



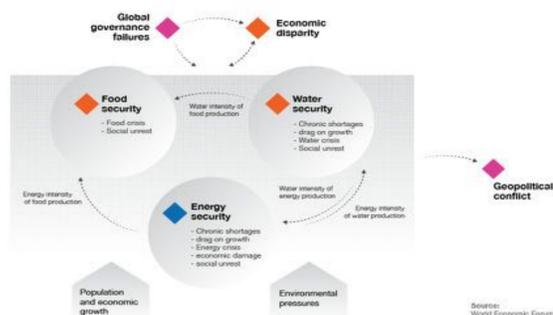
Using Satellite-Derived Precipitation Measurements to Assess Water Resources on the Navajo Indian Reservation

Ansley Long (University of Georgia) and J. Marshall Shepherd (University of Georgia)



Contact me: kalong@uga.edu

Background



This work is pushing PMM science further into the realm of societal benefit at a critical time in water and food security—Dr. Marshall Shepherd

Thanks to Dr. Ramesh Kakar and the PMM science team.

- The economy of food-water security risk is manifested by the following numbers (UN Report): global projections for a 50% increase in food demand, 30% increase in water demand, and 40% increase in energy demand by 2030.
- Demands for food, water, and energy will increase:
 - Vulnerable populations are the most likely to be subjected to restricted access to resources.
 - Augments strains on socioeconomic issues already at play within these communities.

Native American Reservations in Four Corners Region

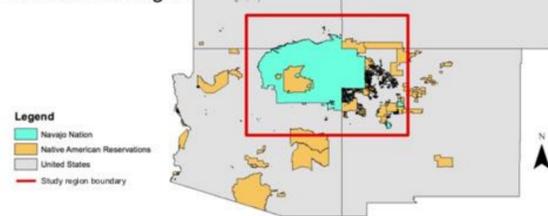


Figure 1. Native American Reservations in the Four Corners Region with the proposed study area outlined in red.

- Four Corners Region in the United States:
 - High concentration of Native American reservations with the Navajo Indian reservation as the largest:
 - >27,500 square miles of desert landscape in complex terrain
 - Population: >174,000 people.
 - Only 60% of families have access to clean running water (Navajo Water Project).
 - Few surface precipitation observations are available within the boundaries of the reservation, making assessments of water resources and effective management practices challenging.

Goals

- Integrate satellite-derived precipitation and other NASA data to support the energy, water, and food nexus (EWFN) related to the Navajo Nation in the Four Corners Region of the southwestern United States.
- Satellite-derived precipitation measurements from NASA's Global Precipitation Measurement (GPM) Mission and Integrated Multi-Satellite Retrievals for GPM (IMERG) data can be used to assess optimal water resource mitigation strategies such as rainwater harvesting and assessing hydroclimate vulnerability.
- Assist in understanding water resources on the reservation and increasing food and water security for the Navajo Nation.

Research Themes

1. Research Theme 1: Climatology of precipitation on the Navajo Reservation

- The Four Corners Region of the southwestern United States is topographically complex and extremely arid, with a majority of the annual precipitation occurring during the summer monsoon seasons.
 - High temperatures also increase the evaporation rate, resulting in limited precipitation reaching the surface at times throughout the year.
- Precipitation observations at the surface within Navajo reservation boundaries are sparse (Fig. 3).
- Utilizing precipitation measurements from GPM and IMERG (Fig. 2) as well as the Nation Weather Service's Multi-sensor Precipitation Estimation (MPE) algorithm will provide a comprehensive analysis of the spatiotemporal distribution and trends of precipitation on the reservation.
- This analysis using satellite precipitation measurements and data will ultimately provide information for more detailed hydroclimate vulnerability assessments and better practices for water resource management on the reservation.

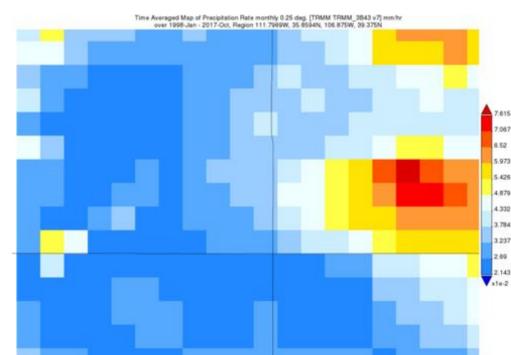


Figure 2. Climatology of precipitation rate from TRMM from 1998-2017.

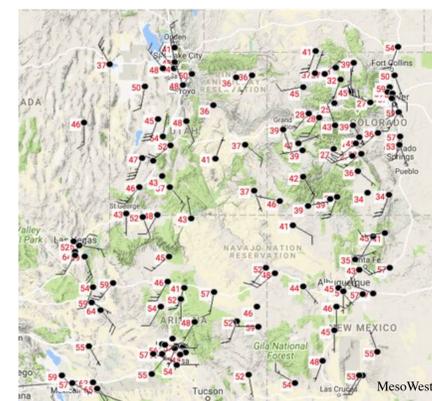
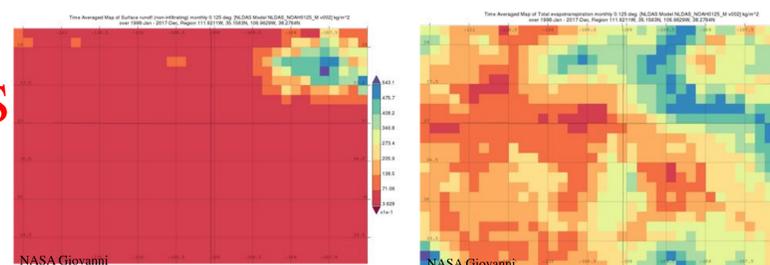


Figure 3: Available surface observations in the Four Corners Region from MesoWest. This figure shows the scarce amount of surface observations on the Navajo Reservation.

