Evaluation of Design Flood Frequency Methods for Iowa Streams

Technical Brief

IIHR-Hydroscience
& Engineering
The University of Iowa
107 C. Maxwell Stanley
Hydraulics Laboratory
Iowa City, IA 52246
www.iihr.uiowa.edu

TECHNICAL BRIEF

JUNE 2008

PROJECT TITLE

TR-533

Evaluation of Design Flood Frequency Methods for Iowa Streams

SPONSOR

Iowa Highway Research Board

Iowa Department of Transportation

Research and Technology Bureau

800 Lincoln Way

Ames, IA 50010

PRINCIPAL INVESTIGATOR

Allen Bradley

Associate Professor

IIHR-Hydroscience & Engineering

Department of Civil and Environmental Engineering

University of Iowa

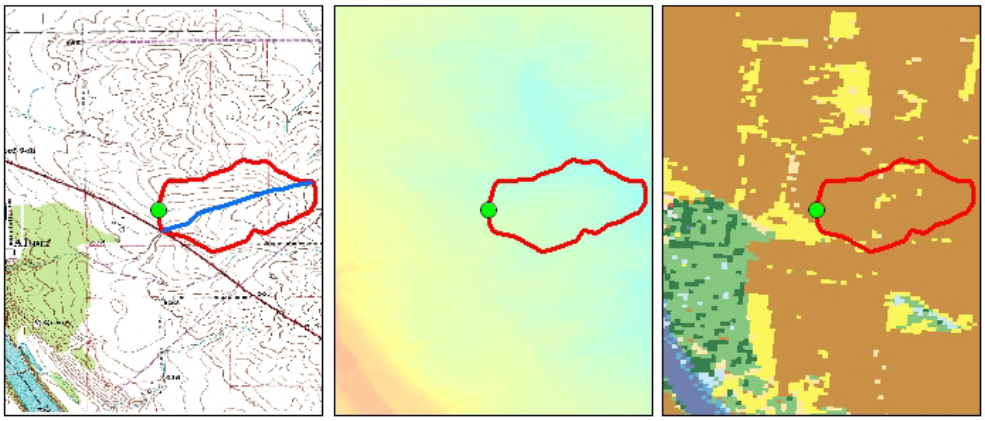
Iowa City, IA

allen-bradley@uiowa.edu

Summary & Objectives

The objective of this project is to assess the predictive accuracy of flood frequency estimation for the Rational Method, the NRCS curve number approach, and the Iowa Runoff Chart, for applications to small Iowa streams (drainage areas of 200 acres or less).

The evaluation is based on comparisons of flood frequency estimates at sites with sufficiently long streamgage records in the Midwest, and selected urban sites throughout the United States. The sensitivity of estimates to several watershed characteristics, such as soil properties, slope, and land use classification, is also explored.



Watershed characteristics used in design flood frequency methods are assembled from geographic data sources

Problem Statement

Estimates of flood frequencies — like the 25-year return period peak discharge — are needed for many engineering design problems. For applications requiring flood hydrographs, or for very small drainages, flood frequency estimates are usually based on design approaches that transform rainfall frequency estimates — the 25-year return period design storm — into flood frequencies. The most common approaches — the Rational Method and the NRCS (or SCS) method — are used in roughly the same manner throughout the United States, in part because they are well-documented and accepted methods. However, a serious drawback with the use of standardized design approaches is that their predictive ability has not been verified for Iowa streams.

Continued on next page

Technical Methods

The evaluation of design flood methods for small streams (200 acres or less) is based on their comparison with the flood frequency estimates for gaged streams. The comparison is made for:

- Sites in the Midwest (46), which represent mostly pre-development agricultural (rural) land uses
- Urban sites throughout the US (21), which represent post-development (urban and suburban) land uses

An empirical assessment for a sample of streamgage sites quantifies the systematic biases (Figure 1 and 2) and predictive accuracy (Figure 3) of the design flood frequency approaches.

