NM WRRI Student Water Research Grant Final Report

Effects of NRCS and BLM Conservation Practices on Plant and Soil Biological Communities and Hydrologic Processes in the Rio Puerco Watershed

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Introduction: The Rio Puerco watershed (RPW) is a highly dynamic and diverse ecological system that has a long history of anthropogenic alterations (Figure 1). Like many rangeland systems, the regional environmental conditions that drive the development of plant and animal communities in this watershed are highly variable in space and time. Most precipitation on the RPW occurs during intense convection storms from July through September, with occasional winters of substantial snowfall. The topography and geology of the region adds to this variability by creating specific micro-environmental conditions throughout. Prior to the introduction of Spanish livestock in the 1750's, sagebrush-grassland or piñon-juniper communities dominated the region and were characterized as open stands with productive herbaceous understories (Vincent, 1992). By the early 1900's, heavy grazing pressure and the diversion of water resources for crop irrigation and livestock watering resulted in drastic alterations to ecosystem structure and function. This overutilization caused a shift in the plant community from grasslands and open shrublands to dense shrublands, with Wyoming big sagebrush (*Artemisia tridentata* spp. *wyomingensis* Beetle and Young) being the dominant species at lower elevations (Vincent, 1992). This woody species densification resulted in reduced herbaceous production leading to lower forage production, greater bare soil, and higher erosion rates. For example, only 4% of the Rio Grande's average annual run-off originates in the RPW, but over 70% of the Rio Grande's average annual suspended-sediment load is derived from the RPW (Gellis et al., 2004).

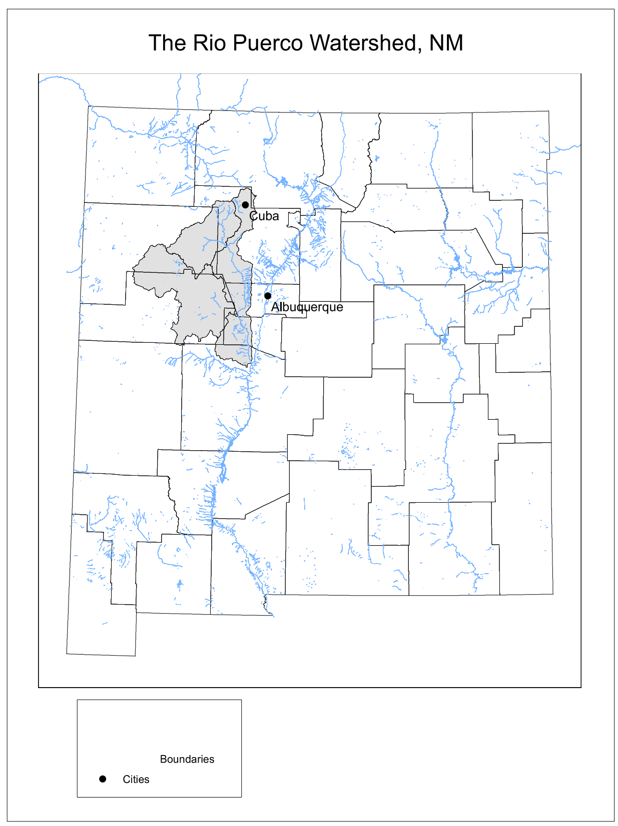

Figure 1: Location of the Rio Puerco Watershed in New Mexico.

Management within the RPW has focused on multiple uses, namely grazing and wildlife habitat, with brush encroachment and erosion as their primary ecological concerns. Prescribed grazing and brush management conservation practices are used on private and public lands throughout this watershed to improve their condition. Although, many changes in the plant and soil community have been noted visually and anecdotally, limited monitoring of these conservation practices have left many questions regarding outcomes beyond sagebrush reduction or elimination.

The objectives of this project are to assess the effects of prescribed grazing and brush management conservation practices on plant and soil communities, wildlife habitat, hydrologic processes, and erosion in the RPW, and to provide a foundation for future range management decisions.

