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User guide for *FluvialCorridor* toolbox

Networks sequencing and orientation

Toolset name : *DISAGGREGATION PROCESSES*

Tool's name : *Sequencing*

How to cite : Roux, C., Piégay, H., 2013. Sequencing guideline for the *FluvialCorridor* toolbox, a new ArcGIS toolbox package for exploring multiscale riverscape at a network scale. Sedalp (Sediment Management in Alpin Basins) and CNRS (UMR5600).

FluvialCorridor **package for ArcGIS**

Version V01 - 2014

CNRS - UMR5600 Environnement Ville Société
Alpine Space Program - Sedalp

For each use of the *FluvialCorridor* GIS package leading to a publication, a report, a talk presentation or any other document, please refer to the following paper :

Roux, C., Alber, A., Bertrand, M., Vaudor, L., Piégay, H., submitted. "FluvialCorridor" : A new ArcGIS package for multiscale riverscape exploration. Geomorphology.

I. Concept and methods

Mutliscale characterization of fluvial system is based on fluvial linear such as the hydrographic network or the centerline network. To ensure a consistent process, one of the necessary conditions is that networks must be (i) oriented, (ii) connected and (iii) relevant of the in-field configuration. *Sequencing* tool aiming at ordering and, if it is needed, flipping streams of a network, to ensure :

1. a good flow direction from upstream to downstream.
2. a good ordination of streams in order to spatially and hierarchically located them within a network.