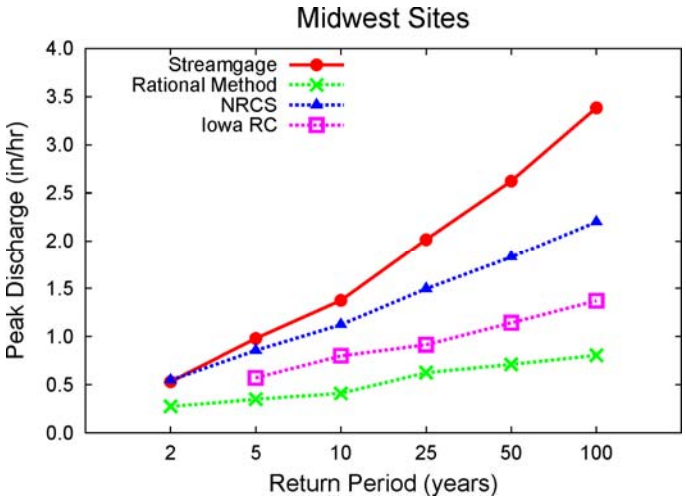


Figure 1: Average flood frequencies for 46 Midwest sites

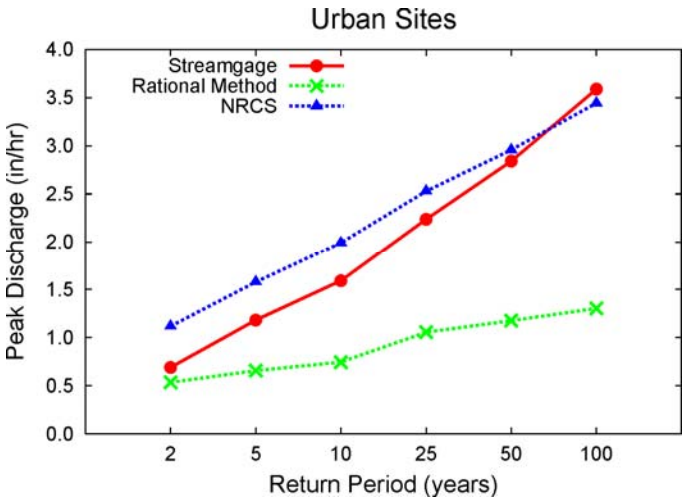


Figure 2: Average flood frequencies for 21 Urban sites

Key Findings

Bias: The Rational Method tends to underestimate flood magnitudes for rural (Midwest) and developed (Urban) sites (see Figures 1-3). The NRCS method is much less biased for rural sites, and slightly overestimates for developed sites.

Accuracy: Errors on the order of 50 to 100% are not uncommon with design methods (see Figure 3).

Sensitivity: The Rational Method and NRCS curve number estimates depend on the runoff potential, as indicated by the hydrologic soil group; however, estimates based on streamgage data are not as sensitive to the soil group determination as these methods would imply.

Usage: The different biases for rural and urban sites have implications for engineering design (see Notes below).

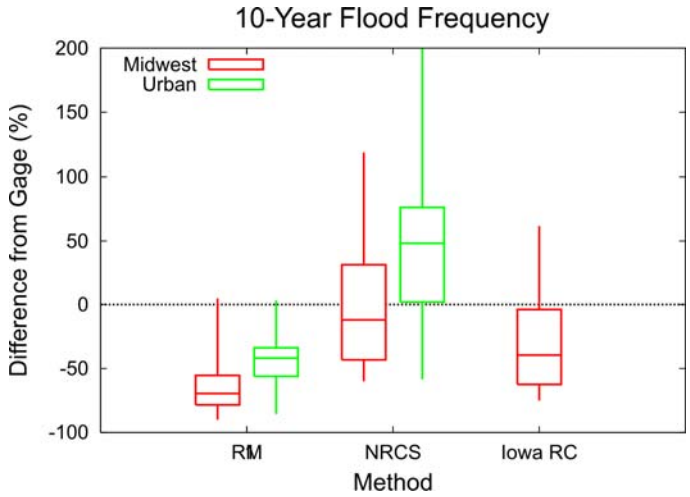


Figure 3: Range of errors (in %) for the 10-year flood frequency estimate

Implementation Notes

Some implications of the key findings:

- For best accuracy, used the NRCS method for small urban streams (if you have a choice).
- Even if methods underestimate flood magnitudes, *relative increases* in magnitudes from pre-development to post-development conditions would tend to be conservative.

IIHR-Hydroscience & Engineering
The University of Iowa
107 C. Maxwell Stanley Hydraulics Laboratory
Iowa City, IA 52242-1585

E-mail:
iihr@uiowa.edu