Most effort in gaining knowledge of hydrologic systems is devoted to incorporation of new technological tools in the acquisition of data that supports statistical and deterministic analyses and to the development of computer algorithms for high performance computers that facilitate faster computational speed and higher resolution of a system being studied. However, if progress is to be made in addressing the ever-more-complex environmental problems that we face, theory, as well as experimental and computational efforts, must also advance. Here, we expose two commonly accepted and employed theoretical models that are ingrained in hydrological studies despite the fact that they can be shown to be woefully inadequate as foundations of serious fundamental advances. The first myth is that in the modeling of two-fluid-phase flow in a porous medium, the capillary pressure is a hysteretic function of saturation. The second is that minimum stream power theory can be employed to predict Manning’s $n$ for a sedimentary stream. We will identify the failures of these myths and point out potential paths to useful alternative formulations. Significant effort remains for the next generation of theoretical models to be effectively employed. This fact, in itself, is an obstacle to theoretical advances.

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