ANN Applications for Sediment Transport

River bed-load flux

Prediction of bedload sediment transport rates in rivers is a notoriously challenging problem due to inherent variability in river hydraulics and channel morphology.

We try to design an ANN model to predict the mean bedload transport rates based on 8,117 measurements from 134 rivers for

- Bedload fluxes,
- River discharge,
- Flow width,
- Bed slope, and
- Four bed surface sediment sizes.

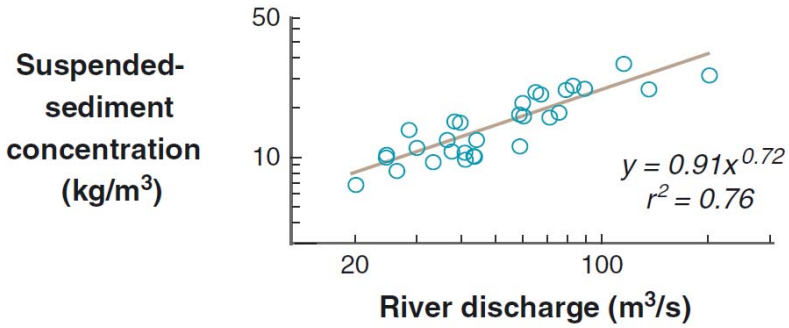
The data set has been published by Hossein Hosseiny et al. (2022).

