Geophysical Research Abstracts, Vol. 6, 07446, 2004
SRef-ID: 1607-7962/gra/EGU04-A-07446

EXTENDED PHASE-SPACE RECONSTRUCTION TECHNIQUE FOR THE PREDICTION OF RIVER FLOWS

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The processes contributing to the hydrological cycle are described by theoretically sound non-linear partial differential equations of mass and energy transfer. The hydrodynamic equations describing hydrological processes were developed in non-linear form in the nineteenth century. In the case of surface runoff from a natural catchment or flow in an open channel, an accurate application of the hydraulic approach requires a detailed topographical survey and determination of roughness parameters. In order to avoid these difficulties, alternative approaches via black box models were developed in the second half of the last century.
In the paper performance of two different types of approaches were investigated with respect to the daily river flow predictions. The first approach based on the deterministic chaos concept, is so called Phase-Space Reconstruction (PSR) model. The second one is Multi-Layer Perceptron Artificial Neural Network. Both models were applied to daily river flow data collected from several gauges, located in river reaches in western Canada. Each data set consists of more than 10000 consecutive daily measurements.
The authors of the present study benefit from the phase-space reconstruction method which in fact is a way of finding the most similar situations in historical data and applying only these selected parts of data set for forecasting. It seems that this method may stand alone as a reliable tool without linking it to the existence or non-existence of a hypothetical deterministic dynamical system leading to disordered solutions.
In the paper an extension is proposed to classical phase-space method that may be applied to single time series data only. To this end a technique, further called as quasi-phase-space reconstruction method, is proposed and this method allows for the use of

the data from more than one gauge station. Comparison of modelsŠ performance was made for this extended and classical approaches for both phase-space reconstruction and Artificial Neural Networks models.

The comparison of the results of two black box models is presented according to the following scheme. In the 1st version as inputs only historical runoff data from the same gauge are applied for both ANN and phase-space reconstruction approaches. In the 2nd version forecast is made for the same gauge as in the 1st version, but input data set consists of data from 2 or 3 gauges. Additional gauge for the 2nd version is selected at the same river where the forecasting gauge or its main tributary is placed.

For each case 3 consecutive measurements from particular gauge were treated as input variables which means that we have 3 input variables in the 1st version, and 6 or 9 in the 2nd version.