A Critical Introspection into the Kinematic Wave Theory

Muthiah Perumal

Indian Institute of Technology Roorkee, Indian Institute of Technology Roorkee, Hydrology, India (p_erumal@yahoo.com)

This study focuses on the logicalities behind the well-known Kinematic Wave (KW) theory initially introduced by Lighthill and Whitham in 1955 and the same has been used for studying various hydrological problems, especially related to flood wave movement in mountainous and steep river reaches, and overland flow movement on land surface. However, a critical introspection of the KW theory based on one-to-one stage (flow depth)- discharge relationship implies that the longitudinal water surface gradient of the kinematic wave remains parallel to the bed surface at any instant of time, which implies that the dynamics of unsteady flow movement is characterized by the water surface remaining parallel to the bed surface. This is a practically an impossible proposition and this logically incorrect reasoning behind the KW theory resulted in the misinterpretations of the well-known Muskingum method theory, originally proposed by McCarthy in 1938 as a conceptual flood routing model using the prism and wedge storages concept. Also the theory behind the success of the Jones formula for converting stage hydrograph into discharge hydrograph characterized by a small water surface gradient was considered as logically incorrect approach by F.M.Henderson in his well-known text book on open channel flow published in 1966. The search for the correct theory behind the nearly non-attenuating flood wave movement as theorized by the KW theory as well as that of small diffusion flood wave movement in channels can be obtained based on the approximate or small water surface gradient diffusive wave equation. Its use can validate the success of the McCarthy's storage based Muskingum method and the logical appropriateness of the Jones formula. The study discusses all these details.