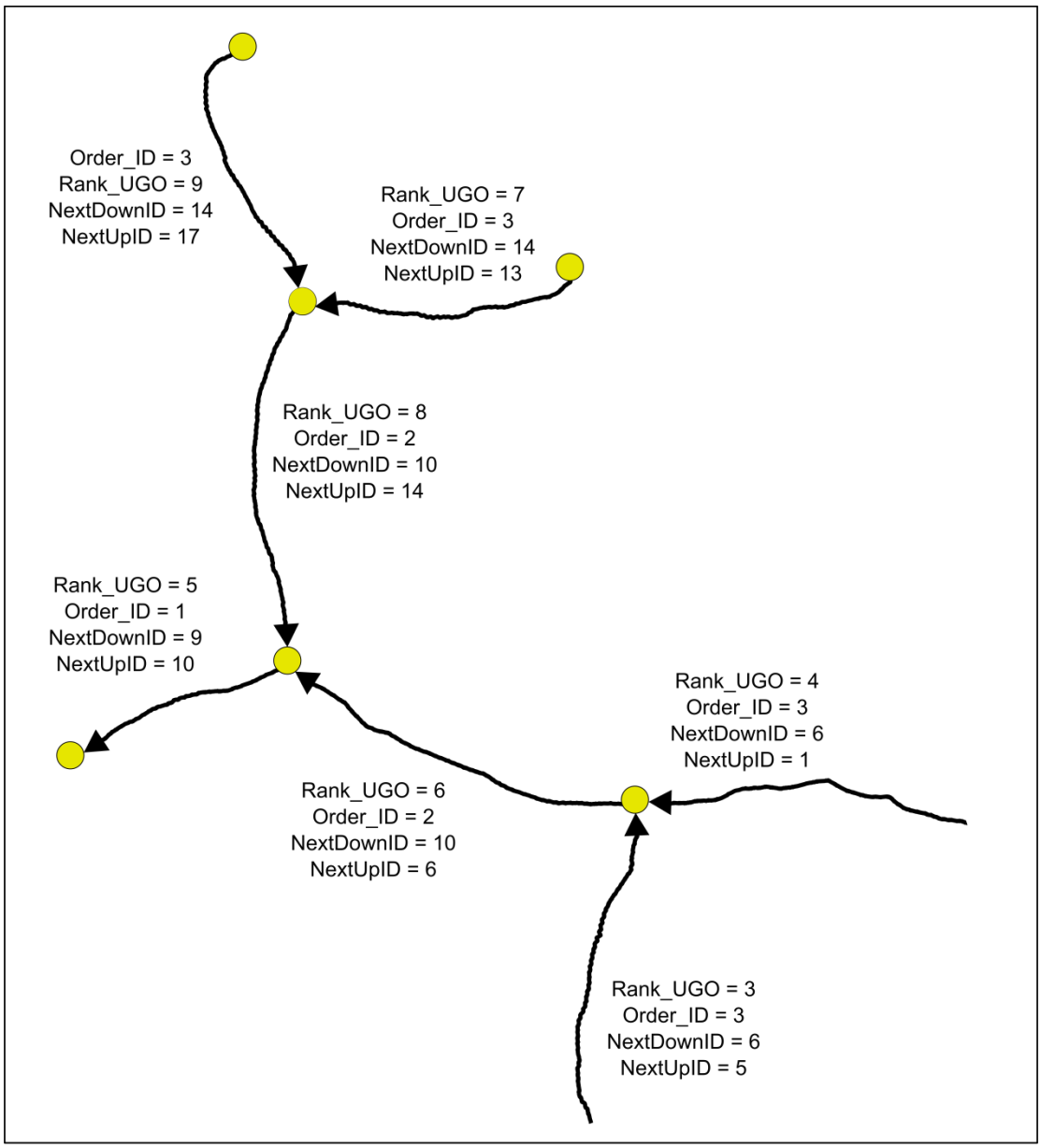

Figure 1 Network sequenced with the *Sequencing* tool of the *FluvialCorridor* toolbox (Le Guil river, French southern Alps).

Implementation of this tool has been done with a GIS software (ArcGIS 10.0) thanks to a vector layer of a hydrographic network (obtained with the *Stream network* tool of *FluvialCorridor).*

General algorithmic framework

The algorithmic scheme developed for the *Stream network* tool is presented in the Fig. 2.

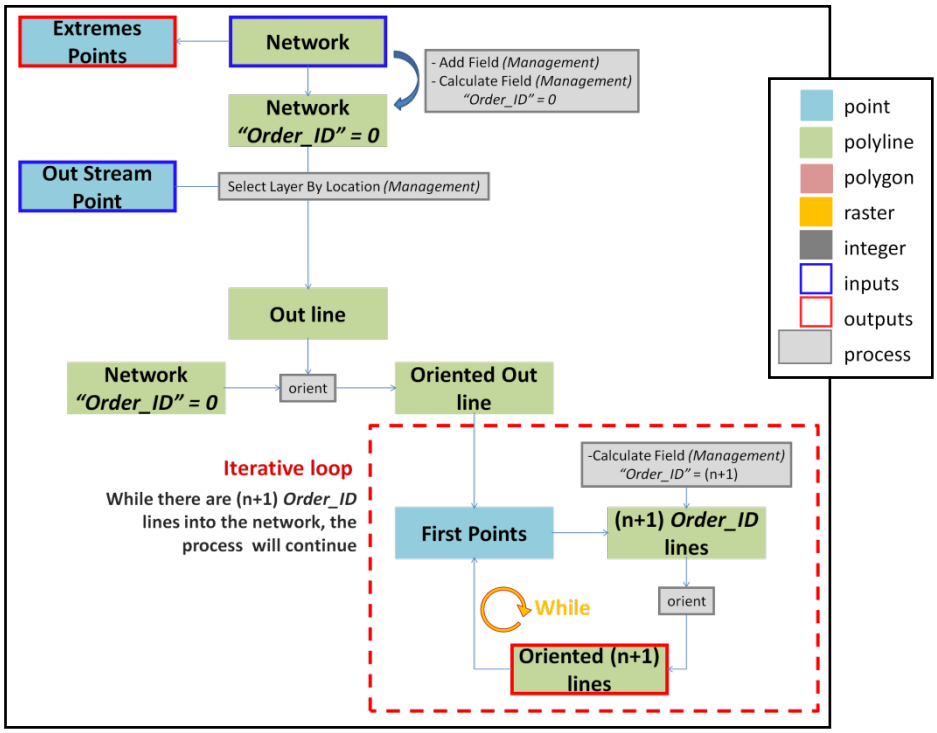

Figure 2 General algorithmic framework of the *Sequencing* tool

Network ordination and orientation workflow involved into *Sequencing* are iterative processes, running through the network from downstream to upstream. Firstly, the input network is converted into a polyline feature thanks to the "*Multi Part To Single Part*" ArcGIS tool (Fig. 3A). Each line is then attributed with a unique id "*Rank_UGO*" and with fields "*Order_ID*" (initialized at 0), "*NewtUpID*" and "*NextDownID*". All links and extreme points are also extracted into a point feature (Fig. 3B).

