WATER RESOURCES RESEARCH GRANT PROPOSAL

Project ID: GU1343

Title: Groundwater Infiltration and Recharge in the Northern Guam Lens Aquifer as a Function of Spatial and Temporal Distribution of Rainfall

Focus Categories: Groundwater, Climatological Processes

Keywords: Groundwater, Sustainable yield, Climate, Data Analysis, Rainfall, Remote sensing, Atmospheric processes

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Non-Federal Matching Funds: $0

Congressional District: N/A

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Abstract

Groundwater is the most important source of Guam's drinking water. Nearly 40 million gallons per day (mgd) are currently extracted from the thin lens-shaped body of fresh water that floats atop the seawater permeating the limestone beneath it. Current environmental regulations on water production are based on the sustainable yield estimates from the 1982 Northern Guam Lens Study which totaled to 59 mgd. Later estimates by J.F. Mink, based on well responses predicted by a computer model totaled to 70-80 mgd. There remains uncertainty of the sustainable yield, and its meteorological and geological determinants. To make accurate estimates of sustainable yield, groundwater hydrologists need to know the amount of water that infiltrates to the lens from the surface at slow enough rates for the lens to capture and retain it for sufficient time for it to be extracted by pumping.

Ongoing work at WERI) indicates that up to 20% of total rainfall comes in such small amounts (less than 0.25 in./day) that it is likely to be lost to surface evaporation and plant transpiration. At the other extreme, at least another 20% comes from heavy storms at such high intensity (greater than 2 in./day) that it infiltrates too rapidly for the lens to absorb it; most of it probably discharges to the ocean within two weeks or less. It is uncertain how much of the remaining 60% is retained. If the water descending through the 60-150 meter-thick vadose zone arrives at the lens slowly enough, the lens will thicken as is takes the water into storage, and the amount of water available for pumping will increase. If it arrives too rapidly, it may run off of the surface of the lens before the lens can adjust. Determining the amount of storm water that is captured in long-term phreatic storage is a key question for improving estimates of sustainable yield. The purpose of this study is to examine the relationship between storm intensity and the response of the freshwater lens, in order to improve estimates of how much storm water goes into long-term storage in the freshwater lens.

We will import historical data into a spreadsheet program from which we will graph rainfall and well levels as a function of time at several different scales. Since 30-minute records are available for several USGS observation wells and rain gages and hourly data are available for NWS gages (and for target rain events from NEXRAD), we will be able to resolve the rainfall intensity and well-level responses into hourly intervals, and daily means, as well as monthly, seasonal, and annual means. We will select specific wells and nearby rain gages for focused study. For each well selected, we will conduct a field survey to characterize the nature of the surface catchment and infiltration.

Results from this project will provide insight into how much recharge is associated with different weather phenomena on Guam. This improvement in our understanding of rainfall-recharge relationships will enable more accurate and precise estimates of recharge, and therefore sustainable yield, to be made for designated well fields and sectors of production in the aquifer. We will also be able to infer the contribution of surface conditions, most especially the contributions of sinkholes, retention basins, and other natural and artificial surface features that modify infiltration rates. Such understanding will provide a basis for determining appropriate environmental and land use regulations and stormwater management practices over the aquifer. A far-reaching goal of this project will be to establish an automated system for calculating recharge in real time based on NEXRAD radar output. Continuous NEXRAD estimates of rainfall at six-minute intervals could eventually be assimilated into an operational model of recharge.