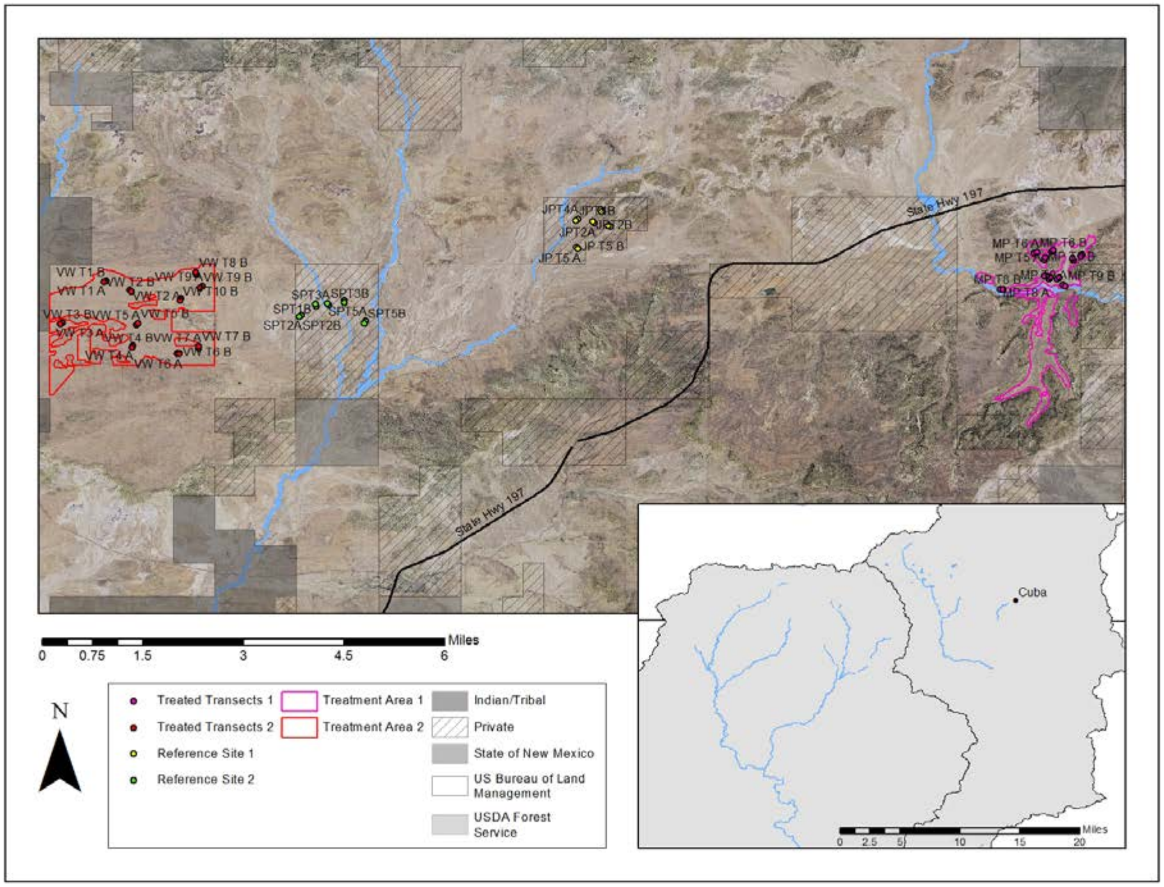

Figure 2: Detailed map of the Rio Puerco Project.

Methodology: Standard USDA-NRCS monitoring procedures were used to assess the plant community prior to implementation of a brush management conservation practice (Pellant et al., 2005). Tebuthiuron is a soil-delivered herbicide that targets woody species, and is used in the RPW with Wyoming big sagebrush control as the primary objective. The treatment areas received an application of tebuthiuron in October 2016 with an application rate of 0.5 pounds of active ingredient per acre. Ten transects were established on two treatment sites, and five transects were established on two non-treated reference sites to describe the pre-treatment plant community (Figure 2). Measurements taken on these transects include canopy and basal cover, line-point intercept, visual obstruction, biomass measurements, and a belt transect to determine density of big sagebrush. Along these transects, soil biological community components and soil stability were also assessed to provide a baseline to track possible changes in community composition and other related soil properties.

To characterize surface runoff, Upwelling Bernoulli Tube (UBeTube) monitoring devices were constructed following Stewart et al. (2015) with minor modifications of the design. Four-inch Schedule 40 PVC pipe was used in place of the 4-inch Schedule 40 Aluminum pipe due to lower cost and ease of manufacture, but the slot geometry was kept the same (Figures 3 and 4).

