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Simple models for streamflow time series

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The last few decades witnessed the development of numerous stochastic models (most of them linear) for streamflow time series. These models assume, as the name indicates, that streamflow dynamics are essentially stochastic in nature, and they also often adopt separation of the deterministic components (e.g. trend, seasonality, annual cycle) from streamflow series to suit this stochastic assumption. Although noticeable progress has been made in the applications of these linear stochastic models, their practical utility is certainly debatable since nonlinearity and determinism are inherent in streamflow dynamics. Recent advances in computational power and data collection have facilitated the development of a host of nonlinear models to better identify the salient properties of streamflow. One important outcome of research in this direction is the growing evidence as to the nonlinear deterministic (and possibly chaotic) nature of streamflow dynamics. It is reasonable, therefore, to view streamflow series consisting of strong nonlinear deterministic components (e.g. order) with some weak stochastic components (e.g. noise). With this view, an attempt is made in this study to formulate simple, and largely deterministic-based, models for streamflow series. The procedure involves three steps. First, different levels of noise are added to time series generated from simple deterministic equations (chosen appropriately to represent the trend, seasonality, and annual cycle of streamflow series). Next, the salient properties of the noise-added time series are investigated using a host of linear and nonlinear tools. Finally, these properties are compared with those of the real streamflow series to identify the model (equation + noise) that is most appropriate. Many different deterministic equations and noise levels are considered, and the results are compared with many different streamflow series.