# General information

**Reference paper:** Botter G. and Falzoni F., *An Analytical Rank-Based Framework for the Evolution of Distance-to-Channel Distributions in Response to Stream-Network Expansion and Retraction.*

**Contacts/Email:** gianluca.botter@unipd.it

# Code and data

This document provides useful information on how to deal with the input data and the codes about FLS model, referring to above paper.
The sub-folder *LSF_DATA*, in turn, contains subfolders named *catchmentName_Results*, each of which, for every studied catchment, contains MATLAB workspaces from which the empirical pdfs of hillslope lengths can be extracted.

The DTM data on which the empirical pdfs are built can be found at the following addresses: `https://researchdata.cab.unipd.it/id/eprint/1433` and `https://researchdata.cab.unipd.it/id/eprint/1586`.

Moreover, the folder contains four different scripts:

- `p1_LSF_means_analysis.m`;
- `p2_LSF_eta_universal.m`;
- `p3_FLS_vs_OBS_cdf.m`;
- `p4_HYP_EMP_CDF_error.m`;

which have been written in MATLAB (R2025b).

The scripts must be placed in the same location of folder *LSF_DATA* in order to work properly. In the next subsection, a brief explanation of the working of each script will be provided.

## 0.1 Code explanation

All scripts are based on a maximum active network length, $L_{\max}$, such that the condition $L_{\max}/\sqrt{(A)} = 3$ is satisfied.
In the scripts all the measures are already scaled in km and km$^2$, being respectively multiplied by the factor $dx/1000$ ($dx$ is the DTM resolution) and $1/10^6$.

Here follows how the scripts work:

- `p1_LSF_means_analysis.m`: this code takes as input the data relative to each studied catchment and for each one of them performs the comparison between the observed mean and the two analytical models: the hyperbolic model and the geomorphic model.
  The geomorphic model is evaluated on a range of *b_values* by a *for loop* and also on the fixed value of $b = 0.5$. This code provides the figure which collects the plots relative to the mean comparison.

- `p2_LSF_eta_universal.m`: this script is run on all the studied basins and identifies the value of $\eta_{\text{glob}}$ that minimizes the sum of the $L^2$ errors across the watersheds, based on the conditions selected for the average model. The average model is selected by the boolean variables *hyperbolic_model* and *best_catchment_b*.
  The array *best_catchment_b* comes from the file `p1_means_models_optimization.m`.

  The Boolean variable *use_modeled_IC* is used to set the initial condition for each iteration of the quantile evolution: either the condition derived from the observed quantiles at the previous active length (if *false*) or the condition derived from the model at the previous iteration (if *true*). It is recommended to keep it *true*.

- `p3_FLS_vs_OBS_cdf.m`: this script operates on the same principle as the previous one with regard to the selection of mean models and initial conditions. It iterates over all the basins under study and, for each one, calculates the CDFs derived from the FSL model based on the settings for the $\eta$ values, iterating over these values to find the one that minimizes the error. For each studied catchment, the modeled CDFs and their support are saved in the variables *best_CDF_LSF* and *LSF_support*, respectively. The code also returns plots of the lines describing $\gamma$ vs $L/\sqrt{(A)}$ and comparative figures between the observed and modeled CDFs.

- `p4_HYP_EMP_CDF_error.m`: this script calculates the error between the CDFs calculated using the hyperbolic model and the observed CDFs. The result is used as a benchmark for comparison with the FSL model.