XXXVIII
IAH Congress

Groundwater Quality Sustainability
Krakow, 12–17 September 2010

Extended Abstracts

Editors:
Andrzej Zuber
Jarosław Kania
Ewa Kmiecik

University
of Silesia
Press 2010

abstract id: **391**

topic: **3**
Aquifer management

3.4
Environmental and artificial tracers in hydrogeology

title: Use of specific conductance in streams as a tracer to map groundwater recharge and discharge across the commonwealth of Virginia, USA

author(s): **Ward E. Sanford**
U.S. Geological Survey, United States, `wsanford@usgs.gov`

David L. Selnick
U.S. Geological Survey, United States, `dselnick@usgs.gov`

Jason P. Pope
U.S. Geological Survey, United States, `jpope@usgs.gov`

keywords: hydrograph, baseflow, recharge, evapotranspiration, specific conductance

Recharge is an important quantity that partly determines the long-term sustainability of groundwater resources. Quantifying the recharge flux in space and time is a challenge that has been undertaken by many scientists using many different techniques (Scanlon et al., 2002). For the purposes of water sustainability estimates and model calibration, the long-term average recharge rate is often the sought after value. In many watersheds, groundwater discharge (or baseflow) to the stream is related directly to the groundwater recharge rate within the watershed through the groundwater budget equation $RA = B + RET - U + \Delta S$, where R is recharge, A is the watershed area, B is the baseflow to the stream, RET is riparian evapotranspiration, U is the net underflow to the watershed (usually relatively small in Virginia watersheds), and ΔS is the change in storage (negligible over decades). Automated graphical hydrograph separation (*GHS*) techniques (Rutledge and Daniels, 1994) have been employed widley along these lines to make estimates of baseflow and recharge. One potential problem with this approach is that natural chemical tracers (which provide additional information) in watersheds usually indicate that during storm events more of the peak flow is groundwater discharge than simple graphical separation techniques would indicate. In this study we have used specific conductance (*SC*) as a tracer of groundwater discharge at real-time stream-gaging sites throughout Virginia to estimate baseflow and recharge using chemical hydrograph separation (*CHS*).

The real-time stream gages were instrumented at 72 sites across four physiographic provinces of Virginia with *SC* probes for a period of one to two years. Discharge and SC were measured every 15 minutes. Total evapotranspiration (*TET*) also was estimated using the difference between long-term (1971–2000) average stream flow (Q) and precipitation (P) associated with each gaged site and its watershed, where $TET = P - Q/A$. A regression equation then was made for *TET* as a function of P and the average annual minimum and maximum daily temperatures (T) (over 1971–2000) for the watersheds (data from Daly et al., 2008). The real-time Q at each site was divided into two components, B and *Ro* (runoff), based on *SC* and then adjusted to the long-term average Q. The one-to-two-year results were compared with estimates from the automated GHS program PART (Rutledge, 1998) made using the discharge data from the same one-to-two-year periods. The estimated average baseflow index, $BI = B/Q$, using the *CHS* was 0.71, as compared to 0.61 from using PART. This result is consistent with the many reported studies indicating that small forested watersheds have a large fraction of groundwater discharge during storm events (Rice and Hornberger, 1998).

The long-term average recharge, R, can be calculated based on the water balance relation $RA = B - RET$. The *RET* is typically a relatively small component of *TET* and was estimated independently in this study as a fraction of *TET*. Of all the landscape characteristics, the *BI* and *RI* (Ro/Q) were found to correlate most with physiographic province and rock type. Little additional improvement was made to the regression by including the topographic slope, land cover type, or soil permeability, partially because strong correlations exist between those other landscape parameters and rock type. The *ET* regression based on climate and discharge data explains about 80% of the variance in *ET*, and the runoff regression explains about 70% of the variance in *Ro*. These regressions were then applied to the entire Commonwealth of Virginia to create maps of *ET*, baseflow, runoff, and recharge.

REFERENCES

Daly C., Halbleib M., Smith J.I., Gibson W.P., Doggett M.K., Taylor G.H., Curtis J., Pasteris P.A., 2008: *Physiographically-sensitive mapping of temperature and precipitation across the conterminous United States. International Journal of Climatology* 28, p. 2031–2064.

Rice K.C., Hornberger G.M., 1998: *Comparison of hydrochemical tracers to estimate source contributions to peak flow in a small forested headwater catchment*. Water Resources Research 34, p. 1755–1766.

Rutledge A.T., 1998: *Computer programs for describing the recession of ground-water discharge and for estimating mean ground-water recharge and discharge from streamflow data – update*. U.S. Geological Survey Water-Resources Investigations Report 98–4148.

Rutledge A.T., Daniel C.C., 1994: *Testing an automated method to estimate ground-water recharge from streamflow records*. Ground Water 32, p. 180–189.

Scanlon B.R., Healy R.W., Cook P.G., 2002: *Choosing appropriate techniques for quantifying groundwater recharge*. Hydrogeology Journal 10, p. 18–39.

International Association of Hydrogeologists

AGH University of Science and Technology

2-vol. set + CD
ISSN 0208-6336
ISBN 978-83-226-1979-0