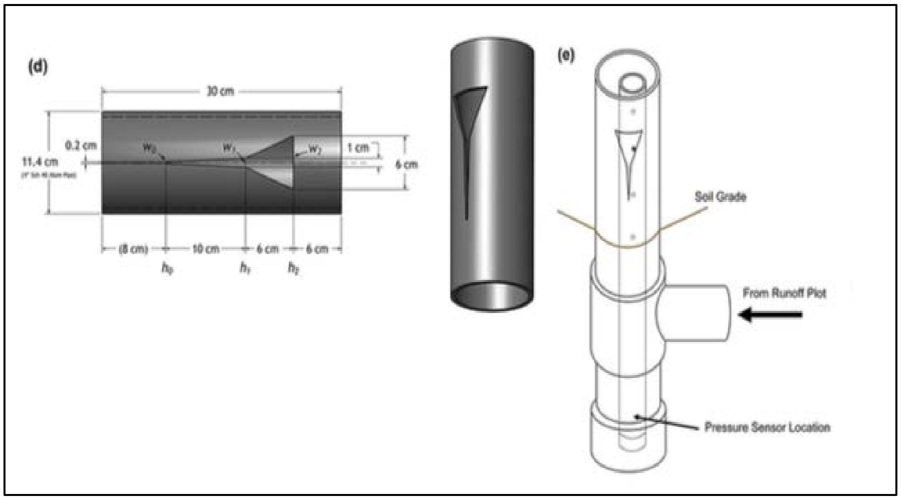

Figure 3: UBeTube original schematic.

Decagon CTD-10 sensors were utilized to measure water depth within the devices. These sensors use a vented pressure transducer to obtain water level depths from 0 to 10 meters with a resolution of 2 millimeters. Water depth readings are recorded at one minute intervals using Decagon Em50 Data Loggers.

Calculations for flow based on changes in water depth are obtained through formulas provided (Stewart et al., 2015). We reconstructed the rating curve presented in this source to verify

Figure 4: UBeTube devices as constructed.

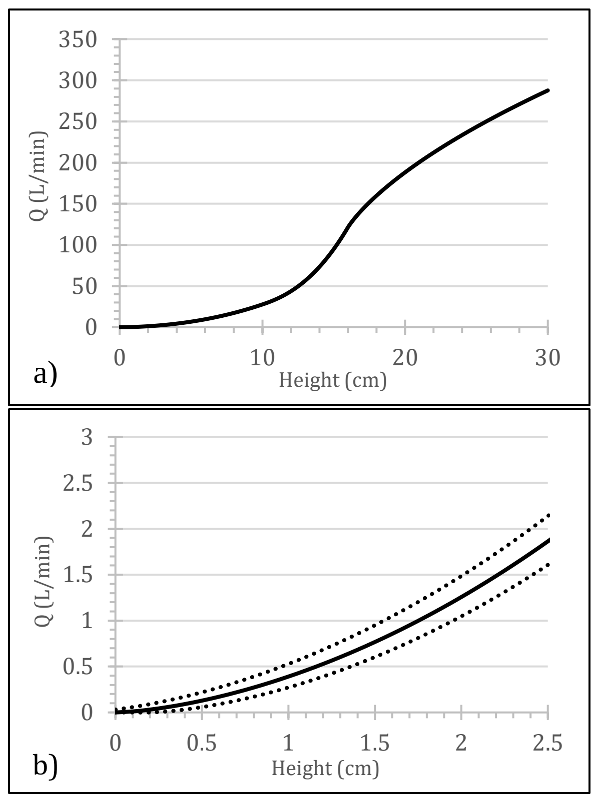

Figure 5: a) Rating curve for UBeTube configuration with correction coefficient of 0.95, and b) Detail of curve at low flows. Dotted lines indicate 2mm resolution of sensors.

proper application of the provided formulas (Figure 5), and all devices were tested and calibrated prior to field installation.

