Interim Report, NMAMA (Eduardo Dorado, Ana Sofia Rodriguez, and Zaaliyah Thomas)

I. Introduction

Hydrological models have been used for decades to predict the effect of rainfall, snow melt, and other ecological features on our water table in New Mexico (Dunbar et al., 2022). These hydrological models function well for predicting water levels, river flow, and other related factors, but often fall short when addressing how worsening climate change and increasing water use will specifically affect the Rio Grande and how we can manage it. Current models are too localized and rely on historical weather data and water usage to predict water levels in the Rio Grande Valley and connected rivers (Abraham et al., 2024). “Use less water” has been a common response to repeated concerns, and even when followed, it doesn’t give the desired result. Existing models often struggle to identify which factors significantly affect the river, and it is difficult to predict with certainty when the river will run dry. Our state needs detailed data to create an effective plan for future water management.

Existing models of the impact of precipitation on water flow utilize variables such as hydraulic travel times, seepage, reservoir evaporation, and losses to deep percolation to predict downstream water levels (URGWOM Summary, 2025). All of these factors help make an accurate representation of New Mexico’s waterways. While URGWOM (Upper Rio Grande Water Operations Model, Hanson et al., 2019) is not a water supply model, it can offer valuable insight into what is needed to measure and predict water supply.

II. Problem

Why is this a problem? New Mexico has been facing drought conditions since the year 2000. Rising temperatures and less precipitation are threatening New Mexicans, especially farmers. The Rio Grande is critical for farmers as they need the river to irrigate their crops; without it, their crops will die. Farmers struggle to manage a limited water supply, worsening drought conditions, and weather events. Additionally, the Rio Grande is a major water source for the Santa Fe Group Aquifer, which provides most of Albuquerque’s drinking water (ABCWUA, 2025).

In the past 3 years, the Rio Grande has run dry twice, once in 2022 and 2025. When the river runs dry, it disrupts plants' and wildlife's access to water, kills aquatic organisms, and causes trees in the Bosque to become stressed. Additionally, plants grow in the riverbed, affecting flow when water returns. These factors intensify wildfires and affect local economies through reduced crop yield, putting stress on farmers, which can increase prices and reduce supply (Tashjian, 2025). This then affects local businesses that rely on local products, overall weakening local economies.

III. Modeling

The function of our model is to show how different water use strategies can be used to mitigate the effects of climate change, while still meeting the demands of a growing population. We seek to identify how leadership can respond to these challenges to better manage our state. This data is crucial in identifying the conservation actions that will have the largest positive effects on the Rio Grande and the communities that rely on it.

We will use our research as a framework to build a predictive model, specifically an autoregressive model in Python (Autoregressive (AR) Model for Time Series Forecasting, 2025), to model river flow and predict variables like river level, flow, and environmental flow (environmental flow is the amount and quality of water flowing from the river through groundwater and wetlands to support plants and animals) when the river will run dry. Simulations will use multiple input and output variables for predicting river flow. Input variables will include monsoon rainfall, rain runoff, snow melt, reservoir release, tributary rivers, and urban runoff. The model will also account for water output, including evaporation, aquifer/groundwater recharge, agricultural water use, municipal water use, irrigation structures, and cross-state/country water allocation. We plan to run our model with 3 different conditions: improving, stable, and worsening. Improving conditions will model how circumstances improve with lower temperatures and more precipitation, worsening conditions will model higher temperatures, less precipitation, and a worsening climate due to global warming. We will use the data to suggest approaches and strategies to focus on to conserve water, showcasing predicted results in different conditions. Ultimately, we want our model to be used to aid conservation efforts and help our city and state with our intensifying water crisis.

IV. Progress

Our progress to date has focused on our background research, as we needed to have a solid foundation of existing models and relevant variables before we ran our simulations. While there has been extensive research on hydrological models in the desert Southwest, we've encountered very little discussion of strategies to improve the health of the river, aside from "conserve water", to improve the health of the communities that rely on the river. Our model serves to establish the effectiveness of various water conservation strategies on the Rio Grande in a context of stable, improving, or worsening climatic conditions.

V. Next Steps

We will use our research to build our model and begin running our simulations. We will run a total of 1,500 trials, 500 for each condition (stable, improving, and worsening). Afterwards, we will utilize SSPS to analyze our results in order to determine the strategies that have the strongest positive impact on overall river health and the communities that rely on the river. It is our hope that our results will have the potential to offer management strategies that state agencies might employ in order to preserve the Rio Grande for generations to come.

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