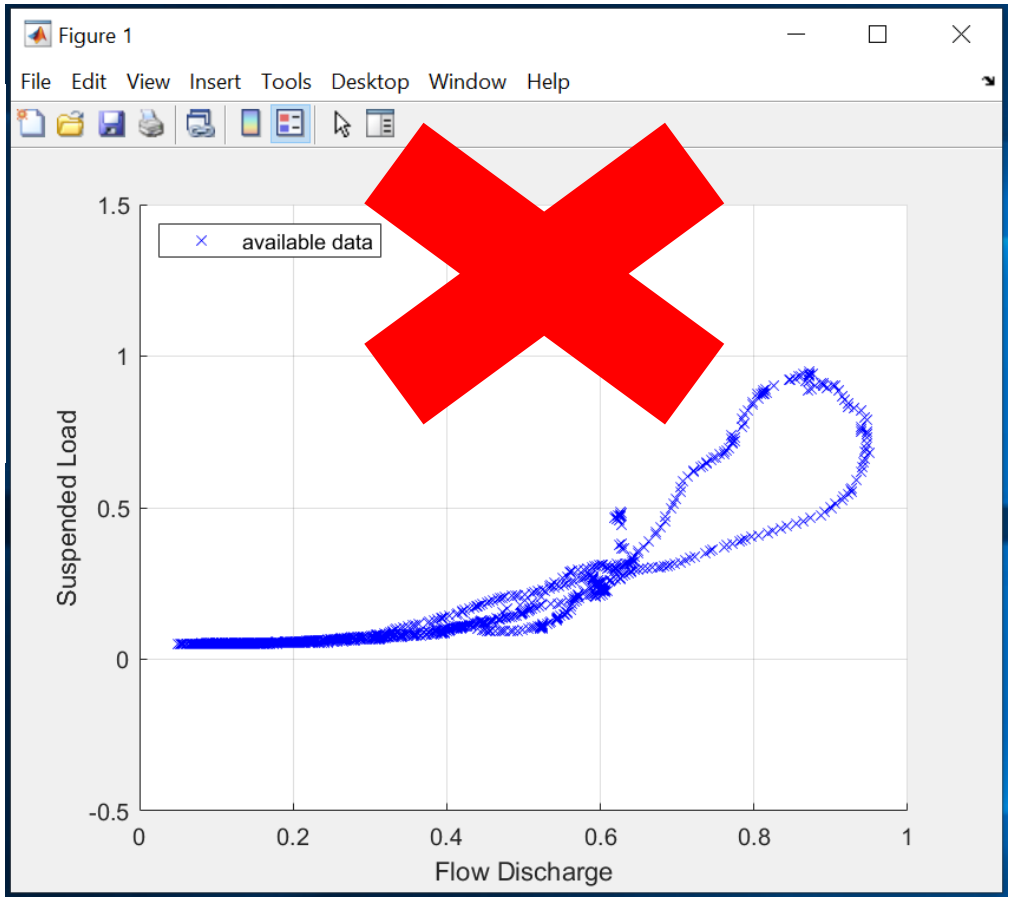
MATLAB - Exercise 7.1

1. Import Data: Bedload_Data.xlsx
2. Normalize variables
3. Divide into 3 datasets: Training (70%); Validation (15%); Testing (15%)
4. Design MLP networks with
   - 7 Inputs: River discharge, Flow width, Bed slope, and 4 bed surface sediment sizes D_{16}, D_{50}, D_{84}, D_{90}
   - 1 output: Measured q_b
5. Train and test the networks by applying
   - Case1: one hidden layer
   - Case 2: two hidden layers
6. View the networks and evaluate the results.

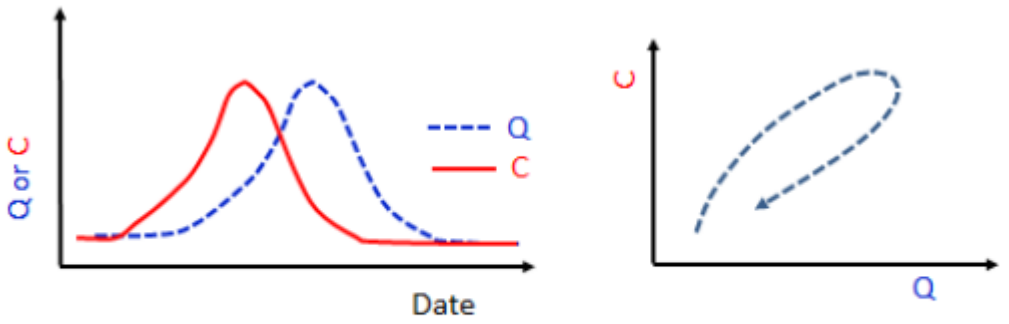
Suspended sediment load

Rating curve (single value log-line)
based on observed data

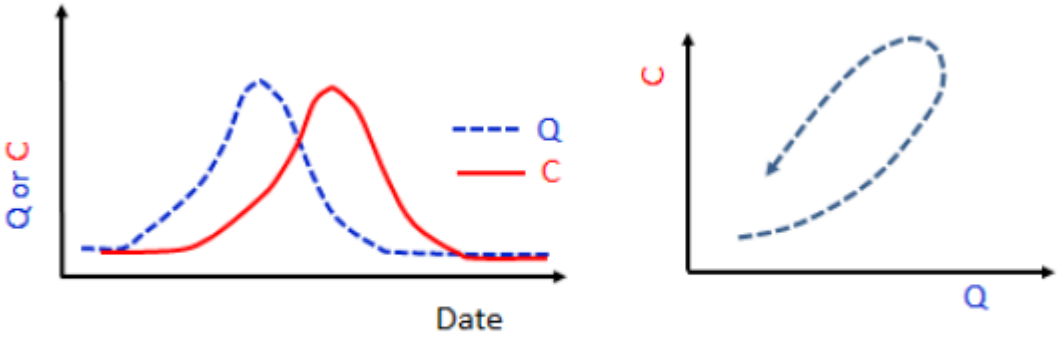




Hysteresis in the relationship between suspended sediment concentration (C) and flow rate (Q) during flood events