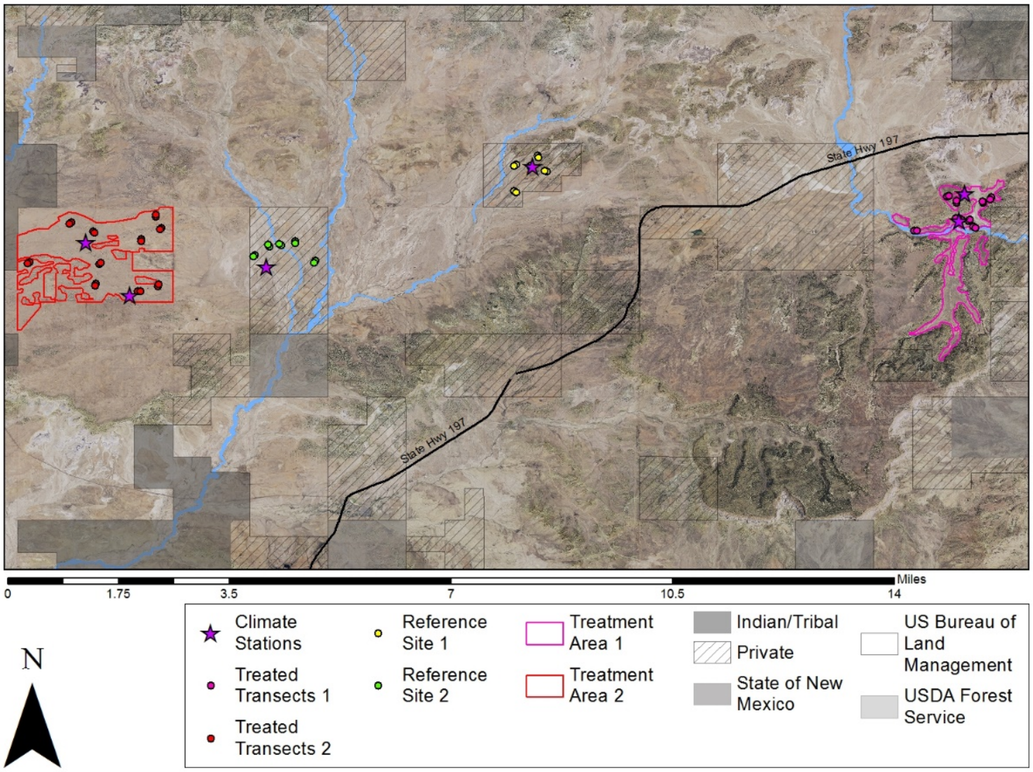

Figure 6: Climate monitoring station locations and treatment areas in the Rio Puerco Watershed.

Six devices were constructed and installed in association with independent climate monitoring stations provided by the USDA-NRCS previously installed on the research site (Figure 6). The climate stations will provide a suite of meteorological measurements including precipitation, temperature, and wind speed along with soil moisture and temperature readings at three depths (10, 20, and 50 centimeters). Full soil characterization was performed during the installation of the climate stations. The data collected by the climate stations will be used to determine local weather patterns that would impact the runoff measurements collected by the UBeTubes.

Figure 7: UBeTube device installed.

Each UBeTube device is 65 centimeters in length, and was installed with approximately 35 centimeters below the soil surface (Figure 7). Soil displaced by the installation was collected on a tarp on site and returned to the gaps around the device after installation. Any remaining soil was evenly distributed downslope of the monitoring device. The installation depth will help to buffer the sensor from environmental conditions while still providing a clear determination of runoff amounts. The inflow piping is located at the soil surface and protected from sedimentation using 1/8-inch galvanized mesh. Data Loggers and excess sensor cables were mounted to a steel T-post adjacent to the installation site, and all sensor cables crossing the soil surface were protected from wildlife damage using UV resistant, high-temperature split loom and secured to the soil surface using landscape pins. The plant and biological soil communities on the installation sites and associated catchments were described prior to disturbance of the soil at each location. The catchments were manually mapped using a GPS unit, and spatial calculations will be performed using ArcMap software. This characterization will allow for the calculation of spatially distributed runoff patterns across the installation sites.

Additionally, the collected data will be used to calibrate landscape-scale hydrological models for the RPW. Using the field-collected data in this way, a greater understanding of how upland conservation practices truly impact the hydrology of the system can be gained.

Figure 8: Wyoming big sagebrush community in the Rio Puerco Watershed.

Results: This project has been developed to provide the opportunity for long-term monitoring data in the RPW. We collected pre-treatment plant community data in Fall 2016 (Figure 9, Tables 1 and 2), which provides the baseline against which repeated measurements over the course of subsequent growing seasons will be compared.

