

Human Effects on the Hydrologic System of the Verde Valley, Central Arizona, 1910–2005 and 2005–2110, Using a Regional Groundwater Flow Model

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Abstract

Water budgets were developed for the Verde Valley of central Arizona in order to evaluate the degree to which human stresses have affected the hydrologic system and might affect it in the future. The Verde Valley is a portion of central Arizona wherein concerns have been raised about water availability, particularly perennial base flow of the Verde River. The Northern Arizona Regional Groundwater Flow Model (NARGFM) was used to generate the water budgets and was run in several configurations for the 1910–2005 and 2005–2110 time periods. The resultant water budgets were subtracted from one another in order to quantify the relative changes that were attributable solely to human stresses; human stresses included groundwater withdrawals and incidental and artificial recharge but did not include, for example, human effects on the global climate. Three hypothetical and varied conditions of human stresses were developed and applied to the model for the 2005–2110 period. On the basis of this analysis, human stresses during 1910–2005 were found to have already affected the hydrologic system of the Verde Valley, and human stresses will continue to affect the hydrologic system during 2005–2110. Riparian evapotranspiration decreased and underflow into the Verde Valley increased because of human stresses, and net groundwater discharge to the Verde River in the Verde Valley decreased for the 1910–2005 model runs. The model also showed that base flow at the upstream end of the study area, as of 2005, was about 4,900 acre-feet per year less than it would have been in the absence of human stresses. At the downstream end of the Verde Valley, base flow had been reduced by about 10,000 acre-feet per year by the year 2005 because of human stresses. For the 2005–2110 period, the model showed that base flow at the downstream end of the Verde Valley may decrease by an additional 5,400 to 8,600 acre-feet per year because of past, ongoing, and hypothetical future human stresses. The process known as capture (or streamflow depletion caused by the pumping of groundwater) was the reason for these human-stress-induced changes in water-budget components.