

Use of StreamStats in the Upper French Broad River Basin, North Carolina: A Pilot Water-Resources Web Application

StreamStats is a Web-based Geographic Information System (GIS) application that was developed by the U.S. Geological Survey (USGS) in cooperation with Environmental Systems Research Institute, Inc. (ESRI) to provide access to an assortment of analytical tools that are useful for water-resources planning and management. StreamStats allows users to easily obtain streamflow statistics, basin characteristics, and descriptive information for USGS data-collection sites and selected ungaged sites. StreamStats also allows users to identify stream reaches upstream and downstream from user-selected sites and obtain information for locations along streams where activities occur that can affect streamflow conditions. This functionality can be accessed through a map-based interface with the user's Web browser (fig. 1) or through individual functions requested remotely through other Web applications (Ries and others, 2008).

The StreamStats Web-page portal is <http://water.usgs.gov/osw/streamstats/>. This web site provides helpful information for the user, including definitions of basin characteristics details about the functionality and limitations of the StreamStats application, user help information for using StreamStats, and links to access State applications.

North Carolina StreamStats

Currently (2009), the StreamStats application relies exclusively on 10- and 30-meter Digital Elevation Models (DEMs) and 1:24,000- and 1:100,000-scale National Hydrography Datasets (NHDs). Although these datasets are adequate for some applications, availability of higher resolution elevation data, predominately from Light Detection and Ranging (LIDAR), provides an opportunity for more accurate results from StreamStats for a variety of scientific applications. In 2007, the State of North Carolina developed a local-resolution NHD product (at an approximate 1:4,800 scale) for 19 western counties in the State. The best available combination of digital orthophotography, DEMs derived from LIDAR, and existing hydrography was used to create the local-resolution NHD product.

A pilot project was conducted by the USGS, in cooperation with the North Carolina Department of Transportation (NCDOT), to develop and implement a StreamStats application for the upper French Broad River basin in western North Carolina. This StreamStats application interfaces with the local-resolution NHD product, 20-foot DEMs (derived from LIDAR data), and the most current regional streamflow regression equations and datasets of landscape characteristics. Basin characteristics, such as rainfall data, topographic variables, such as slope and drainage area; and

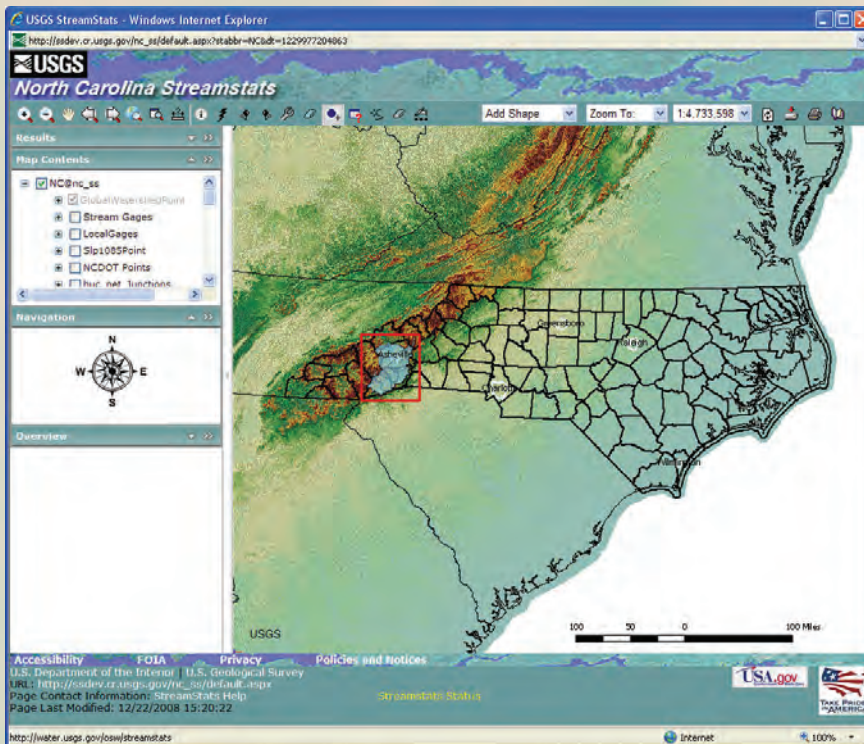


Figure 1. View of the StreamStats user interface for the North Carolina pilot application in the upper French Broad River basin.

