Overbank Flow Estimation using ANFIS and Genetic Programming

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Abstract

The estimation of discharge capacity in river channels is complicated once the river is flowing out-of-bank due to complex 3D turbulent structure and interactions at the interface region between main channel and flood plain. These interactions can significantly reduce the discharge capacity of the river or channel. When flooding, traditional flow equations and methods in estimating the discharges are found to be not very accurate and may lead to over or under estimation of discharge capacity. Therefore, this study is carried out to estimate the discharge for overbank flow in compound channels and natural rivers using traditional methods, empirical method and soft computing tools. It is found that Genetic Programming (GP) is the most accurate among all the methods being tested with a smallest average error of 5.76%, 5.29% and 1.02% in overbank flow estimation for River Senggi, River Senggai and River Main, respectively.

Keywords: *ANFI; Discharge estimation; Flood; Genetic Programming; Overbank flow*

1. Introduction

In analyzing flow through river channels, one of the most common tasks of a river engineer is to make estimates of discharge based on an estimated, recorded or simulated water level. This is very important not only to ensure sufficient water supply and waste disposal etc. during low flow, but also for practical purposes such as flood forecasting and flood mitigation during overbank flow or extreme water level.

For inbank flow the theoretical determination of the stage-discharge relationship at a given cross-section of a river is a straightforward issue. It is sufficient, in general, to use the overall hydraulic radius as the parameter, which characterizes the properties of the cross section. It is then possible to calculate the discharge through the channel from one of a range of well-known uniform flow formulas (such as Chezy, manning or Darcy-Weisbach) in terms of the channel roughness, slope and depth.

However, once the river is in flood, and flowing out-of-bank, it becomes much more difficult due to the complex 3D turbulent structure and momentum transfer at the interface region between main channel and flood plain (Figs 1 and 2). These interactions, i.e. momentum transfer and apparent shear can significantly reduce the discharge capacity of a river.

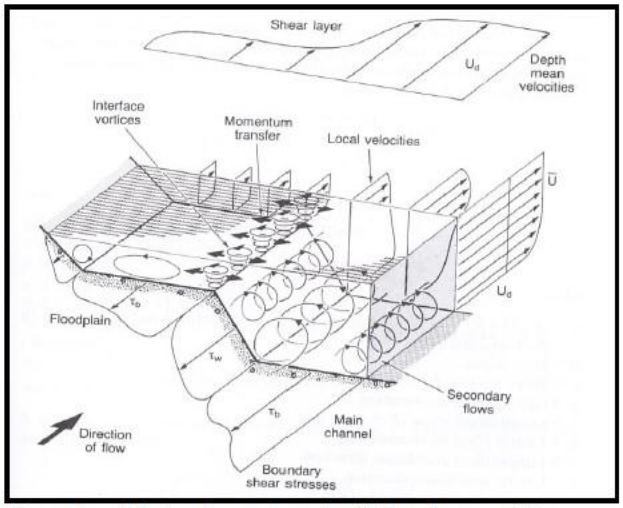

Figure 1: Mechanisms of overbank flow in a straight compound channel [1]

Figure 2: Momentum transfer characterized by series of vortices at the interface region of main channel and flood plain [2].