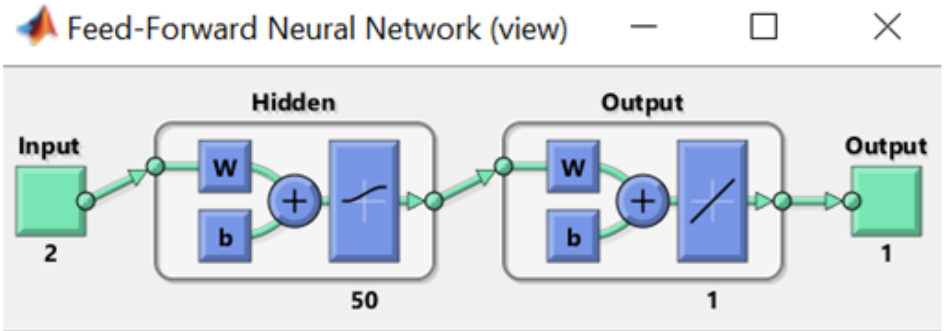


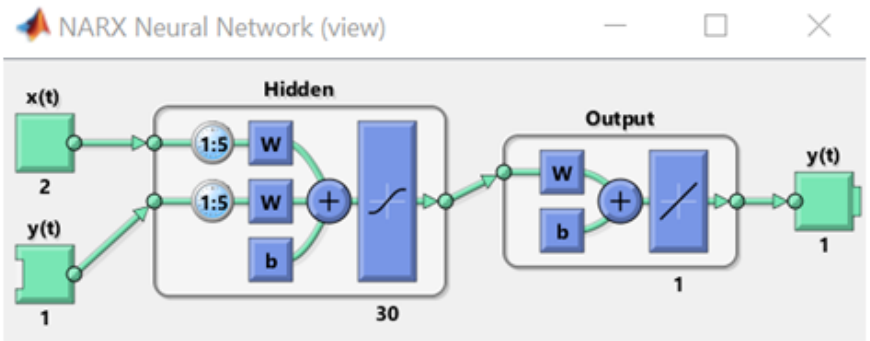
(a) Clockwise hysteresis

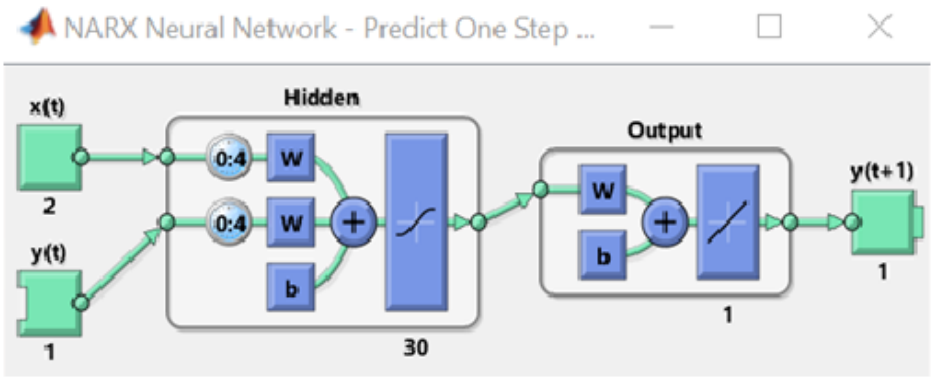


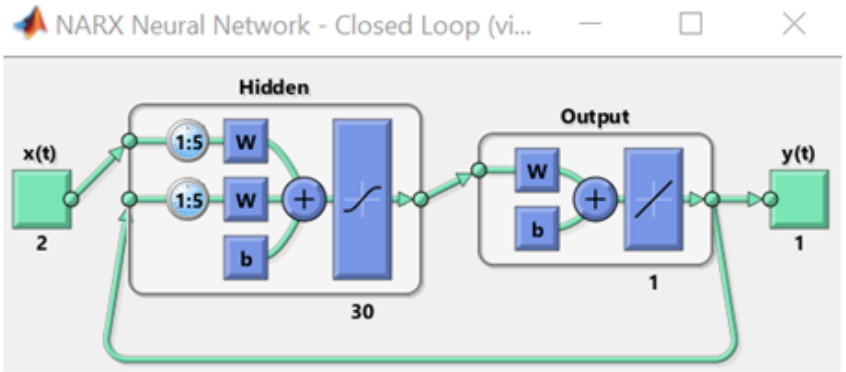
(b) Counter clockwise hysteresis

Different ANN models can be used to predict time-variation of SS load responding to changes in geohydrological and hydromorphological factors









MATLAB - Exercise 7.2

1. Import time series data: SuspendedLoadoad_Data.xlsx
2. Normalize variables
3. Design, train and test two following networks
    I. MLP network with 2 inputs (flow discharge and precipitation) and one output (suspended sediment load) at each moment time.
    II. TS-ANN (Time Series Distributed Delay Networks) with 6 inputs (flow discharge and precipitation at the present and at two former time steps) and one output (suspended sediment load) at the present time.
4. View the networks and evaluate the results.

Homework 5: (deadline for submission is 28th June 2022)

1. Train and test the networks in Example 7.1 by increasing the number of hidden neurons in two hidden layers.
2. View the best networks.
3. Compare the ANN-results and the results of the other empirical formulae (see in Excel data file) with the observed data.