Category: Water Quantity
Indicator: Trends in Groundwater Contribution to Baseflow

Methodology

Trends in Groundwater Contribution to Baseflow is an indicator of the impact of groundwater development, drought and other factors on springflow and river baseflow in Texas. This indicator is measured as the trend in annual total baseflow (in acre-feet) at selected streamflow gages calculated via hydrograph separation of daily average flow data. The data are presented over two periods, the most recent 20 years and the entire period of record.

Hydrograph Separation

We estimated groundwater-fed baseflow for selected streamflow gages by using hydrographic separation to remove the stormflow portion of a hydrogaph. We selected gages for this analysis if they are likely to be good index locations where groundwater connects to surface water and have been relatively unimpacted by major dams (i.e., are unregulated) and other water infrastructure. We also selected gages that have a nearly continuous period of record for at least the last 20 years.

To calculate baseflow we used the Web-based Hydrogaph Assessment Tool (WHAT) from Purdue University to perform hydrogaph separation. WHAT is a flexible tool that allows variable parameterization of hydrogaph analysis and includes local minimum, one parameter digital filter and recursive digital filter methods. We used the one parameter digital filter (default filter parameter of 0.925), which is a very similar algorithm to that used in the Baseflow Index (BFI). We ran WHAT on daily streamflow data for each selected gage and then summed the resulting daily baseflow (and stormflow runoff) values for each year to obtain annual volumes of estimated baseflow.

Statistical Analysis and Mapping

We ran a Mann-Kendall trend test on the time series of total annual baseflow to evaluate trends. This test is a non-parametric test that determines whether a time series of data exhibits an increasing or decreasing trend and reports a level of significance. We considered the test significant with a p-value of less than 0.05. We used the Mann-Kendal results to determine if each streamflow gage has an increasing, decreasing, or no trend for each of two periods of analysis: the full period of record for each gage (varies across gages) and the most recent 20 years (1993-2014). Maps of streamflow gages analyzed are included in the web viewer and include the results of this trend analysis for both periods.

Data Sources

U.S. Geological Survey. Daily Discharge for selected gages in Texas. Accessed April 2014. http://waterdata.usgs.gov/tx/nwis/dv/?referred_module=sw

International Boundary and Water Commission. Daily Discharge for selected gages. Provided to TNC Staff June 2014.
http://www.ibwc.gov/Water_Data/histflo1.htm

Web-based Hydrograph Analysis Tool (WHAT). https://engineering.purdue.edu/~what/
Reference: Lim, K.J., B.A. Engel, Z. Tang, J. Choi, K. Kim, S. Muthukrishnan, and D. Tripathy. 2005. Automated web GIS based hydrograph analysis tool, WHAT. Journal of the American Water Resources Association 2005: 1407-1416.

US Geological Survey, USGS Streamgages Linked to the Medium Resolution NHD shapefile. Accessed April 2014.
http://water.usgs.gov/GIS/metadata/usgswrd/XML/streamgages.xml#stdorder

International Boundary and Water Commission. Gage locations extracted from 2006 Rio Grande Water Bulletin and updated based on IBWC instructions to TNC Staff June 2014.
http://www.ibwc.gov/wad/Rio_Grande/2006.pdf