POSSIBILITY OF CHAOS IN RAINFALL-RUNOFF PROCESS

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Understanding the dynamics of rainfall-runoff process constitutes one of the most important problems in hydrology. During the past few decades, a wide variety of approaches, e.g. conceptual, has been developed to model the rainfall-runoff process. However, an important limitation of such approaches is that treatment of the rainfall-runoff process as a realization of, e.g., a stochastic process means that only some statistical features of the parameters are involved. What is required, therefore, is an approach that seeks to understand the complete dynamics of the process, capturing not only the overall appearance but also the intricate details. The present study introduces a new approach based on the notion of deterministic chaos to investigate the behavior of the dynamics of the rainfall-runoff process. The possible existence of chaotic behavior in the rainfall-runoff process is studied by investigating the behaviors of the rainfall and runoff processes separately and jointly. The underlying assumption is that the individual behavior of the rainfall (input) and the runoff (output) processes should provide important information on the behavior of the dynamics of the joint rainfall-runoff process. Monthly rainfall and runoff observed over a period of 131 years (1807 – 1937) for the Gota River in south of Sweden are analyzed using the correlation dimension method. The dimension obtained for the rainfall time series is 6.4, and for the runoff time series is 5.5. The finite and low dimensions obtained for the rainfall and runoff time series indicate chaotic behavior in the rainfall and runoff processes. The time series are further analyzed jointly by investigating the runoff coefficient. Finally, a modeling approach preserving the chaotic properties of the rainfall-runoff process is outlined.