Methods for Estimating Streamflow Statistics for Ungaged Streams in Maine

Figure 1. Flood on the Kennebec River at Augusta, Maine, April 1987.

Introduction

Streamflow statistics such as flood peak flows, monthly means and medians, and 7-day 10-year low flows (7Q10) are used for a variety of purposes, including the design of bridges, culverts, and flood-control structures; the management and regulation of flood plains and reservoirs; and the allocation of limited water resources during seasonal low flows and droughts.

Although a number of rivers in Maine have long-term continuous gaging stations with up to 100 years of streamflow record, it often is necessary for hydrologists and water-resource managers to estimate flows on ungaged rivers, at ungaged locations on gaged rivers, or on gaged rivers with insufficient periods of record. To provide simple methods to estimate flow statistics at ungaged sites in Maine, the U.S. Geological Survey (USGS), in cooperation with State, local, and other Federal agencies, has developed methods that can be used by hydrologists, engineers, and managers to estimate characteristic flows based on measured hydrologic and climatic basin characteristics such as drainage area, wetland area, precipitation, elevation, and surficial geology.

Peak Streamflows

Regression equations to estimate peak flows with 2- to 500-year recurrence intervals in basins with drainage areas from 1 to 1,650 square miles are presented in U.S. Geological Survey Water-Resources Investigations Report 99-4008 (Hodgkins, 1999). Guidelines provided in this report assist water-resource managers in choosing the most appropriate equation to apply. Guideline criteria include evaluating the amount of development in the basin, the degree of regulation at the site of interest, the proximity of the site of interest to a gaging station,

Table 1. Methods for estimating streamflow statistics for ungaged basins by basin size.

Streamflow statistic	Basin size		
	0 to 1 square miles	1 to 10 square miles	10-1,500 square miles
Peak flow	Under development	Hodgkins (1999)	Hodgkins (1999)
Annual mean/median	Not available	Not available	Dudley (2004)
Monthly mean/median	Not available	Not available	Dudley (2004)
August median—Aroostook County	Lombard and others (2003)	Lombard and others (2003)	Dudley (2004)
August median—Downeast	Under development	Under development	Dudley (2004)
7Q10—Statewide	Not available	Not available	Dudley (2004)
Flow duration	Not available	Not available	Not available

and the degree of accuracy compared to the ease of application. Statewide equations are derived to calculate the 2-, 5-, 10-, 50-, 100- and 500-year recurrence interval peak flows based on the drainage area of the basin and the percentage of wetlands in the basin. A simplified technique using only drainage area is quicker and easier to apply, but results in estimates of peak flows that are less accurate.

Estimating peak flows for small basins (less than 1 square mile) often is done with models such as the Rational method and the National Resources Conservation Service TR-20 model. A crest-stage gaging network currently is in operation on 15 small basins throughout Maine, which will allow the accuracy of the models to be evaluated.

Mid-Range Streamflows

The USGS recently developed improved statewide regression equations to estimate annual and monthly mean and median streamflows at ungaged streams with drainage areas from 10 to 1,420 square miles (Dudley, 2004). The new equations supersede those derived by the USGS 25 years ago (Parker, 1978). The new equations took advantage of 25 years of additional flow data and basin characteristics calculated with a Geographic Information System (GIS).

The statewide regression equations estimate annual and monthly mean and median flows using drainage basin characteristics including drainage area, surficial geology, precipitation, and distance from the coast.

Low Streamflows

A method to estimate the August median flow for ungaged basins in eastern Aroostook County is described in U.S. Geological Survey Water-Resources Investigations Report 03-4225 (Lombard and others, 2003). New generalized least-squares regression equations are applicable to small drainage basins from 1 to 40 square miles. Basin characteristics, including drainage area and mean elevation, are used to estimate August median flow. A similar study for small drainage basins in Washington and Hancock Counties currently is underway.

New regression equations to estimate the 7Q10 low-flow statistic and summer monthly means and medians on drainage basins >10 mi^2. also have recently been developed (Dudley, 2004).

Figure 2. 100-year drought at Piscataquis River at Dover-Foxcroft, Maine, August 2001.

Future Directions

In U.S. Geological Survey Water-Resources Investigations Report 99-4008 (1999), Hodgkins indicated that very steep watersheds may behave differently than other watersheds with regards to peak flows. Work to investigate peak flows on steep watersheds has been proposed.

References

Dudley, R.W., 2004, Estimating monthly, annual, and low 7-day, 10-year streamflows for ungaged rivers in Maine: U.S. Geological Survey Scientific Investigations Report 2004-5026, 22 p.

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