Efficiency Assessment of Local Prediction Method Considering Reconstruction of Phase Space and Artificial Neural Network Model for Prediction of Runoff (Case Study: Pole-Kohneh Station, Kermanshah)

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1-Introduction

It is very substantial to forecast streamflow hours, days, months, or possibly longer in advance for the effective operation of a water resources system. Water authorities can administer water reserves optimally for such water users as hydropower generation, agricultural, domestic, and for the maintenance of environmental flows through a reliable streamflow forecast. Forecasting stream-flow is exceedingly important in the case of multipurpose reservoirs since they are essential to the operation of flood mitigation reservoir systems. Forecasting flow is also imperative in predicting the sediment amount carried by the river to the reservoirs. Forecasting stream-flow is exceedingly important in the case of multipurpose reservoirs; they are essential to the operation of flood mitigation reservoir systems. Forecasting flow is also imperative in predicting the sediment amount carried by the river to the reservoirs.

2-Study area and methodology

In the present study, daily, weekly and monthly flow series (1988–1999) observed in the Qareh-Soo River in Kermanshah province are considered. As for the methodology, the methods based on nearest trajectory strategy, including reconstructing of the system state and local prediction method (LPM) and method of surrogate as well as artificial neural network approach are used for investigating chaos in river flow at Pole-Kohneh located in the Qareh-Soo River.

3-Application and results

3.1-Phase Space reconstruction

After determining 1) the proper delay times using the variation of the fraction of FNNs for different embedding dimensions for daily, weekly and monthly river flow (see Figure 1) , and 2) embedding dimension based on the Takens theorem, the phase space can be reconstructed. Figure 2 depicts the 2D plot of the constructed phase space of daily river flow.

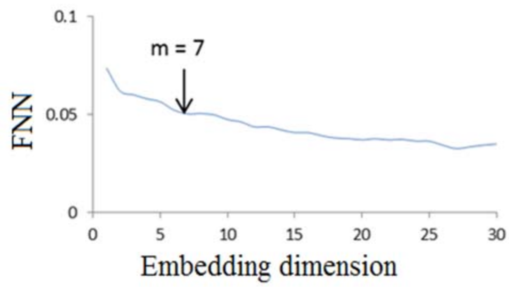

Fig. 1 Variation of average mutual information with lag time in daily river flow

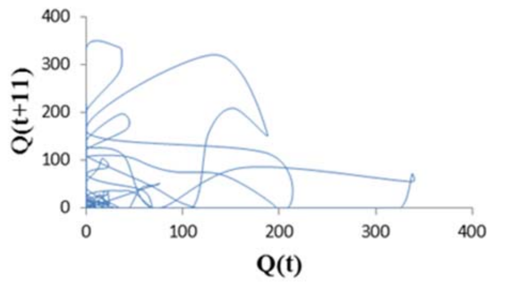

Fig.2 2D constructed phase space of daily flow rate

3.2-Determination of the Maximal Lyapunov Exponent

The maximal Lyapunov exponents were calculated (Figure 3). The analyses found weaker chaos characteristics at short term daily scale ($\lambda max= 0.0063$) and stronger chaos characteristics ($\lambda max= 0.0252$) at mid-term monthly scale.

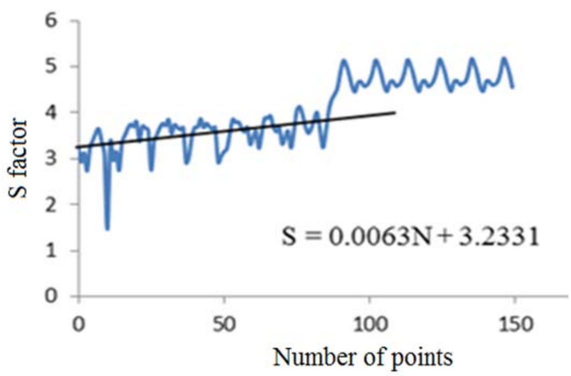

Fig. 3 plot of maximal Lyapunov exponent for daily river flow

3.3-Prediction process

In brief, the results of predicting process using the nonlinear chaos theory (local prediction method,

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LPM) and ANN are tabulated in Table 1.

Table 1. Performance of the NLA method and ARIMA for short term and mid-term temporal scales

	LPM		ANN	
Scale	RMSE (m3/s)	r	RMSE (m3/s)	r
Daily	0.73	0.940	0.79	0.921
Weekly	7.87	0.948	8.03	0.941
Monthly	71.38	0.378	30.48	0.758

Based on the results of this study shown in Table 1, it can be concluded that the LPM method had better performance in predicting daily and monthly scales, while ANN showed superiority on the monthly scale.

4-Conclusions

Based on the outcomes of this study, the following conclusions are drawn:

1- According to the correlation analysis, chaosity was observed in daily (cd=2), weekly (cd=4) and monthly (cd=4).

2- Test of the maximal Lyapunov exponent showed that there is more chaotic behavior in mid-term flow rate rather than short-term flow.

3- ANN had superiority in predicting monthly flow while LPM method outperformed the ANN method in daily and weekly scales.