The Development of a Low Flow Estimation Tool for Watershed Assessment in West Virginia

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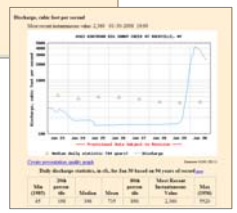
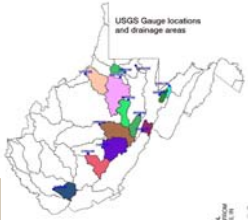
Introduction

Land-use planners and resource managers involved with fish, wildlife, or water rights issues require stream flow estimates. Estimating stream flow is important for determining the assimilative capacity of streams when discharge permits are being evaluated.

Issue

There are relatively few continuously-monitored stream gauging stations. The WV Department of Environmental Protection needed calculate the low flow values for non-gauged streams. Specifically, they required a way to spatially query stream locations anywhere in the state and determine the 7 day 10 year low flow occurrence (7Q10).





Approach

We have developed a Geographic Information System based decision support system for calculating low flow stream estimates in WV. The method incorporates regional and stream variability curves and equations to provide annual and average values for 7Q10 flow estimates.

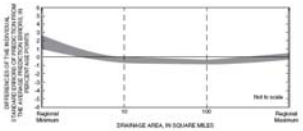
Model Development

Multiple and simple least-squares regression models for the log10-transformed 1.5- and 2-year recurrence intervals of peak discharges with independent variables describing the basin characteristics (log10-transformed and untransformed) for 236 streamflow-gauging stations were evaluated, and the regression residuals were plotted as areal distributions that defined three regions in West Virginia designated as East, North, and South. Regional equations for the 1.1-, 1.2-, 1.3-, 1.4-, 1.5-, 1.6-, 1.7-, 1.8-, 1.9-, 2.0-, 2.5-, and 3-year recurrence intervals of peak discharges were determined by generalized least-squares regression. Log10-transformed drainage area was the most significant independent variable for all regions.

Eleven basin characteristics were used to describe the basins at and upstream from West Virginia gauging stations. The following 11 basin characteristics were considered for the correlation and regression analyses:

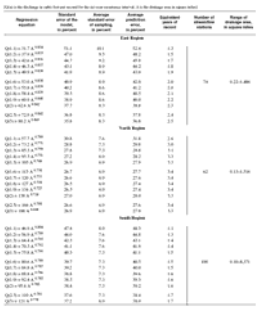
1. Drainage area
2. Main-channel slope
3. Stream length
4. Mean basin elevation
5. Forested area
6. Mean annual precipitation
7. Precipitation intensity
8. Mean annual snowfall
9. Mean minimum January temperature
10. Local station slope
11. Streamflow variability index

Regional boundaries for low-recurrence-interval peak-discharge estimating equations for rural, unregulated streams in West Virginia.



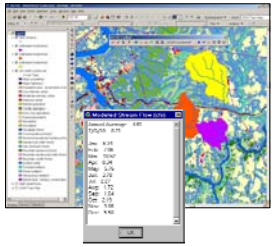
Range of differences for drainage area of the individual standard errors from the average prediction errors.

Equations and regression statistics determined in the regional regression analysis of peak discharges.



Procedure

1. Determine the location of the selected point along a stream relative to gauging stations and/or partial record stations.
2. Determine if those existing stations (if any) are regulated or unregulated.
3. Calculate (7Q10) at the selected location using the appropriate equation or regional equations.
4. The final result is an estimation of the annual 7Q10 representative of the period 1930-2002 for the selected location, as well as several other parameters. A comprehensive stream flow report is generated.



Decision Support System

The decision support system accesses the spatial variables and allows users to quickly select a watershed, stream segment, and location in the stream to query for 7Q10. Results are reported back to the user as annual and monthly conditions as well as the variance and confidence thresholds for each computation. While the statistical relationships are unique for the topography and landscape of WV, the methodology and user interface could be adopted for other regions.

Source reference for figures and tables: Wiley, J.B., J.T. Atkins, D.A Newell. 2002. Estimating the Magnitude of Annual Peak Discharges with Recurrence Intervals Between 1.1 and 3.0 Years for Rural, Unregulated Streams in West Virginia. Water Resources Investigations Report 02-4164. U.S. Department of the Interior, U.S. Geological Survey, Charleston, WV.