OREGON'S WATER RESOURCES RESEARCH INSTITUTE

WATER NOTE

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Water Resources Research Institute
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PREDICTING PEAK DISCHARGES ON SMALL WATERSHEDS FOR CULVERT DESIGN

PROBLEM AND SCOPE OF RESEARCH

Flood frequency estimates are often required for small watersheds where no streamflow records exist. This is particularly important for designing road culverts. For example, Oregon's Forest Practices Act states that culvert installations must be designed to accommodate floods having a return period of 25 years. Overdesign may result in needless expense; underdesign may result in road failure and adverse downstream impacts.

Empirical formulae and simplified rainfall runoff models are available to predict floods from small watersheds but require considerable judgement to give reasonable results. As an alternative, this study presents equations to predict peak flows on small watersheds in Oregon. The equations were developed from 80 watersheds ranging in size from 0.21 to 10.60 square miles. Oregon was divided into six physiographic regions, based on previous flood frequency studies. In each region, annual peak flows were analyzed for gaging stations with more than 20 years of record. Four flood frequency distributions were used: Gumbel, two-parameter log-normal, three-parameter log-normal, and log Pearson type III.

RESEARCH FINDINGS

The log Pearson type III distribution was found to be suitable for use in all regions of the state, based on the chi-square goodness of fit test. Flood magnitudes having recurrence intervals of 10, 25, 50, and 100 years were related

to physical and climatic indices of drainage basins by multiple regression analysis. Drainage basin area (A) was the most important variable in explaining the variation of flood peak (Q_t) in all regions. Mean basin elevation (E) and mean annual precipitation (P) were also significantly related to flood peaks in two regions in western Oregon.

The following equations to predict the 25-year flood were developed for each physiographic region in Oregon:

(1) Willamette $Q_{25} = 156\ A^{0.80}$

(2) Coast $Q_{25} = 6.31\ A^{1.01}E^{0.51}$

(3) Cascade $Q_{25} = 0.032\ A^{0.44}P^{1.97}$

(4) Rogue-Umpqua $Q_{25} = 163\ A^{0.77}$

(5) Blue-Wallowa $Q_{25} = 67.6\ A^{0.47}$

(6) Klamath $Q_{25} = 41.9\ A^{0.79}$

Average percent error for these equations ranged from 16.1 to 64.1 percent, the smaller errors being associated with the more humid regions. Confidence limits for the equations provide estimates of prediction uncertainties over the range of design flows. These equations will lead to better culvert design on small forested watersheds.

PROJECT DATA

Investigation Period: October 1, 1979 - September 30, 1981

Sponsors of Investigation

U.S. Department of Interior, Office of Water Research and Technology
Water Resources Research Institute, Oregon State University

Researchers

Co-Principal Investigators: Professors Roy C. Sidle and Henry A. Froehlich, OSU Forest Engineering Department
Graduate Student: Alan J. Campbell (Forest Engineering)

REPORT AVAILABLE FROM WRRI

WRRI-74. Prediction of Peak Flows for Culvert Design on Small Watersheds in Oregon. 1982. 96+ pp. Cost $2.50.

Order requests should identify specific report desired and be accompanied by prepayment check, payable to Water Resources Research Institute. Price listed includes mailing (4th class) and handling charges.

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