How StreamStats Works

StreamStats version 4 is a map-based web application that incorporates a Geographic Information System (GIS) to provide users with access to an assortment of analytical tools that are useful for water-resources planning and management, engineering and design purposes. Coding for the StreamStats application was done primarily by the Web Informatics and Mapping (WiM) team of the USGS Wisconsin Water Science Center, with support by ESRI, Inc.[1]. The user interface was built using the Leaflet (http://leafletjs.com/) open-source JavaScript library for mobile-friendly interactive maps. Individual StreamStats tools were implemented as web services, and are based partly on the ArcHydro Data Model and Tools, as implemented using ArcGIS Enterprise technology, and partly on Python scripts. StreamStats incorporates (1) a map-based user interface for the site selection; (2) a relational data base that contains information for data-collection stations and regression equations used to estimate flow statistics for ungaged sites; (3) a GIS program that allows locating sites of interest in the user interface, delineates drainage basins and measures basin characteristics; and (4) a database of geospatial datasets needed for the GIS program to work. Geospatial datasets include digital representations of the land surface (digital elevation models and derivative products), water features, historic climate data, soils information, and land-use information.

Implementation Strategy

Although StreamStats version 4 has a single, national user interface from which information for USGS data-collection stations can be obtained anywhere nationally, the functionality that allows for obtaining basin delineations, basin characteristics, and estimates of streamflow statistics for user-selected ungaged sites was implemented for each state individually. Implementation requires (1) the processing of numerous geospatial datasets, (2) assembling information for streamgages and importing it into a database, (3) importing regression equations needed to estimate streamflow statistics for ungaged sites into a database, (4) organizing and installing the geospatial datasets on a server, (5) coding to specify how each state will function and the datasets that it will use, and (6) evaluation to assure that StreamStats is producing accurate information. The needed work is coordinated among a national team, which sets up the applications and maintains it after implementation, and scientists in the USGS Water Science Centers (WSC), who primarily prepare the needed data and evaluate the application before it is released to the public. The work done by WSC scientists generally is accomplished through cooperative agreements with other federal, state, or local agencies, in which those agencies pay for at least half of the cost of the work. As a result, some states have not been implemented in StreamStats because the local WSCs have been unable to obtain cooperative funding agreements with other agencies to accomplish the needed work.

Functionality

StreamStats includes tools for (1) selecting one of several base maps and changing the map scale and center of the map (zoom in or out and pan) by various methods to select locations where information is desired, (2) getting information for USGS data-collection stations, (3) getting information for user-selected ungaged sites on streams, including drainage-basin delineations, basin characteristics, and estimates of streamflow statistics, and (4) obtaining geographic information, such as measuring distances and obtaining land-surface elevation profiles. The StreamStats users' manual provides complete descriptions of the available tools and how to use them.

Streamgages

USGS streamgage locations are identified on the map by triangles in different colors, as defined in the map legend, depending on the types of data collected there. Clicking on a streamgage location will cause a pop-up text box to appear with information about the streamgage and links to additional information. Users can obtain descriptive information about the stations, such as station name and number, type of data collected, and period of record, as well as previously published basin characteristics and streamflow statistics, along with citations to the reports from which the information was taken. The information is provided in tabular format on a pop-up web page, which can be printed or saved in machine-readable format. The cited reports provide descriptions of how the basin characteristics and streamflow statistics were computed. A link is also provided to the NWIS-Webpage for the station, which provides access to all USGS data that were collected at the station.

User-Selected Sites

StreamStats can delineate the drainage basins for user-selected sites on streams. The map must be at zoom level 15 or greater before a gridded representation of the stream network will appear and users can select locations of interest. After a delineation has completed, users are given options to clear, edit, or download the basin boundary, or to continue on to compute a variety of physical and climatic characteristics for the basin or obtain estimates of streamflow statistics for the selected site. StreamStats provides prompts and other feedback as users progress through this process.

StreamStats determines drainage-basin boundaries by use of digital elevation data obtained from digital elevation data from the USGS 3D Elevation Program (3DEP). In most cases, the elevation data have been specially processed so that the elevation data conforms to the digital stream channels depicted in the high-resolution version of the National Hydrography Dataset (NHD) and to the drainage-basin boundaries of the Watershed Boundary Dataset WBD. This processing results in drainage-basin boundary delineations that generally are superior to delineations that can be obtained directly from the 3DEP. Still, users should be aware that use of any digital elevation data to delineate drainage boundaries can lead to errors; especially in flat areas. Users should check delineations carefully and use the *Edit Basin* tool to correct any errors, if necessary.

