9th International Congress on Civil Engineering, May 8-10, 2012
Isfahan University of Technology (IUT), Isfahan, Iran

ESTIMATING STABLE WIDTH OF ALLUVIAL RIVERS USING ANFIS MODEL

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Abstract

An intelligent method based on adaptive neuro-fuzzy inference system (ANFIS) for identifying stable width of alluvial channels is presented. Many equations are available in the literature to predict stable width of alluvial channel. However, none of them is widely accepted at present, due to the fact that most of them are limited to hypothesis, aimed to simplify the high quantity of involved variables, and a lack of knowledge of some physical process associated with channel formation and maintenance. In this paper, an ANFIS model was established to predict the regime width of gravel bed channels, with the bankfull discharge, mean bed particle size, bed load sediment per unit width and channel slope as four input parameters. A regression equation is also applied to the data. Statistical measures were used to evaluate the performance of the models. Based on comparison of the results, it is found that the ANFIS model gives better estimates than that of the empirical equations.

Keywords: ANFIS model, regime width, gravel bed channel, channel design, stable width.

1. INTRODUCTION

Estimation of regime or stable width of alluvial channels is a debatable topic with significant implications in design practices of irrigation canals, river improvement works and other fluvial hydraulics applications [1]. A stable channel is that in which there is no significant change of their geometric (width, depth, channel slope and cross sectional area) and flow (velocity and discharge) variables through a long period of time [1]. As a matter of fact, natural channels are constantly exhibiting aggradation and degradation processes for the concept of stability is applied in time scales of relatively high, from 1 to 10 years [2]. Regime represents a long-term average of river form rather than an instantaneously variable state. That means stable or "in regime" channels do not change over a period of one or several water years [1], it then expresses the natural tendency of channels carrying sediment within alluvial boundaries to seek a dynamic equilibrium [3, 4]. Regime theory defines a regime channel as a nonsilting, nonscouring equilibrium channel carrying its normal suspended load [3]. Alluvial rivers continuously change their hydraulic geometry to seek a balance between incoming and outgoing water and sediment discharges [5]. The following definition of stream channel stability was presented by Rosgen [6]: "is the ability of a stream, over time, in the present climate, to transport the sediment and flows produced by its watershed in such a manner that the stream maintains its dimension, pattern and profile without either aggrading or degrading". Generally, an alluvial channel is in a condition of stability, dynamic, equilibrium or regime, when the sediment transport capability of the flow is balanced with the supply rate of solid material to the reach under consideration [1].

The dimension of width of gravel bed channels is self-formed by the interaction of water discharge and sediment supply. Therefore, stable width is self-formed when bed material is transported without changes in channel cross sectional geometry and bed slope [1]. For determination of regime of channel, consider a channel of a given initial geometry such as trapezoidal that excavated in alluvial non-cohesive soil and water flows at or about bankfull stage [1], after some time that this operation continues in the channel, the boundary material show characteristics comparable to the sediment transported by the river from which the water is