Spatial Precipitation Trends and Effects of Climate Change on the Hawai'ian Hualalai Aquifer

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Abstract. While trends in temperature are well studied and understood spatially and temporally at a multitude of scales, trends in precipitation are less understood. As the predominant source of groundwater recharge in Western Hawai'i, precipitation plays a vital role in maintaining tourism and industry throughout the Kona Region. Kaloko-Honokohau National Historical Park was established in 1978 to perpetuate and maintain traditional native Hawai'ian culture and the surrounding ecosystem, which is dependent on freshwater from the surrounding Hualalai Aquifer. Precipitation increases with elevation from the coast to approximately 1500 meters up the slope of Hualalai Volcano and then decreases to approximately 2000 meters. Western Hawai'i has a dense rain gauge network and changes in precipitation in the last several decades have been observed, though the rate sand significance of change is unclear. This study introduces a new method of integrated spatial analysis aimed at representing spatial trends in more detail. Using the Rainfall Atlas of Hawai'i produced by the University of Hawai'i at Manoa, spatial trends from 1978-2007 were studied by annually (and monthly) adjusting the 30-year climate normal and calculating residuals between adjusted and observed precipitation. The Mann-Kendall and Sen's Slope statistical tests were used spatially to determine the rate and significance of change. This method was then compared with spatial interpolation by inverse distance weighting (IDW) and ordinary kriging to assess the differences in methods. Results from the integrated spatial analysis show an annual decrease of -8.42×10^6 m^3/year across the entire study area and a decrease of -4.62×10^6 m^3/year when only significant areas are considered. This can be compared with -10.8×10^6 m^3/year total and -0.64×10^6 m^3/year in significant areas from IDW and -8.41×10^6 m^3/year and -1.31×10^6 m^3/year respectively from ordinary kriging. On a monthly basis, both the integrated spatial analysis and IDW yield similar trends regarding an increase or decrease in the net volume entering the aquifer, however IDW underestimates the overall magnitude. The introduced integrated spatial analysis method provides an improved assessment of spatial trends that, while not limited to precipitation, can assist in broadening the limited knowledge of spatial precipitation trends across the globe.