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Neural network forecasting of suspended sediment load in the Schuylkill River

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It is axiomatic that most pioneering studies in an emerging field will possess the status of 'unique case studies' or 'awareness demonstrators'. However, there remains a pressing need for published results to be corroborated and for effective comparisons to be performed based on further studies of the same catchments and datasets. Modelling experiments should also be replicated on similar or dissimilar watersheds. This would permit the findings of individual studies to be placed in their proper 'scientific setting'; providing an informed position out of which 'real knowledge could be extracted'. To help support some earlier reported results and provide a set of useful comparisons this poster revisits the published modelling investigations of Cigizoglu & Kisi (2006). Feedforward neural network solutions were used in both previous and current studies to perform a series of suspended sediment forecasting experiments for the Schuylkill River at Manayunk, Philadelphia, in Southeastern Pennsylvania, USA (4740 kmˆ2).

The Schuylkill River is important and unique in several respects. It is the largest tributary to the Delaware River Estuary. This river flows through four natural regions whose different geologic and topographic settings provide the foundation for its drainage patterns and the natural characteristics of its ground and surface waters. 75 percent of the watershed comprises an intricate network of small headwaters streams that are particularly vulnerable to individual and cumulative land-use decisions and practices. 15 percent of the watershed is developed. 85 percent remains in agriculture and forest; but an increasing number of its tributaries are affected by suburban development. Industrialization and mining in the last two centuries has left the river with problems of storm water runoff, agricultural pollution, active and abandoned mine drainages, and sewage overflows.

Cigizoglu & Kisi (2006) used downloaded discharge (Q) and suspended sediment (S) datasets obtained from the USGS. Their four training datasets spanned 24 'water years' (WY); 12-month periods that started on 1 October and ended on 30 September and designated according to the calendar year in which each period ends. Models were developed on four different periods: WY 1952-60 (8); WY 1961-68 (8); WY 1969-76 (8); and WY 1952-76 (24). Each model was tested on the same period WY 1977-81 (5). Two types of model were developed; single models based on the full range of each training dataset; combined solutions developed on threefold partitions of each training dataset. Four different sets of input variables were used: Qt; Qt, St-1; Qt, Qt-1, St-1; Qt, Qt-1, St-1, St-2. Most scenarios favoured the range dependent 'divide and conquer' tactic but there were nevertheless several inconsistencies which appeared to be related to the input scenarios and error measures involved. The modelling process had also been deconstructed in an informal manner into a set of simpler operations and negative sediment outputs were sometimes observed. It was suggested that other neural network methods might perhaps be useful.

The results of four different feedforward network neural modelling solutions applied to identical full period model development and testing datasets will be presented. Each model development procedure used a different method of generalisation: [1] 'back-propagation of error' applied (a) with early stopping based the use of a cross-validation dataset and (b) with the inclusion of different amounts of noise; [2] neuroevolution applied both (a) with and (b) without a negative sediment constraint using a customised version of the software package JavaSANE (Moriarty & Miikkulainen, 1998).

Cigizoglu, H.K. & Kisi, O. (2006) Methods to improve the neural network performance in suspended sediment estimation. Journal of Hydrology 317(3-4): 221-238.

Moriarty, D.E. and Miikkulainen, R. (1998) Forming neural networks through efficient and adaptive coevolution. Evolutionary Computation 5(4): 373-399.