StreamStats provides an accurate, consistent, and fast process for computing basin characteristics and streamflow statistics. Streamflow statistics for gaged sites are immediately accessible without the need to obtain the original publications containing the original statistics. Examples of streamflow statistics that can be obtained from StreamStats include the 1-percent exceedance level flood, mean annual flow, and 7-day 10-percent exceedance level low flow. Examples of basin characteristics that can be computed in StreamStats include drainage area, stream slope, mean annual precipitation, and percentage of forested area (Ries and others, 2008). These data are valuable for making decisions related to bridge design, floodplain delineation, water supply, and for sustaining stream ecology.

best-available land-cover classifications were incorporated in the pilot StreamStats application.

The North Carolina Center for Geographic Information and Analysis (CGIA) partnered with the NCDOT and USGS on a pilot project to generate high-resolution land-cover data for the upper French Broad StreamStats application. CGIA used visible near-infrared satellite imagery (ASTER) from 2005 to 2006 to generate a 10-class land-cover dataset for the upper French Broad River basin in the vicinity of Asheville and Hendersonville, North Carolina. Both the 2001 National Land Cover Dataset (NLCD) and 2005–2006 ASTER land cover data are available in the pilot North Carolina StreamStats application.

Application Functionality

Current (2009) functions of the North Carolina pilot StreamStats in the upper French Broad River basin include the following:

- View a range of base-map features, such as roads, streams, political boundaries, aerial imagery, and USGS topographic maps in the user interface map frame for navigation purposes;
- Use roadway and aerial imagery data layers from NCOneMap at <http://www.nconemap.com/>, which provide the most up-to-date geospatial data available in participating counties in the State;
- Zoom in or out to a different map scale based on input of (1) a user-drawn rectangle, (2) a place name, (3) coordinates of longitude and latitude, or (4) a specified scale;
- Obtain previously published peak-streamflow statistics, basin characteristics, and descriptive information for USGS data-collection stations, and link to the USGS National Water Information System (NWIS) Web site, which provides access to data collected at selected sites;
- Delineate the drainage-basin boundary for a user-selected un-gaged site and edit the basin boundary (fig. 2);
- Compute 37 basin characteristics, such as drainage area, stream slope,

land cover, soil type, and mean annual rainfall, for the selected site and summarize in a tabular format (fig. 3);

- Estimate peak streamflow statistics at un-gaged locations and provide indicators of the accuracy of the estimates in tabular format (fig. 4);
- Search upstream or downstream from a selected site to identify the connected stream network and to locate and provide information on natural or manmade features, such as dams and wastewater discharges, that may affect the quantity or quality of the streamflow;
- Download the basin boundary as an ESRI shapefile for use in other applications, along with basin characteristics and streamflow statistics that have been computed for the site; and
- Print the results displayed in the user interface map frame.