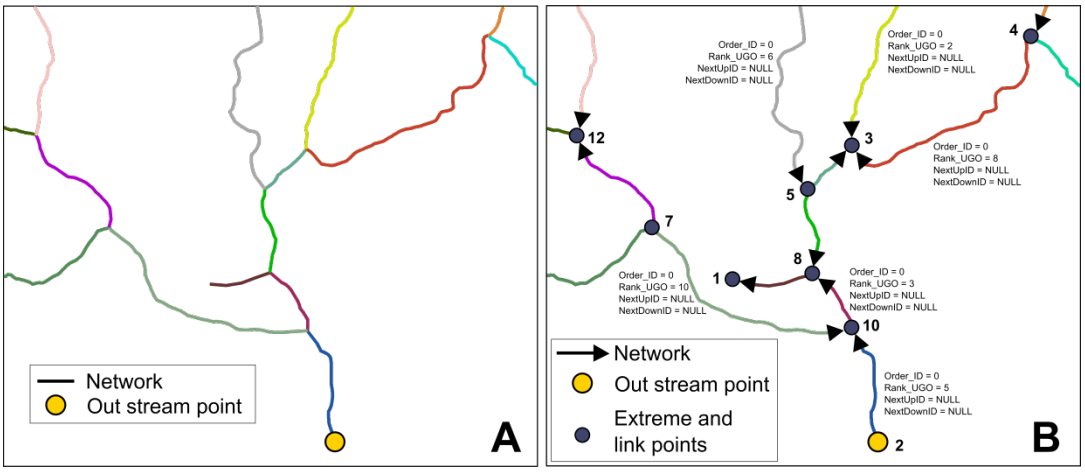

Figure 3 Pre-processing of the original network (A) : conversion into a polyline feature and extraction of extreme and link points (B)

The entire process is then based on the good orientation of the most downstream stream (Fig. 4A). This step is based on the outstream point given by the user :

1. The most downstream stream is selected with the ArcGIS tool "*Select Layer by Location*" thanks to the outstream point. Its "*Order_ID*" field is set at 1. The outpoint of this line, randomly defined by ArcGIS, is then extracted.

2. The tool counts who many streams touch this outpoint. If counter is equal to 1, it means that outpoint of the most downstream stream is correctly located near the user given outstream point. The line is so correctly oriented. Conversly, if counter is higher than 1, it means that the outpoint of the most downstream stream is wrongly located at the first confluence of the network. The line is so wrongly oriented and it is flipped thanks to the "*Flip Line*" ArcGIS tool.
3. Once the most downstream stream is correctly oriented, ends points (i.e. FPt and EPt) are extracted. They are both similar to two points of the set of network extreme points so that "*OBJECTID*" field is transferred into "*NextUpID*" and "*NextDownID*".
4. Finally, the upstream point of the most downstream stream is stored into a point feature named "*FPtoSelect*".

Once this step executed, the most downstream stream is correctly oriented and its upstream point is stored. The iterative process can be run (Fig. 4B and 4C) :

① Thanks to the points of "*FPtoSelect*", already processed and just upstream streams are selected. This selection is then restricted to the upper stream (i.e. unprocessed streams) by kepping only ones with an "*Order_ID*" field equal to 0. This field is so updated.

② Each selected streams are processed through the same workflow than the most downstream stream :
   a. extraction of the outpoint randomly defined by ArcGIS ;
   b. counting the number of adjacent streams ;
   c. flipping the stream if it is needed ;
   d. extraction of the new FPt and EPt ;
   e. assignment of the "*NextUpID*" and "*NextDownID*" fields ;
   f. storing the new upstream point into "*FPtoSelect*" ;
   g. selecting the next stream : back to (a).

③ Go to the upper "*Order_ID*" : back to ①

At the end of the process, each stream is (i) correctly oriented, (ii) identified by a unique id "*Rank_UGO*", (iii) hierarchically ordered within the network thanks to the "*Order_ID*" field, and (iv) spatially located with the "*NextUpID*" and "*NextDownID*". This last information comes from the layer "*Out Point Network*", available at the end of the process.