After the user indicates that the boundary is correct, StreamStats can compute basin characteristics (such as drainage area, stream slope, and mean annual precipitation) and estimate streamflow statistics (such as the 1-percent flood, the mean flow, and the 7-day, 10-year low flow) for the site. The basin characteristics and streamflow statistics that are available vary widely among states and individual sites. Unless otherwise noted on a state's *State/Regional Info* page, estimates obtained for ungaged sites assume natural flow conditions at the site.

StreamStats provides estimates of various streamflow statistics for user-selected sites by solving equations that were developed through a process known as regionalization. This process involves use of regression analysis to relate streamflow statistics computed for a group of selected streamgages within or near a region of study (usually a state) to basin characteristics measured for the stations. Once the equations have been published, users can enter basin characteristics measured for ungaged sites into the equations to obtain estimates of the streamflow statistics. Equations generally were developed by the USGS separately for each state through cost-sharing agreements with other Federal, state, or local

agencies. As a result, the equations that are available for a given state vary based on which statistics the other agencies need for regulatory, planning, or other purposes.

The USGS National Streamflow Statistics Program (NSS) is a desktop program that contains all of the USGS-developed regression equations for estimating flood-frequency statistics in the Nation, plus equations for estimating other streamflow statistics in many states. NSS relies on manual entry of the basin characteristics used as explanatory variables in the equations and then solves the equations to estimate the statistics. The NSS program has been linked through a background process to StreamStats in which StreamStats provides the needed basin characteristics to NSS for an ungaged site and then NSS estimates the streamflow statistics, sends them back to StreamStats, and then StreamStats presents the statistics and the basin characteristics to the user. All of the equations in NSS, and limitations for their use, are documented in reports that can be accessed through links to each individual state from the NSS Web site. The StreamStats application also provides these links on the *State/Regional Info* tab that can be accessed after selecting a state and clicking on the About button in the black banner above the map in the StreamStats user interface.

A previous version of StreamStats (version 2) included an additional method for estimating streamflow statistics for user-selected sites on streams where there was an upstream or downstream streamgage with a drainage area that was within 0.5 and 1.5 times the drainage area for selected site. In these cases, the flow per unit area of the statistics for the streamgage would be multiplied by the drainage area for the selected site to estimate the statistics for the selected site. This method is documented on page 9 of a report by Ries (2006). The tool that implements this method of estimation was not available at the time of the release of StreamStats version 4, but efforts are underway to restore it.

Exploration Tools

The Exploration Tools button with the toolbox cartoon image is near the top left of the map. Clicking on the button reveals additional buttons for querying information for streamgages, measuring distances between two or more points on the map, and showing your current location on the map (primarily for mobile users). Several additional tools are in development that will rely on searching along the stream network upstream or downstream from user-selected sites to identify stream reaches and water-related activities along the streams, such as dams and point discharges, and obtain information about those activities.

Outputs

Outputs for streamgages and ungaged sites are provided in pop-up pages within the user interface. At the top of outputs for ungaged sites are text boxes in which users can enter a report title and comments, if desired, and a map of the delineated basin. Below that are tables of basin characteristics and estimated flow statistics for the selected site. Outputs for streamgages include a table of descriptive information, followed by tables of available basin characteristics and streamflow statistics. Each type of output provides short names of the basin characteristics and streamflow statistics. Definitions are provided on the Basin Characteristics Definitions and Streamflow Statistics Definitions pages. The StreamStats users' manual provides complete descriptions of the outputs, which can be printed or saved in machine-readable (.csv) format. In addition, the delineated boundaries for ungaged sites can be downloaded and saved in a variety of formats with computed basin characteristics and streamflow statistics included as attributes.

Our Team

The StreamStats application is managed by the USGS [Water Mission Area](). It is funded nationally by the USGS Groundwater and Streamflow Information Program and by contributions from USGS Water Science Centers for maintenance of the computer infrastructure needed to operate the application. Development team members include: John Guthrie (programmer, site administrator), Tana Haluska (GIS expert), Katharine Kolb (GIS expert), [Pete McCarthy]() (hydrologist, team leader), Jeremy Newson (programmer), Richard Santoro (site administrator), Martyn Smith (programmer), Peter Steeves (GIS expert), Ryan Thompson (GIS expert, hydrologist), and Hans Vraga (information technology specialist).

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[1]The use of trade or product names is for identification purposes only and does not constitute endorsement by the U.S. Geological Survey.