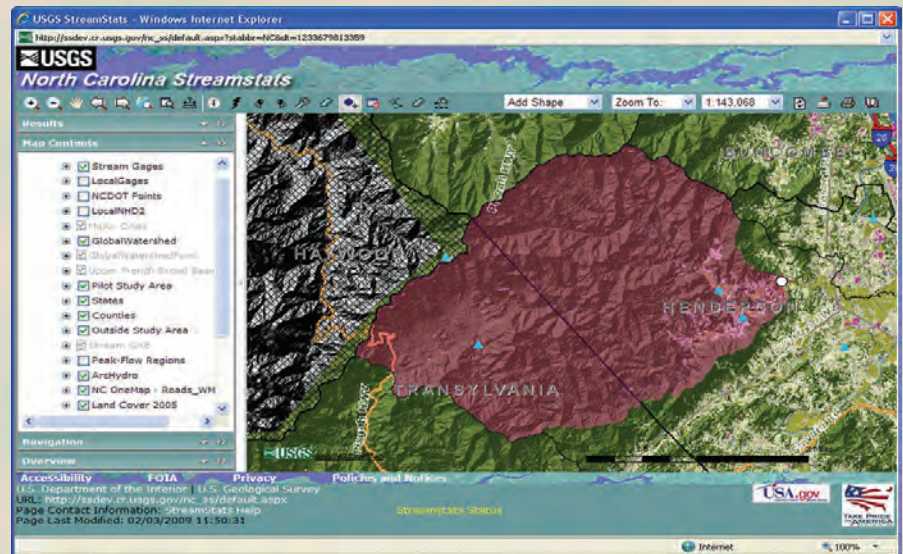


Figure 2. Example of an automated watershed delineation for a user-defined stream location in StreamStats where the selected site is shown by a white circle, the drainage area is shaded magenta, and streamgage locations are indicated by blue triangles.

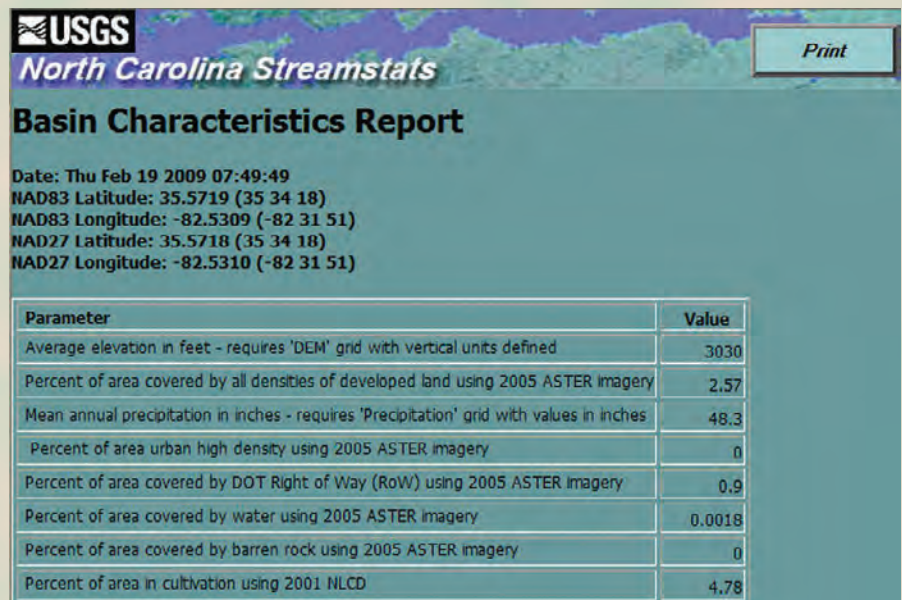


Figure 3. Example of a summary table of basin characteristics for the watershed of a user-defined point in StreamStats.