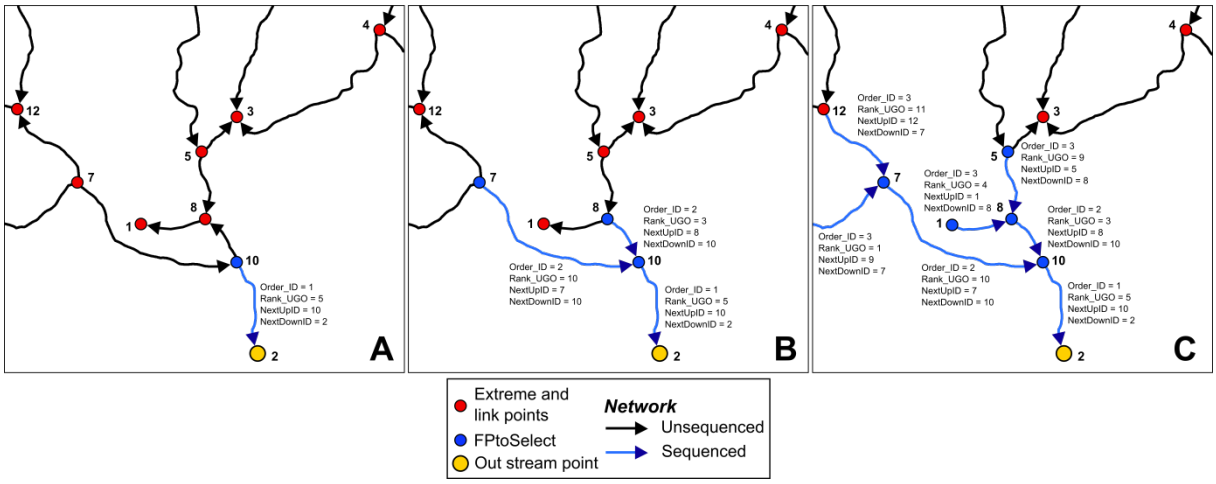

Figure 4 Iterative process on the network. (A) first step aiming at orienting and attributing the most downstream line. (B) and (C) : iterative process from downstream to upstream

Note
Sequencing tool has been developed to set the orientation and the ordination of a fluvial network but it can also be used for only one fluvial reach. In that case, process is based on the same algorithm and the same parameters.

II. Screen user interface

II.1. Startup screen

Into the screen user, several fields have to be filled (Fig. 4). Be careful that a green mark in front of a field is not a guaranty that this field is not optional. Into *Stream network*, if a field is available, that means that it **must be filled**.

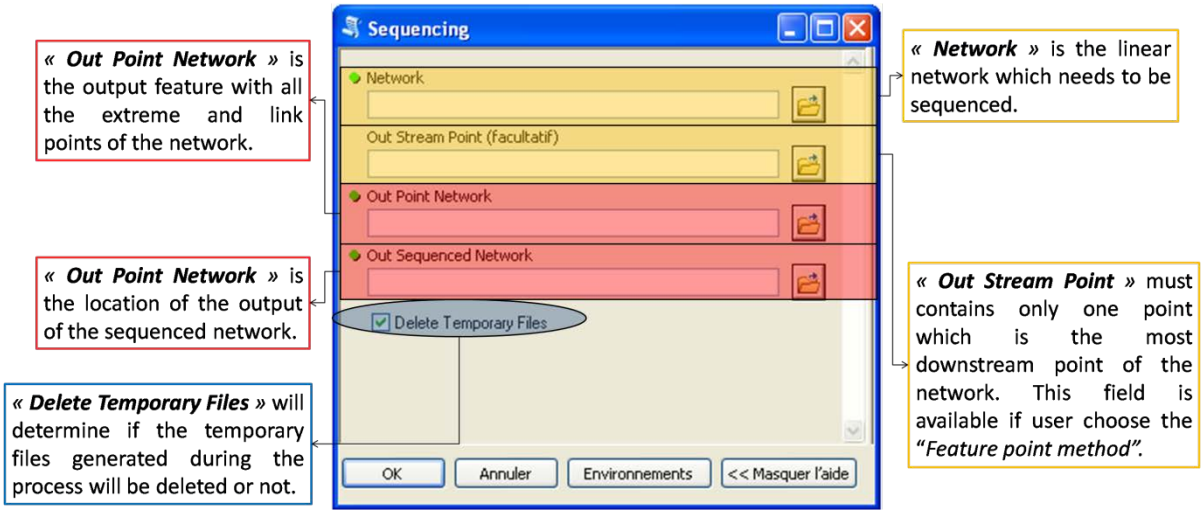

Figure 5 Screen user interface of *Sequencing* tool

In a first hand, user has to provide the network he wants to sequence in the "*Network*" fields. Then, the outstream point of the entire network is asked.

The field "*Out Point Network*" relates to the path name of the points feature with the links and extremities of the network. "*NextUpID*" and "*NextDownID*" populating the table of the output sequenced network come from the field "*OBJECTID*" of this set of points.

Finally, the "*Out Sequenced Network*" is the path name of the output sequenced network.

II.2. Management of temporary files

Temporary files created during the compilation are managed thanks to the ArcGIS default geodatabase (*%ScratchWorkspace%*). If the user does not modify this geodatabase in the general environment proprieties, its path must looks like C:\Documents and Settings\<user>\My Documents\ArcGIS\Default.gdb. With the box "*Delete Temporary Files*", the user has the choice to keep or erase temporary files.

