolina at Charlotte (UNCC). All samples were analyzed using a LGR model DLT-100 laser water analyzer. Samples were bracketed by four working standards of known isotopic composition which was repeated throughout each run to check for instrument drift.

There was a considerable temporal break in both precipitation and surface water sampling because of the COVID_19 pandemic. Precipitation samples were collected monthly from March 2019 – February 2020, and then again from March 2021 – February 2022. Surface water samples were collected as follows: 4 summer 2019, 8 fall 2019, 8 winter 2019-2020, 8 spring 2021, and 8 summer 2021.

5. Description of results; include findings, conclusions, and recommendations for further research.

The COVID_19 pandemic caused significant delays in sampling efforts as well as sample analysis in the UNCC laboratory. As a result, data collection was not completed until summer 2022. Although data analysis is still underway, preliminary results are as follows:

1. All locations exhibit evaporation trends in surface water samples that create distinct surface water regression lines that differ from precipitation water regression lines.
2. Regional regression lines, however, show close relationships between precipitation and surface water in summer and fall, with a slight difference in winter and the largest difference in spring.
3. The unweighted precipitation water line equation for all samples has a slope of 7.09, while the unweighted surface water line equation for all samples has a slope of 6.73. Generally speaking, these are very close. Both lines have lower slopes than the global average of 8, which is expected in a semiarid environment.
4. There does not appear to be a significant relationship between surface water sampling location elevation, latitude, or longitude with the isotopic composition of samples. Further analysis is needed to compare isotopic composition with other geographic and climatic variables.
5. Comparisons of precipitation, surface water, and groundwater show differing hydrologic processes at the various sampling locations. For example, in Location 1 groundwater is more depleted than average precipitation and surface water values, indicating that groundwater is sourced by recharge at higher elevations. Meanwhile, groundwater is more enriched at Location 8. Groundwater in Location 8 also falls in the middle of the surface water range. This could be a location where the stream alternates between gaining and losing seasonally, allowing for more interaction between the different water reservoirs.

It has not yet been determined whether surface water isotopic values are a suitable proxy for precipitation values in NE NM. While data analysis is ongoing, it can always be said that this research would benefit from additional data collection. The significant differences seen in meteoric water lines at the sampling location scale could simply be the result of a small

dataset. This would explain why the regional lines, which have much more data, are much closer in slope.

6. Provide a paragraph on who will benefit from your research results. Include any water agency that could use your results.

   The results of this study can help determine if surface water is a suitable replacement for costly, lengthy precipitation studies, which can help inform future stable isotope studies in semi-arid regions. The results will also add to our understanding of how water moves through NE NM, assisting in ongoing outreach and extension events in the region.

7. Describe how you have spent your grant funds. Also provide your budget balance and how you will use any remaining funds. If you anticipate any funds remaining after May 17, 2021, please contact Carolina Mijares immediately. (575-646-7991; mijares@nmsu.edu)

   All funds have now been spent. Funds were spent on travel to sampling locations (rental vehicle, gas, lodging).

8. List presentations you have made related to the project.
   None at this time.

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-2020.

I am currently working on a comprehensive review of this topic, followed by a separate paper covering this specific study.

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

Dr. Kenneth Carroll and Dr. Blair Stringham assisted with the methods, while Dr. Kate Zeigler (associated faculty) and undergraduate student Hana Hernandez helped with sample collection.

11. Provide special recognition awards or notable achievements as a result of the research including any publicity such as newspaper articles, or similar.
    None.

12. Provide information on degree completion and future career plans. Funding for student grants comes from the New Mexico Legislature and legislators are interested in whether recipients of these grants go on to complete academic degrees and work in a water-related field in New Mexico or elsewhere.

    I am currently on track to complete my PhD in the fall of 2023. Due to my extensive background in isotope hydrology, I would like to work as an International Atomic Energy Agency (IAEA) researcher or go into climate change research.

You are encouraged to include graphics and/or photos in your draft and final report.

Figure 1: PhD student Victoria Blumenberg shown measuring discharge at one of the surface water sampling locations.

Final reports will be posted on the NM WRRI website.