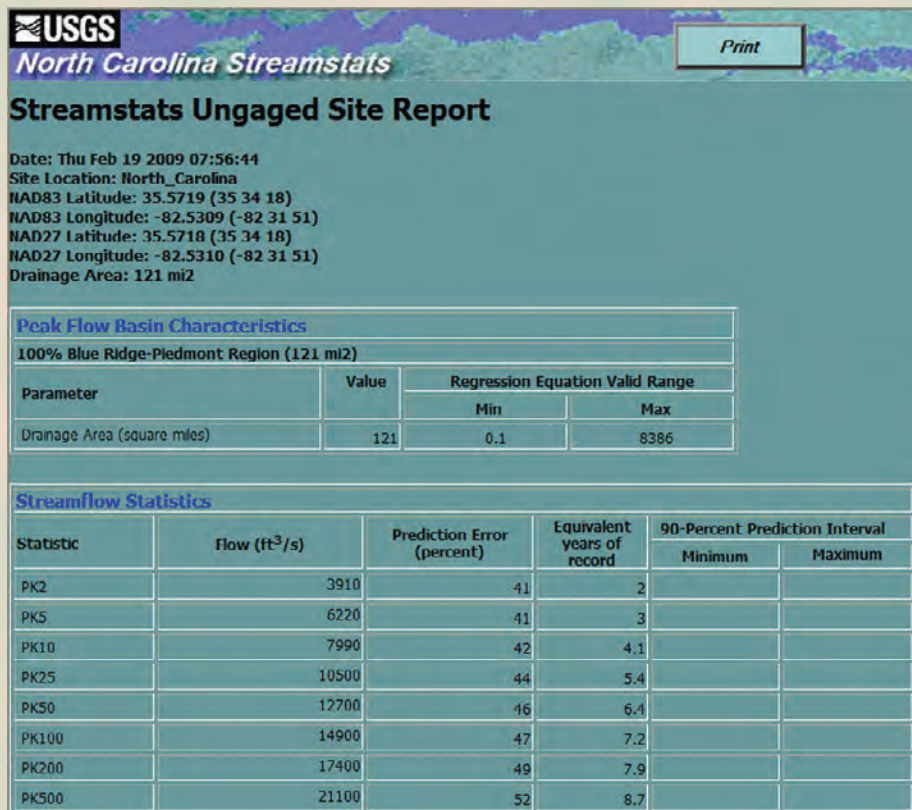


Figure 4. Example of a summary table of peak-flow streamflow statistics for the watershed of a user-defined point in StreamStats.

Streamflow Statistics for Ungaged Sites

StreamStats can estimate selected streamflow statistics for ungaged sites by using regional regression equations. Regression equations are developed by statistically relating streamflow statistics to basin characteristics for a group of data-collection stations within a region. Estimates of streamflow statistics for ungaged sites can then be obtained by using the basin characteristics for the ungaged site in the regression equations (Weaver and others, 2009; see inset below).

The USGS has developed equations to estimate peak-flow frequency statistics, such as the 1-percent exceedance level flood, for ungaged sites in every state. Regression equations also have been developed to estimate other types of streamflow statistics. As an example, the equation for estimating the 1-percent exceedance level flood for ungaged sites in the Blue Ridge Physiographic Province in North Carolina, South Carolina, and Georgia is:

$$Q_{100} = 575.44DA^{0.713}$$

where

Q_{100} is the peak flow with a 1-percent exceedance level (1-percent chance of being equaled or exceeded in any year), in cubic feet per second; and

DA is the drainage area, in square miles.

StreamStats automates the process of measuring the basin characteristics and solving the applicable regression equations for ungaged sites. The drainage-basin boundary can be determined for a selected site by using the 20-foot DEM (derived from LIDAR data) and the digital representation of the stream network (local-resolution NHD). StreamStats users can (1) locate the ungaged site of interest on the map, (2) use the *Point Delineation* tool to obtain the drainage basin for the site, and then (3) either use the *Basin Characteristics* tool to obtain a table that summarizes the basin characteristics provided by the pilot North Carolina StreamStats (fig. 3) or the *Estimate Flows using Regression Equations* tool to obtain the estimates of streamflow characteristics (fig. 4).

Stream-Network Navigation

StreamStats uses stream-network navigation to identify and obtain information for other points of interest that are part of the stream network of the selected location. A view of the StreamStats map frame that illustrates the results of an upstream trace for a selected location on a stream in the upper French Broad River basin is shown in figure 5. The primary benefit of the trace functionality is to understand how the flow at a particular site can be affected by upstream activities or how downstream flow can be affected by existing or proposed activities at the selected site. The U.S. Environmental Protection Agency (EPA) and many State and local agencies have supported the indexing of their water-related data to the NHD, and many similar efforts are underway (Ries and others, 2008). Currently (2009), streamgages are the only layer indexed to the local-resolution stream network in the North Carolina pilot StreamStats application, but additional layers can be added.

