A Fuzzy Model in Forecasting Dissolved Oxygen in Rivers

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Abstract

Amount of dissolve oxygen in a river has a great direct affect on aquatic macroinvertebrates and this would influence on the region ecosystem indirectly. In this paper it is tried to predict dissolved oxygen in rivers by employing an easy Fuzzy Logic Modeling, Wang Mendel method. This model just uses previous records to estimate upcoming values. For this purpose daily and hourly records of eight stations in Au Sable watershed in Michigan, United States are employed for 12 years and 50 days period respectively. Calculations indicate that for long period prediction it is better to increase input intervals. But for filling missed data it is advisable to decrease the interval. Increasing partitioning of input and output features influence a little on accuracy but make the model too time consuming. Increment in number of input data also act like number of partitioning. Large amount of train data does not modify accuracy essentially, so, an optimum training length should be selected.

Keywords: Dissolved Oxygen, Au Sable, Fuzzy Logic Modeling, Wang Mendel

1. INTRODUCTION

Forecasting refers to a process by which the future behavior of a dynamical system is estimated based on our understanding and characterization of the system. If the dynamical system is not stable, the initial conditions become one of the most important parameters of the time series response, i.e. small differences in the start position can lead to a completely different time evolution. This is what is called sensitive dependence on initial conditions, and is associated with chaotic behavior [1,15] for the dynamical system.

More recently, soft computing [9] methodologies, such as neural networks, fuzzy logic, and genetic algorithms, have been applied to the problem of forecasting complex time series. These methods have shown clear advantages over the traditional statistical ones [11]. The main advantage of soft computing methodologies is that, we do not need to specify the structure of a model a priori, which is clearly needed in the classical regression analysis [2]. Also, soft computing models are non-linear in nature and they can approximate more easily complex dynamical systems, than simple linear statistical models. Of course, there are also disadvantages in using soft computing models instead of statistical ones. In classical regression models, we can use the information given by the parameters to understand the process. However, if the main objective if to forecast as closely as possible the time series, then the use of soft computing methodologies for prediction is clearly justified.

The use of fuzzy set theory allows the user to include the unavoidable imprecision in the data. Fuzzy inference is the actual process of mapping from a given set of input variables to an output based on a set of fuzzy rules. The essence of the modeling is to identify fuzzy rules. Four fundamental units are necessary for the successful application of any fuzzy modeling approach. These are, namely, the fuzzification unit, the knowledge base (which is composed of the database and the rule base), the inference engine and defuzzification unit [16, 17]. The main problem with fuzzy logic modeling is related to the choice of the parameters. For this reason some methods such as ANFIS (Adaptive Network based Fuzzy Inference System), firstly proposed by Jang [18], Wang-Mendel [19] and etc. may be applied. Wang-Mendel is one of the easiest methods which lay in *ad-hoc* fuzzy logic modeling category. This technique is expressed in detain in section 3.

Dissolved oxygen is one of the best indicators of the health of a water ecosystem. Dissolved oxygen can range from 0-18 parts per million (ppm), but most natural water systems require 5-6 parts per million to support a diverse population. Oxygen enters the water by direct absorption from the atmosphere or by plant photosynthesis. The oxygen is used by plants and animals for respiration and by the aerobic bacteria which