Kansas
Department of Transportation

TECHNICAL SUMMARY

Estimation of Watershed Lag Times and Times of Concentration for the Kansas City Area

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Introduction

Lag time (T_L) and time of concentration (T_C) are two related measures of how quickly a stream responds to runoff-producing rainfall over its watershed. In this report, a general relationship for lag time is derived from the Manning equation for frictional resistance, the rational formula for bankfull discharge, and a generalized rainfall intensity-duration relationship. This relationship accounts for the length, average slope, and average Manning n value for the longest flow path and three watershed characteristics: average width, a rational runoff coefficient, and a reference rainfall intensity. A simpler form of this relationship is derived for regional calibration. The regional form of the lag-time equation accounts for the impacts of urbanization through two inputs: the fraction of the longest flow path that is paved or enclosed, and the fraction of the drainage area covered by impervious surfaces. The relationships indicate that lag time is strongly related to the length, slope, and roughness of the main channel and less strongly related to other watershed characteristics that affect the bankfull discharge in the channel.

Project Description

The regional lag-time equation was calibrated for the Kansas City area with observed lag times and channel and watershed characteristics for 30 gage sites in the Automated Local Evaluation in Real Time (ALERT) flash-flood warning system. Average lag times for the gaged watersheds were determined from archived rainfall and water-level records for significant runoff events.

Project Results

The new lag-time equation for the Kansas City area performs better than the 2001 KU-KDOT equation for urban lag time, which was developed from a study of 14 gaged watersheds in Johnson County (McEnroe & Zhao, 2001). The main advantage of the new lag-time equation is that it accounts directly for the higher velocities in the paved and enclosed segments of the flow path. The new equation's solid theoretical foundation is also an advantage.

Because time of concentration cannot be determined from gaging data, direct calibration of an equation for T_C is not possible. However, time of concentration and lag time are closely related, so T_C can be estimated from T_L. The Natural Resources Conservation System (NRCS, 2010) recommends the approximation $T_C = 5/3\ T_L$. The recommended time-of-concentration equation for the Kansas City area incorporates this approximation.

Project Information

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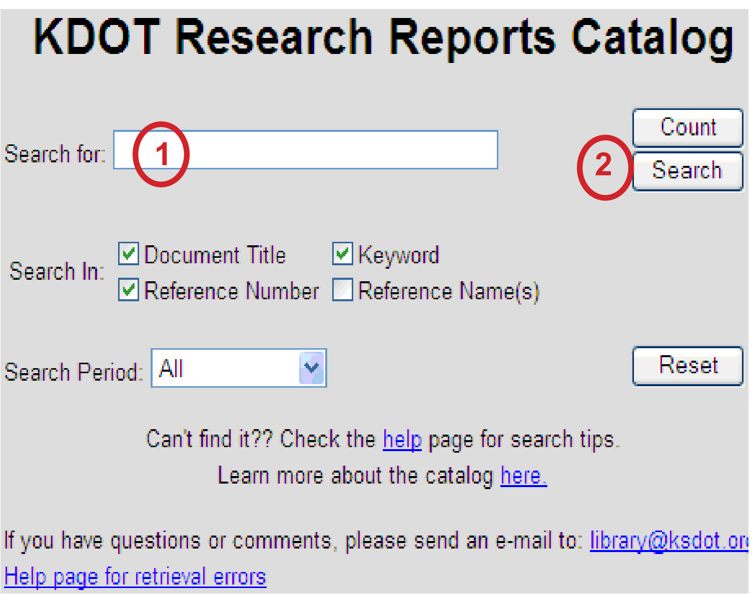

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