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Modelling sediment concentration using back propagation neural network and regression coupled with genetic algorithm

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Abstract

Prediction of minimum sediment concentration is vital for planning, designing and management of hydraulic structures. This work focused on the prediction of the sediment concentration using regression and Back Propagation Neural Network (BPNN) models. Parameters like discharge, temperature and sediment concentration had been collected on daily basis from different basins on River Suktel. BPNN and Regression models had been used to map the sediment concentration with discharge and temperature. Mutually regression and BPNN models are into consideration for predicting the fitness of models. Regression and BPNN model are then coupled with GA to acquire sediment concentration. For minimum sediment concentration, optimum discharge and temperature were obtained from coupled GA. Comparison between GA-BPNN and GA-Regression models are computed for knowing the sensitivity of models at regional scale. This work is unique in predicting minimum sediment concentration.

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Keywords: Regression Model; Back Propagation Neural Network; Genetic Algorithm; Discharge; Temperature; Sediment Concentration;

1. Introduction

Mapping runoff-sediment yield is complex for hydrological observation with catchment characteristic. Sediment concentration depends on precipitation, runoff, slopes and land use pattern of the catchment. Runoff plays crucial rule for controlling flood, and releasing of storage water. Transport of sediment integrated with runoff reduced the

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storage capability of wetlands, lakes, reservoirs and rivers. Here sediment concentration indicates suspended sediment concentration throughout the text. Hence, estimating sediment concentration in watersheds on regional scale is significant process for water resources development and management. Sediment concentration is evaluated either from direct measurement or using sediment transport equations at basin outlet. The process of straight measurement is costly and not performed to every observing station. Alternatively, Artificial Neural Network (ANN) modeling is another technique for identifying complex relationship between data sets of input and output. To verify watershed characteristics due to unpredictable weather pattern different algorithms are used to optimize multi-dimensional non-linear objectives functions.

Crowder et al. (2007) used nonlinear regression technique to calculate approximately sediment concentration and compared the result by fitting linear regression method. Wang and Linker (2008) used multivariate linear regression models to interrelate the sediment load and discharge. Sadeghi et al. (2008) used sediment graphs and hydrographs to measure discharge and sediment transport. Gao (2008) adopted variety of methods for monitoring, estimating and modeling suspended sediment load. Ganju et al. (2008) developed a model for predicting daily sediment load. Arabkhedri et al. (2009) applied sediment rating curves to estimate sediment load. Jain (2001) used feed forward ANNs to develop stage-discharge-sediment model for two sites on the Mississippi River. Partal and Cigizoglu (2008) combined wavelet and ANN method to calculate suspended sediment load. Jothiprakash and Garg (2010) used back propagation neural network (BPNN) to evaluate sediment trap efficiency in a reservoir and found that the BPNN model shows better accuracy as compared to regression analysis. Aytek and Kisi (2008) used genetic programming (GP) for mapping daily suspended sediment-discharge relationship. Cobaner et al.(2009) used Adaptive Neuron-Fuzzy Inference System (ANFIS) to guesstimate suspended sediment concentration and found the potential of neuro-fuzzy technique to multi-layer perceptron (MLP), generalized regression neural networks (GRNN) and radial basis neural networks (RBNN).

The objective of the study compels to forecast sediment concentration at different discharge and temperature conditions. A multiple regressions as well as BPNN models are incorporated to predict the sediment concentration. Concert of both models are analyzed with root mean square error and coefficient of correlation. Genetic algorithm is used to find minimum sediment concentration as well as the optimal hydrologic conditions. At the end GA has been coupled with BPNN and multiple regressions (MR) to forecast minimum sediment concentration. Comparison is then made between coupled GA-BPNN and GA-Regression models to show the efficacy of the system.

2. Study area

Suktel river basin is the largest basin of Bolangir district, Orissa. It is one of the major river basins in the eastern region of Bolangir covering the watersheds of Loisingha, Patnagarh, Bolangir, Puintala, Belpara (Fig. 1).

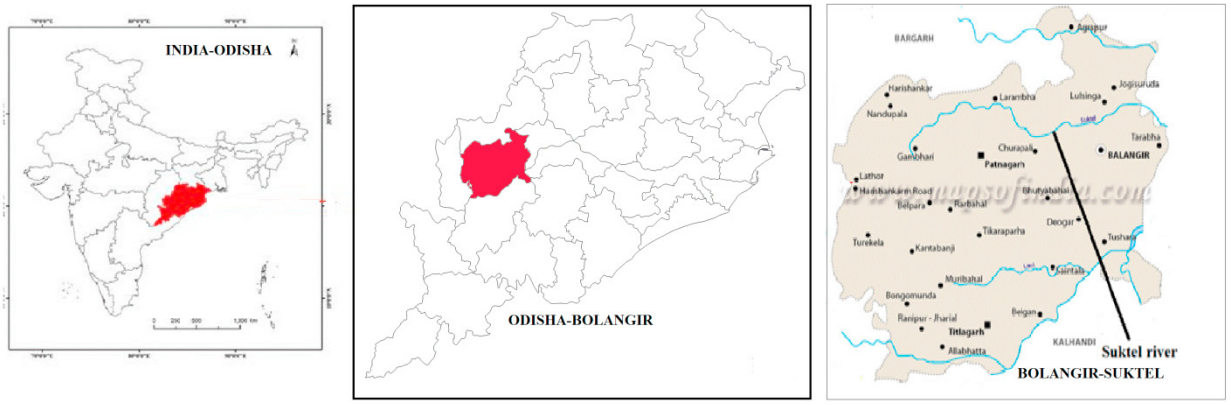

Fig. 1. Study Area: River watershed: Suktel