



Suspended Sediment Load Simulation for Delaware River Using ANNs and Sediment Rating Curves

S.Saadat¹, N.Taleb Beydokhti²

1. PhD Student of Shiraz University

2. Professor; Civil Engineering Department, Engineering Faculty, Shiraz University, Shiraz, Iran

civil78034@yahoo.com

Abstract

Predictions of sediment load are required in a wide variety of water resources engineering problems. In the presented study artificial neural network (ANN) was used to model the daily sediment load in the Delaware River, USA. The feed-forward back-propagation ANNs with one, two and three hidden layers were employed for this purpose. A sediment rating curve also was used to compare the results. Compared with classical sediment rating curves, ANN can generate a better fit under the same data requirement.

Keywords: Artificial neural network, Suspended sediment load, Feed-forward back-propagation, Sediment rating curve

1. Introduction

Sediment yield is defined as the total sediment outflow from a watershed measurable at a point of reference during a specified period of time. The sediment outflow from the watershed is induced by processes of detachment, transportation and deposition of soil materials by rainfall and runoff [1]. Estimation of sediment yield is required in a wide variety of problems such as design of dams and reservoirs; it is a well-known fact that all reservoirs are designed to contain a volume known as dead storage. This volume accumulates the sediment load that will accumulate over a specified period. The underestimation of sediment load results in insufficient reservoir capacities while the overestimation will lead to over-capacity reservoirs. Sediment yield is also an important factor in transportation of sediment and pollutants in rivers, lakes and estuaries, design of stable channels, and debris basins, undertaking cleanup following floods, protection of fish and wildlife habitats, determination of the effects of watershed management, and environmental impact assessment. Fine sediment has been known as an important factor for the transportation of nutrients and contaminants such as heavy metals and micro-organics. The real time distribution of sediment load is necessary in this case and the sediment load forecast is needed for the pollution control in rivers and reservoirs.

Many empirically- and physically-based models have been used in the suspended sediment flux modeling of a catchment. Empirical models predict suspended sediment flux by relating it to catchment characteristics such as drainage area, topography, land cover and climate as well as deposition rates in ponds or reservoirs. These models are widely used because their structure and their related mathematical methods are relatively simple and also they are able to work with limited input data. Although this type of model is not suitable for representing the spatial variability of hydrologic processes and catchments parameters that influence the suspended sediment flux in a river [2].

Physically-based models try to represent the spatial heterogeneity of variables by dividing the catchments into grids, and describe the processes of the sediment transport from grid to grid with simplified partial differential equations [2]. The application of physically-based distributed process computer simulation offers one possible method of prediction to assess the outcome of different management actions and long-term management strategies. But the application of these complex software programs is often difficult because of using idealized sedimentation components, or requiring massive amount of detailed spatial and temporal environmental data, which is not available [3].

It seems the artificial neural network (ANN) approach which is a nonlinear black box model, would be suited to model the complex suspended sediment problems. There are numerous applications of ANNs in water resources. ANN was introduced into hydrological modeling in the 1990s and has been successfully used in rainfall-runoff modeling, stream flow prediction, water quality assessment, drought analysis and reservoir operations modeling [2]. ANNs were also known as a powerful tool to use in different groundwater