Figure 9: Plant community data collection

Table 1: Big Sagebrush Density; Size Classes: Small < 0.5m, Medium 0.5-1.5m, and Large >1.5m

Density (Plants/ha)	Small	Medium	Large
Mesa Portales	2450	2040	15
Valle West	3305	1025	0

Table 2: Basal and Canopy Cover with Standard Error

Site	Basal Gaps (%)	Canopy Gaps (%)
Mesa Portales	50.5 ± 6.9	35.2 ± 4.2
Valle West	68.5 ± 6.9	59.5 ± 6.0

Both treatment sites exhibit similar overall densities of big sagebrush, but have distinct differences in size class components (Table 1). With respect to cover, the Mesa Portales site has much less bare ground and much more canopy cover (Table 2). Due to the nature of the hydrological properties of interest, full results of the runoff monitoring will be collected and analyzed at the end of the growing season along with post-treatment plant and soil community measurements.

Conclusions: The changes in plant and soil biological communities associated with the conservation practices should affect the hydrologic dynamics of the ecosystem. These alterations could potentially affect antecedent soil moisture, and thus runoff potential across the site. The magnitude of change in hydrological properties should correspond to the magnitude of change in plant and soil biological communities. As scale increases, the effect of fine scale properties should decrease accordingly, but the extent is currently not known for this watershed. The amount of overland flow determines the potential of sediment transfer into the stream system, and thus the amount of suspended sediment in the water as it moves through the watershed.

The Rio Puerco Watershed is currently recognized as the main source of suspended sediment in the Rio Grande after the confluence of the two river systems. This sediment load is then deposited in Elephant Butte reservoir, and has been a substantial contributor to the sedimentation and decreased capacity of the reservoir, which then impairs the quality and quantity of water available for production agriculture and domestic use. This project involves a partnership between NRCS, BLM, and the World Wildlife Fund, with initial funding provided by the NRCS to implement long-term monitoring of the plant and soil biological communities. This grant has allowed us to focus on the fine scale hydrological changes with the potential to scale up to the watershed level as the project progresses. Additionally, this grant award stimulated additional interest from our collaborators at the NRCS, and they agreed to provide the independent weather monitoring stations that were installed across the four research sites in the RPW. If conservation practices on rangelands within the RPW can decrease potential runoff and sediment load, the improvement of the ecological and hydrological stability would provide valuable water resources for the state of New Mexico.

The results of this study will be useful for state and federal agencies, as well as private landowners, to evaluate range improvement treatments, specifically the impacts on the hydrology of the associated systems. Linking upland conservation practices to the quantity or quality of water flowing through those areas will increase our knowledge of potential benefits to water supplies downstream.

Budget: The funds from this grant were spent on the materials needed to construct the UBeTube devices. The largest expense was the sensors required.

NMWRRI Student Grant Budget		
Description	**Cost**	**Remaining Funds**
Initial Funding	$0.00	$6,000.00
Sensor Purchase from Meter Group	$4,835.88	$1,164.12
PVC Pipe and Connections	$57.09	$1,107.03
Additional Sensors from Meter Group	$841.23	$265.80
Additional PVC Pipe and Connections	$265.80	$0.00

Presentations:

Poster Presentation at the 2017 Annual Society for Range Management National Conference (A copy of the poster is attached to this report.)

Additional Students and Faculty Involved:

Faculty: Dr. Nicole Pietrasiak and Dr. Kert Young, NMSU
Students: Megan Stovall, Michael Meyers, Margaret Gannon, Devon Fuller, Dustin Ward, Wade Nez, and Adam Chaney, NMSU

Future Career Plans:

I am scheduled to complete my master's degree program in Spring 2018, and plan to continue my education by pursuing a doctoral degree. My career goal is to become a university professor and researcher, which would allow me to make a positive impact on future generations through both teaching and research activities.

References:

Gellis, A.C., Pavich, M.J., Bierman, P.R., Clapp, E.M., Ellevein, A., Aby, S., 2004. Modern sediment yield compared to geologic rates of sediment production in a semi-arid basin, New Mexico: assessing the human impact. Earth Surf. Process. Landforms. 29, 1359-1372.

Pellant, M., P. Shaver, D.A. Pyke, Herrick, J.E., 2005. Interpreting indicators of rangeland health, version 4. Technical Reference 1734-6. U.S. Department of the Interior, Bureau of Land Management, National Science and Technology Center, Denver, CO. BLM/WO/ST-00/001+1734/REV05. 122 pp.

Stewart, R.D., Liu, Z., Rupp, D.E., Higgins, C.W., Selker, J.S., 2015. A new instrument to measure plot-scale runoff. Geosci. Insrum. Method. Data Syst. 4, 57-64.

Vincent, D.W., 1992. The sagebrush/grasslands of the upper Rio Puerco area, New Mexico. Rangelands. 14, 268-271.