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Application of Wavelet Denoising and Artificial Intelligence Models for Stream Flow Forecasting

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ABSTRACT:

In this study, the ability of threshold based wavelet denoising Least Square Support Vector Machine (LSSVM) and Artificial Neural Network (ANN) models were evaluated for forecasting daily Multi-Station (MS) streamflow of the Snoqualmie watershed. For this aim, at first step, outflow of the watershed was forecasted via ad hoc LSSVM and ANN models just by one station individually. Therefore, MS-LSSVM and MS-ANN were employed to use entire information of all sub-basins synchronously. Finally, the streamflow of sub-basins were denoised via wavelet based thresholding method, then the purified signals were imposed into the LSSVM and ANN models in a MS framework. The results showed the superiority of ANN to the LSSVM, MS model to the individual sub-basin model, using denoised data with regard to the noisy data, e.g., DCLSSVM=0.82, DCANN=0.85, DCMS-ANN=0.91, DCdenoised-MS-ANN=0.94.

Key words: Stream flow; denoising; artificial neural network; least square support vector machine; multi-station; Snoqualmie watershed.

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1- Introduction

Astute stream flow forecasting ability will guide river managers and water authorities with better management decisions. In this way, there is a need for forecasts of stream flow events in order to: a concomitant reduction in water losses and deficits in irrigation orders, better targeting of environmental flows, basin wide consistency in management operations based on a thorough knowledge of variation in inflows, an improved capability for predicting and monitoring flood events. Due to the complexity of stream flow process in a river, the black box (lumped) modelling may have some avails over the modelling by the theoretical ruling (white box) equations, so Artificial Intelligence (AI) approaches as new generation of robust tools have been developed for stream flow time series forecasting [1,2]. Among such AI models, the Least Square Support Vector Machine (LSSVM) and Artificial Neural Network (ANN), former one as a persuasive forecasting tool and the latter as a novel neural network technique were employed for the simulation step of this paper [3, 4, and 5].

In spite of suitable flexibility of LSSVM and ANN in modelling hydrologic time series such as stream flow, sometimes, there is a shortage in appropriate forecasting results while data consist of noises. This happens because the efficiency of data-driven models is highly dependent on the available data in context of quantity and quality. Recent studies have shown that the noise limits the performance of many techniques used for identification and prediction of deterministic systems. Therefore, noise reduction is considered as a continuous mapping process of the noisy input data to a noise free output data. Focusing on hydrological processes that are nonlinear, the classic denoising filters may not behave effectively. But the threshold based wavelet denoising, which illuminates the localized characteristics of non-stationary time series both in temporal and frequency domains, is a potential filter in comparison to the other denoising methods [6]. With specific regard

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