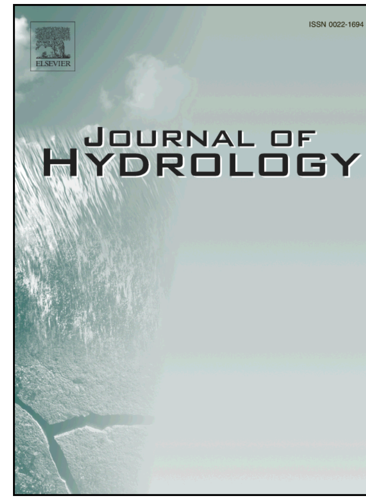

Research papers

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On the theoretical velocity distribution and flow resistance in natural channels

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Abstract

The velocity distribution in natural channels is of considerable interest for streamflow measurements to obtain information on discharge and flow resistance. This study focuses on the comparison of theoretical velocity distributions based on 1) entropy theory, and 2) the two-parameter power law. The analysis identifies the correlation between the parameters of the distributions and defines their dependence on the geometric and hydraulic characteristics of the channel. Specifically, we investigate how the parameters are related to the flow resistance in terms of Manning roughness, shear velocity and energy slope, and several formulae showing their relationships are proposed. Velocity measurements carried out in the past 20 years at Ponte Nuovo gauged section along the Tiber River, central Italy, are the basis for the analysis.

Key words: streamflow measurements, maximum velocity, entropy, velocity distribution, power law, roughness

1. Introduction

The Global Climate Observing System (GCOS) program (http://www.wmo.int/pages/prog/gcos/) identifies river discharge as one of the fifty Essential Climate Variables (ECV) technically and economically feasible for systematic observations. Indeed, all processes involved in the hydrological cycle cannot be correctly quantified if accurate discharge data are not provided at a river site of interest. This has a considerable implication for the analysis of hydrological processes, for which the assessment of rainfall-runoff transformation is of paramount importance. In this context, the calibration of hydrological and hydraulic modeling may fail if the measured value of discharge has high uncertainty.

It's well known that the discharge is not a direct measure and is evaluated by joining the measurements of two variables, i.e. the water level and flow velocity (Herschy, 1989). The water-level monitoring is straightforward and relatively inexpensive compared with the cost necessary to carry out flow-velocity measurements. Overall, velocity monitoring is addressed by using conventional techniques based on contact sensors like the current meter. Therefore, the matter is not