Mountain-Front Distributed Recharge in Nevada

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Basin-scale distributed mean annual recharge is often estimated in Nevada as a fraction of mean annual precipitation by applying the well-known Maxey-Eakin empirical relationship. Some researchers recast the relationship in terms of elevation rather than precipitation, because both precipitation and temperature influence recharge and both change systematically with elevation. The relationship was originally defined as a series of discrete steps corresponding to an available precipitation map. Maxey and Eakin assumed negligible recharge in the lowland areas of their hydrologic basins and assigned zero recharge to the corresponding precipitation bin. The zero-recharge threshold has been widely interpreted as applying to low-precipitation upland areas, such as Yucca Mountain, as well as lowland areas. Other researchers have revisited many of the east-central Nevada hydrologic basins that Maxey and Eakin considered, using evapotranspiration estimates derived from satellite imagery and estimates of interflow from the literature to fit a Maxey-Eakin-like recharge relationship. We independently obtain a power-law relationship (power-law type equation) for the same hydrologic basins that is essentially identical to a power-law form of the Maxey-Eakin relationship when upland and lowland are not differentiated, despite significantly wetter present-day precipitation estimates. We obtain a power-law upland relationship if it is assumed that lowland areas do not contribute to recharge, with the upland relationship matching the Maxey-Eakin relationship at high precipitation values and the upland relationship significantly wetter at low precipitation values. The upland relationship suggests that recharge is at least 1 mm/yr [0.04 in/yr] when precipitation levels are slightly above 100 mm/yr [4 in/yr], whereas the Maxey-Eakin relationship suggests that recharge is zero below approximately 200 mm/yr [8 in/yr]. Inferred estimates of upland recharge from observation are generally consistent with our upland relationship, including estimates from Yucca Mountain at elevations lower than the east-central Nevada hydrologic basins. An independent abstraction developed for use in Yucca Mountain performance assessment, derived from numerous detailed simulations and site data, parameterizes areal-average net infiltration as a function of mean decadal precipitation and temperature. Using change in elevation as an analog for change in climate, the abstracted model provides an extremely close fit to the upland power-law relationship over a wide range of elevations, providing confidence that the abstracted model responds well to climate changes. The upland relationship is further modified to account for regional variation in temperature using insights from the abstracted Yucca Mountain model.

This paper is an independent product of CNWRA and does not necessarily reflect the view or regulatory position of NRC. The NRC staff views expressed herein are preliminary and do not constitute a final judgment or determination of the matters addressed or of the acceptability of a license application for a geologic repository at Yucca Mountain.