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Chaos theory for hydrological modelling: a middle-ground between deterministic and stochastic views

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Abstract There have been two approaches prevalent in hydrological modelling: deterministic and stochastic. The use of deterministic approach may be supported on the basis of the "permanent" nature of the Earth, ocean, and the atmosphere and the "cyclical" nature of mechanisms. The stochastic approach may be favoured because of the "highly irregular and complex nature" of hydrological processes and our "limited ability to observe" the details. With these contrasts, the question of whether hydrological processes are better modelled using a deterministic approach or a stochastic approach is meaningless. Indeed, for most hydrological processes, both the deterministic approach and the stochastic approach are complementary to each other, and thus use of an approach that couples these two could be the most appropriate. This paper argues that "chaos theory" can offer such a coupled deterministic–stochastic approach. Support to this argument is provided through study of the dynamic nature of river flow time series.

Key words hydrological modelling; determinism; stochasticity; chaos; linear; nonlinear; autocorrelation function; phase space; correlation dimension