III. Caution for use and limitations

III.1. Results

Presented results have been obtained with the *Sequencing* tool. Study area is the Durance watershed, upstream the Sisteron Dam, in the French Southern Alps (Fig. 6). This catchment extends over 6313 km^2.
The network is compounded by the centerline of the related valley bottom (tools *Centerline* and *Valley bottom* of the *FluvialCorridor* package). The outlet point has been created manually, just to the downstream extremity of the network.
The entire run requires about 40min. This computation time directly depends on the number of distinct streams into the network. In that case, the network extends over 1360 *km* and includes 313 streams and the tool has to proceed them one after another. Finally, the entire network is correctly oriented and attributed (Fig. 6).

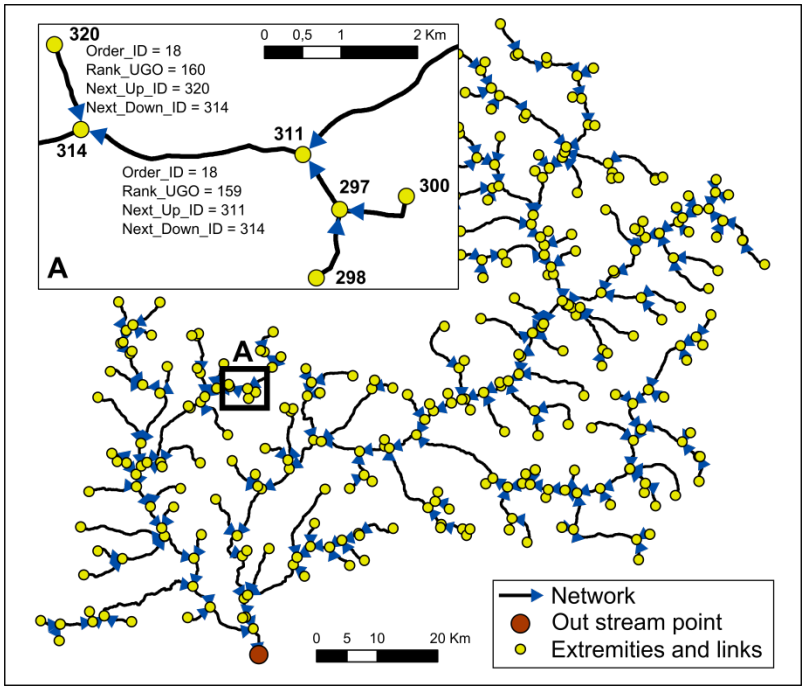

Figure 6 Sequencing result for the upper watershed of the Durance (~1250km and 313 streamlines)

III.2. Non exhaustive list of cautions and limitations

Loops into the network

Sequencing tool has not been developed to process possible loops within the network. Generally, the tool does not crash during such a run but the resulting network is not correctly sequenced (Fig. 7).

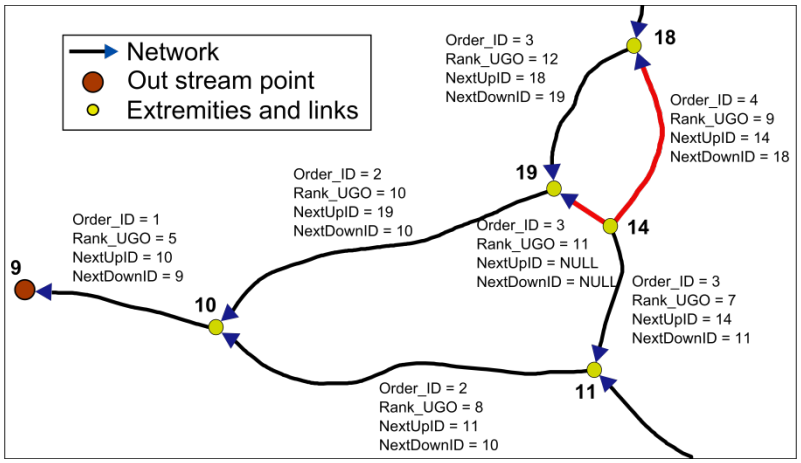

Figure 7 Case of a network including a loop between node 10, 19, 14, 11, and 18, 14, 19. Lines in red are wrongly oriented or attributed.

ANNEX 1

List of temporary files created during the *Sequencing* tool

Name	Description
InputFCMTS	"*Multi Part to Single Part*" ArcGIS function result. The input network is converted into a polyline shapefile in order to distinguish each contained line.
UDPts	Set of points corresponding to the links and extremities of the network. It is the output "*Out Points Network*".
NearTable	Table de proximité entre le point exutoire *Out Stream Pt* et le réseau.
EPt	Downstream point of the stream currently processed.
FPt	Upstream point of the stream currently processed.
FPtoSelect	Set of upstream points of all the streams of the network.