Title	Investigation of Changing Hydrologic Conditions in the Coon Creek Watershed in the Driftless Area of Wisconsin.
Project I.D.	R/UW-GSI-003
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Background/Need

Decreased flooding and increased baseflows in Driftless Area streams over the past century have been attributed to improved land management practices (Gebert and Krug 1996). Kent (1999) tried to relate land management to groundwater recharge (the dominant component of baseflow) in the Driftless Area but the results were largely inconclusive. An understanding of the influence of spatially distributed recharge and hydrostratigraphic properties on local groundwater flow is needed in order to evaluate effects of land management change on the hydrology of the Driftless Area.

Objectives

The purpose of this investigation was: 1) to improve our understanding of groundwater flow in the Driftless Area at various watershed scales, and 2) to evaluate focused recharge (i.e., hillslope recharge) as a driver for changes in baseflow during three different time periods.

Methods

Field data were collected to evaluate spatial variations in infiltration (an indicator for recharge) and for use as calibration targets for a numerical groundwater flow model. The numerical model (MODFLOW – Harbaugh and McDonald, 1996) was calibrated to 2001-2002 data and checked using two historic time periods (1934-1940, 1979-1981) when hydrologic data were collected in the upper Coon Creek Watershed. Specified flux boundary conditions for the numerical model were extracted from an analytic element model (GFLOW – Haitjema 1995). The influence of complexity (e.g., focused hillslope recharge) was evaluated on local (less than 1 mi^2) and catchment (75 mi^2) scales. Optimization of recharge rates with a parameter estimation code (UCODE – Poeter and Hill 1998) was used to quantify differences in recharge in the three study periods.

Results and Discussion

Optimization of recharge produced a hillslope recharge rate that was 2.3 times higher than recharge on ridge-tops, a pattern consistent with field infiltration measurements that were two to ten times higher on hillslopes than on ridges and in valleys. Numerical simulations demonstrated that baseflow in basins smaller than about 30 mi^2 differed as much as 36% when areally uniform recharge was used rather than focused recharge. Simulated baseflow in basins smaller than 15 mi^2 varied as much as 73%, a phenomenon related to the position of the basin relative to a specific hydrostratigraphic unit (Tunnel City Group). Simulated baseflows in basins larger than about 30 mi^2, on the other hand, were relatively unaffected by changes in recharge distribution, or hydraulic properties of the Tunnel City Group. The latter insensitivity is due to the Tunnel City Group being completely eroded through by streams at larger scales. Recharge amounted to 19% of annual precipitation during the 1934-1940 study period and increased to 28% of annual precipitation during the 1979-1981 and 2001-2002 study periods. Thus, the processes responsible for facilitating the conversion of precipitation into recharge appear to be relatively unchanged since the 1979-1981 study period.

Conclusions/Implications/Recommendations

- In the study watershed, influences of hydrostratigraphic properties and focused hillslope recharge were limited to local groundwater flow in basins less than about 15 to 30 mi^2. The basin scale is likely related to vertical location in the hydrostratigraphic section and can be tested using other basins in the Driftless Area.

- Focused recharge on hillslopes produced a better simulation of measured heads and baseflows in the upper Coon Creek Watershed than areally uniform recharge. Thus, focused hillslope recharge is likely a more appropriate representation of the distribution of recharge in the Driftless Area than areally uniform recharge and is especially important in small headwater basins.

- Temporal recharge estimates suggest that the land management practices instituted in the 1930s resulted in the observed increase in baseflow and recharge between the 1940s and late 1970s. However, their effect on recharge has remained relatively unchanged since the early 1980s.

Related Publications:

Hunt, R.J and P.F. Juckem. 2001. How to Collect Meaningful Data – An Example Using Parameter Estimation and a Simple Groundwater Flow Model. *in* American Water Resources Association - Wisconsin state section, proceedings, pp. 30-31.

Juckem, P.F., R.J. Hunt, M.P. Anderson. 2001. Driftless Area Hydrogeology – Preliminary Results of Temporal Change in the Coon Creek Watershed. *in* American Water Resources Association – Wisconsin state section, proceedings, p. 6.

Juckem, P.F., R.J. Hunt, D.M. Chapel and M.P. Anderson. 2002. Conceptual Groundwater Model for the Coon Creek Watershed, Wisconsin. *in* American Water Resources Association – Wisconsin state section, proceedings, p. 6.

Juckem, P.F. 2003. Spatial Patterns and Temporal Trends in Groundwater Recharge, Upper Coon Creek Watershed, Southwest Wisconsin. Master of Science Thesis. Dept. of Geology and Geophysics. University of Wisconsin – Madison. 264 p.

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