2. Research Theme 2: Assessing hydroclimate vulnerability using a simple water budget equation on the Navajo Reservation

- After the climatology of precipitation trends in the study area is established in Research Objective 1, a simple water budget equation can be applied for hydroclimate analysis.
- Surface runoff, evapotranspiration, and water storage data from NLDAS and GLDAS can be used for each component of the water budget equation to make accurate calculations of available precipitation.
- The calculation of a water budget for the Navajo Reservation will allow us to understand how much water is available on the reservation for use and the contribution from precipitation for potential rainwater harvesting operations. Furthermore, the use of Shepherd and C. Liu's Precipitation Per Person (PPP) Metric will provide a more accurate calculation to determine available water for the population of the Navajo Reservation.

$$P=Q+E+\Delta S$$



Precipitation Per Person, GPM

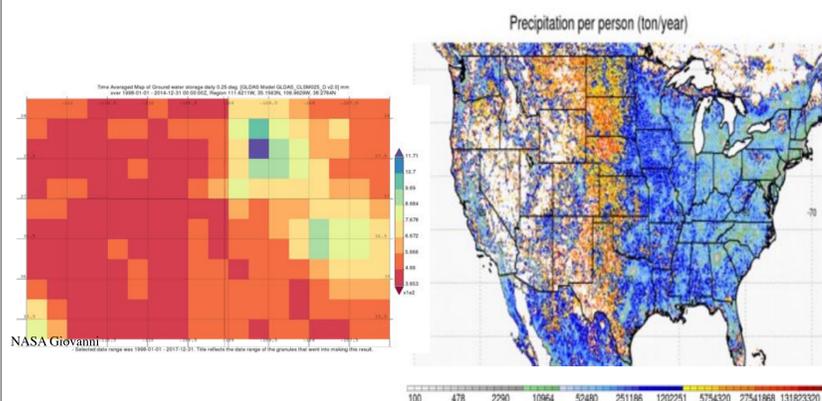


Figure 4. Monthly Runoff (Q), Monthly Evapotranspiration (E), Groundwater Storage Daily Percentile (ΔS) within the study region, and Shepherd and C. Liu's Precipitation Per Person metric (P) that can be used to calculate the Navajo Reservation's water budget to assess hydroclimate vulnerability.

Research Themes (Continued)

Research Theme 3: Environmental Justice for the Navajo: How Water Security Affects Reservation Socioeconomics

- 40% of Navajo families on the reservation have no access to running water (Navajo Water Project).
 - Additionally, many of those that do have access to running water have been exposed to high amounts of uranium that have contaminated the groundwater on the reservation from mining practices.
- Currently, clean water is delivered by truck to families living on the reservation, but many families are frequently left with no choice but to drive to the closest source of water themselves.
- Rainwater harvesting is believed to be a potential solution for the current water scarcity crisis on the Navajo Reservation.
 - Although rainwater can be contaminated with bacteria and other atmospheric pollutants, it can be treated using cost-effective filtration methods and water can be stored on site for future use.
 - Storage of rainwater in central locations will increase access to clean water for the Navajo population
- NASA satellite measurements will also help detect favorable locations within reservation boundaries for rainwater harvesting that will enhance water security for the Navajo Nation.
- The use of NASA satellite data will also aim to understand the EWFN nexus specifically related to the Navajo Nation and help mitigate socioeconomic stressors within the community that have emerged as a result of the lack of available clean water.

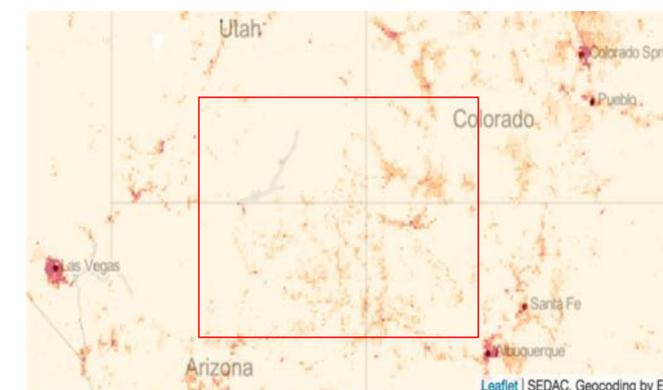


Figure 5. Population density (2015) map of study region.



Figure 6. The locations of reservoirs in the study region suggest that Navajo's likely already experience restricted access to clean water resources.

Special thanks to Chuntao Liu for Precipitation Per Person data. <http://atmos.tamucc.edu/trmm/>