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Selection of the Robust Streamflow Forecasting Model Using Wavelet-Entropy Complexity Criterion

Vahid Nourani[1], Faranak Tootoonchi*[2], Sevil Ranjbar[3]

1- Professor, Faculty of Civil Engineering, University of Tabriz, Tabriz, Iran

2- M.Sc. Student, Faculty of Civil Engineering, University of Tabriz, Tabriz, Iran

*faranak.tootoonchi@gmail.com

Abstract

As one of the most important hydrological processes, Runoff modeling is highly dominant in accurate study of a watershed. Many models are yet being developed in order to define such a complex process, therefore using a measure to scope relative complexity of a watershed results in choosing more appropriate model related to its characteristics. In this study, the runoff process of five different watersheds, which are different in land use, population growth and complexity, are modeled. In order to consider relative complexities, Wavelet-Entropy measure is introduced as a new complexity measurement tool. It is deduced that only in areas with higher complexity levels, Complex modeling structures are needed (such as ANN and WANN) and in those with respective lower wavelet-entropy measure, auto-regressive models (such as ARIMA and ARIMAX) can be consumed efficiently, therefore using complex models are not necessary.

Keywords: Black box Modeling, Rainfall- Runoff Modeling, Wavelet Transform, Artificial Neural Network, Wavelet-Entropy Complexity Measure.

1. INTRODUCTION

Hydrological processes are profoundly affected by occurred changes in the characteristics of the watershed along the time. Hence in order to achieve a better insight into the process, it is important to detect such changes using a precise measure of fluctuations which are involved in the time series of the process. Change of the land cover/use could be created by human industrial activities and/or urbanization which ultimately lead to change in the natural pattern of the environment. In order to understand these changes, Runoff modeling is highly dominant in accurate study of a watershed as one of the most important hydrological processes and is primarily used in water resources management, flood mitigation and discharge prediction of a river. As a result of non-linear and stochastic characteristics of hydrological processes, discovering a simple yet precise algorithm for modeling which is based on the geomorphological characteristics of the studied area and its complexity, leads to time consumption and easier mathematical formulization. Complexity is generally used to characterize something with many parts where those parts interact with each other in multiple ways. As the level of disorderliness of the process is increased, its complexity is increased relatively and a more developed and complex model should be considered for forecasting. On the other hand if the process has a lower level of disorderliness, simple models could be consumed sufficiently.

In the past decades, several methods have been presented to measure the complexity of time series and signals in different fields of science and engineering. Shannon introduced information content (entropy) as a measure for examining the probability distributions and quantifying the degree of uncertainty [1]. Although only a few studies have been conducted in the field of watershed engineering, discussing the complexity changes [2], entropy based complexity measure has been widely used in biomedical engineering especially for analyzing EEG (electroencephalography) and ECG (electrocardiography) and as a common point of all these biomedical studies, it has been deduced that deeper sleep or anesthesia, diseasing and aging in human are leading to decrease in complexity of the related physiologic signals, [3]. Conjunction of entropy and wavelet concepts have been used to develop a new complexity measure of wavelet-entropy by Rosso et al. [4]. They