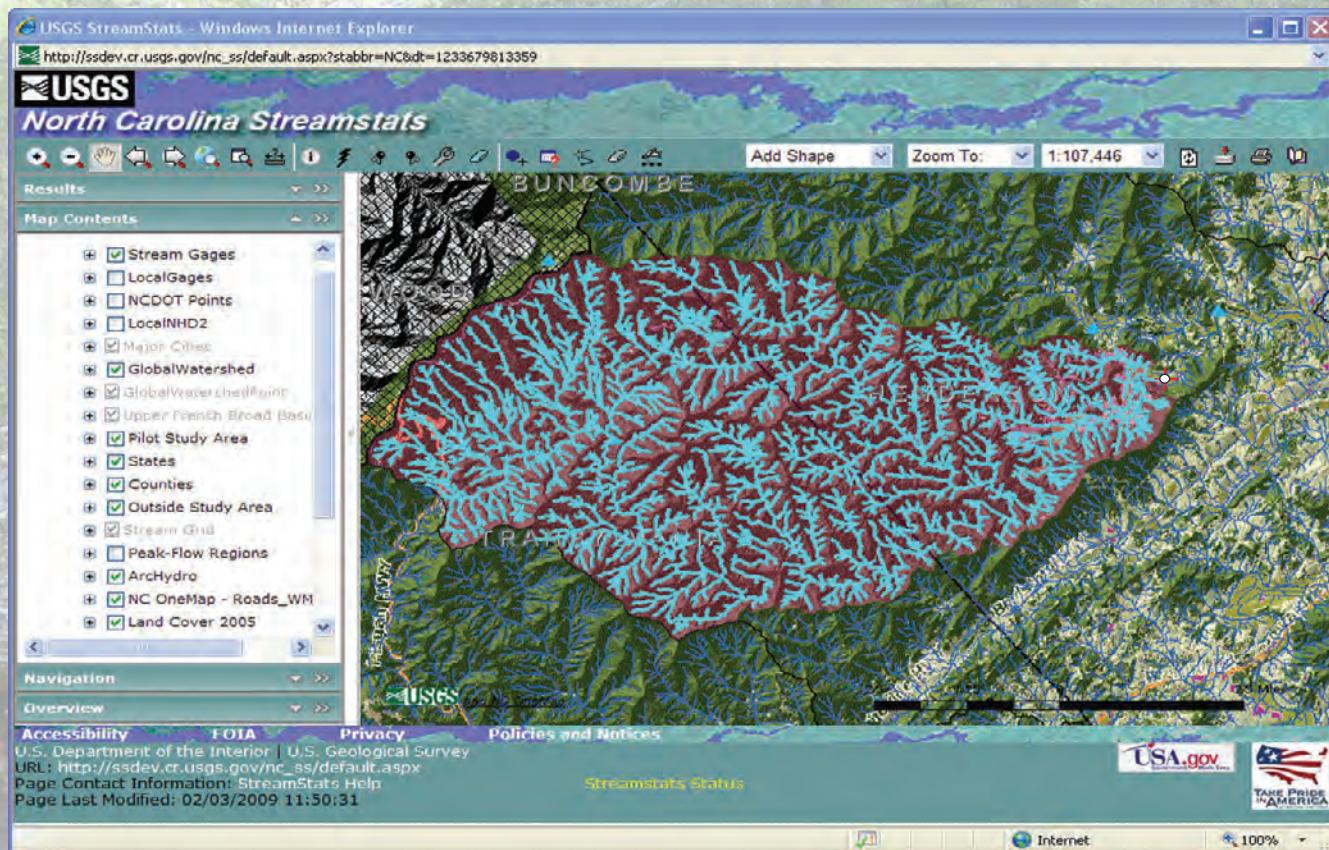


Figure 5. Example results of an upstream network navigation from a user-defined point in StreamStats where the selected point is shown by a white circle with a red cross behind it, the drainage area is shaded magenta, and the upstream network is light blue.

StreamStats Availability and Future Direction in North Carolina

The North Carolina pilot StreamStats application for the upper French Broad River basin can be accessed from the USGS North Carolina Water Science Center Web site at <http://nc.water.usgs.gov/>. Although 2006 ASTER land-cover and local-resolution NHD products are not available state-wide, StreamStats can be implemented for the remainder of the State by using LIDAR-based topographic data and the best-available land cover and hydrography, which currently (2009) are 2001 NLCD and 1:24,000-scale NHD, respectively.

References Cited

- Ries, K.G., III, Guthrie, J.G., Rea, A.H., Steeves, P.A., and Stewart, D.W., 2008, StreamStats: A water resources web application: U.S. Geological Survey Fact Sheet 2008-3067, 6 p.
- Weaver, J.C., Feaster, T.D., and Gotvald, A.J., 2009, Magnitude and frequency of rural floods in the southeastern United States, through 2006: Volume 2, North Carolina: U.S. Geological Survey Scientific Investigations Report 2009-5158, 111 p.

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