User guide for *FluvialCorridor* toolbox

Extraction of the centerline

Toolset name : *SPATIAL COMPONENT*

Tool's name : *Centerline*

How to cite : Roux, C., Alber, A., Piégay, H., 2013. Centerline 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

A crucial step for the fluvial corridors characterization is the assessment of metrics over linear (e.g. hydrographic stream network) or polygon (e.g. valley bottom, active channel) features. To ensure a geomorphologic analysis to be possible and to make it easier to proceed, these metrics must be available within a single entity. Centerline of the valley bottom, of the active channel or of a single fluvial reach can so be viewed as a linear reference axis over which all assessed metrics can be reported. This unit is of course not a real and physical unit but it is a key unit for metric analysis and metrics assessment.

Initially developed to extract the centerline of a valley bottom polygon over an entire watershed, this tool can also be used to extract the centerline of only one polygon (fluvial reach or any slender polygon).

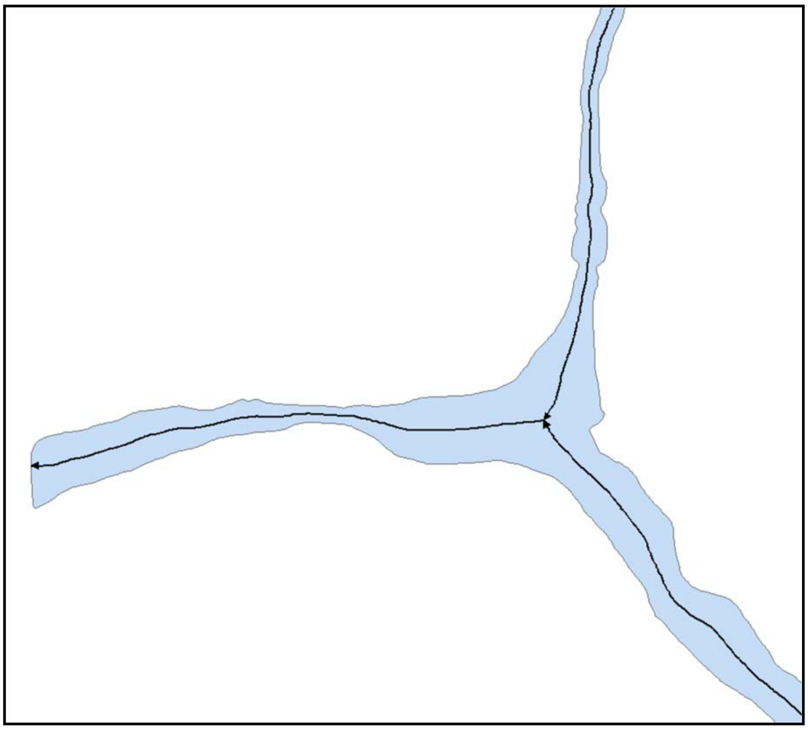

Figure 1 Centerline extracted with the *Centerline* tool of the *FluvialCorridor* toolbox (Le Guil river, French southern Alps).

Framework used in this tool has been inspired of the one developed by Alber and Piégay (2011) and it is based on a Thiessen polygonization of the input polygon.

Implementation of this extraction method has been done with a GIS software (ArcGIS 10.0) thanks to two vector layers. The first one representing the valley bottom and the second is the related hydrographic stream network.

General algorithmic framework

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

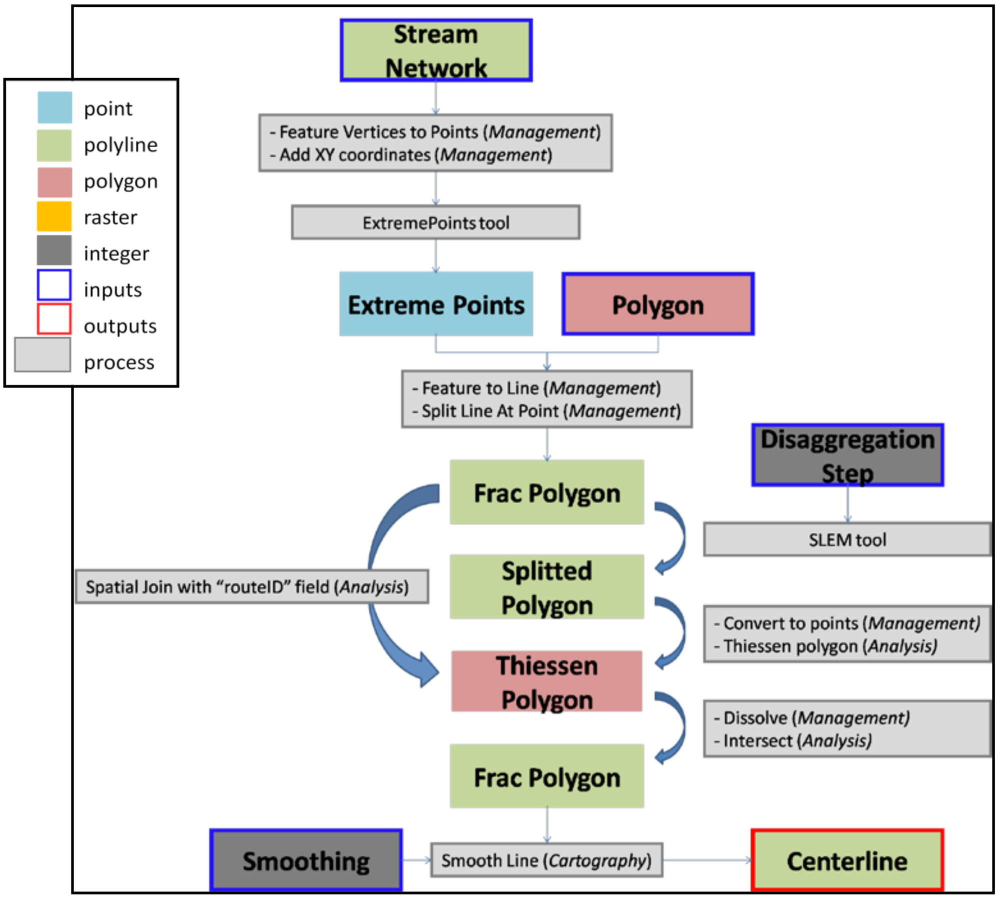

Figure 2 General algorithmic framework of the *Centerline* tool

Creation of the centerlines is based on a geomatic framework :

1. In a first hand, each extremities of the input polygon are stored into a set of points, extracted from the stream network. In this way, start and end points of each streams are extracted thanks to the *Feature To Points* ArcGIS tool and they are attributed with their (x, y) coordinates (Fig. 3A). Resulting shapefile is then run into the *ExtremePoints* tool (included into the *FluvialCorridor* package) to delete duplicates and only keep extremities (i.e. upstream sources of each tributaries and the extreme downstream point of the entire network) (Fig. 3B).
2. The second step consists in creating a set of points over the input polygon boundaries. These points will be used for the Thiessen polygonization. Firstly, boundaries are splitted at extremities with the extreme points (Fig. 3C). Resulting lines are then identified with a unique id "*Rank_UGO*" and are splitted in elementary segments with a constant user defined step (in meters) thanks to the *SLEM* tool (included into the *FluvialCorridor* package) (Fig. 3D). Each segments is converted into midpoint, transferring the origin line id "*Rank_UGO*".
3. Thiessen polygonization is finally applied over this set of points (Fig. 3E). Resulting set of polygons is dissolved according to the "*Rank_UGO*" field and then, converted into lines which are intersect with the input polygon in order to only retain the centerline (Fig. 3F).

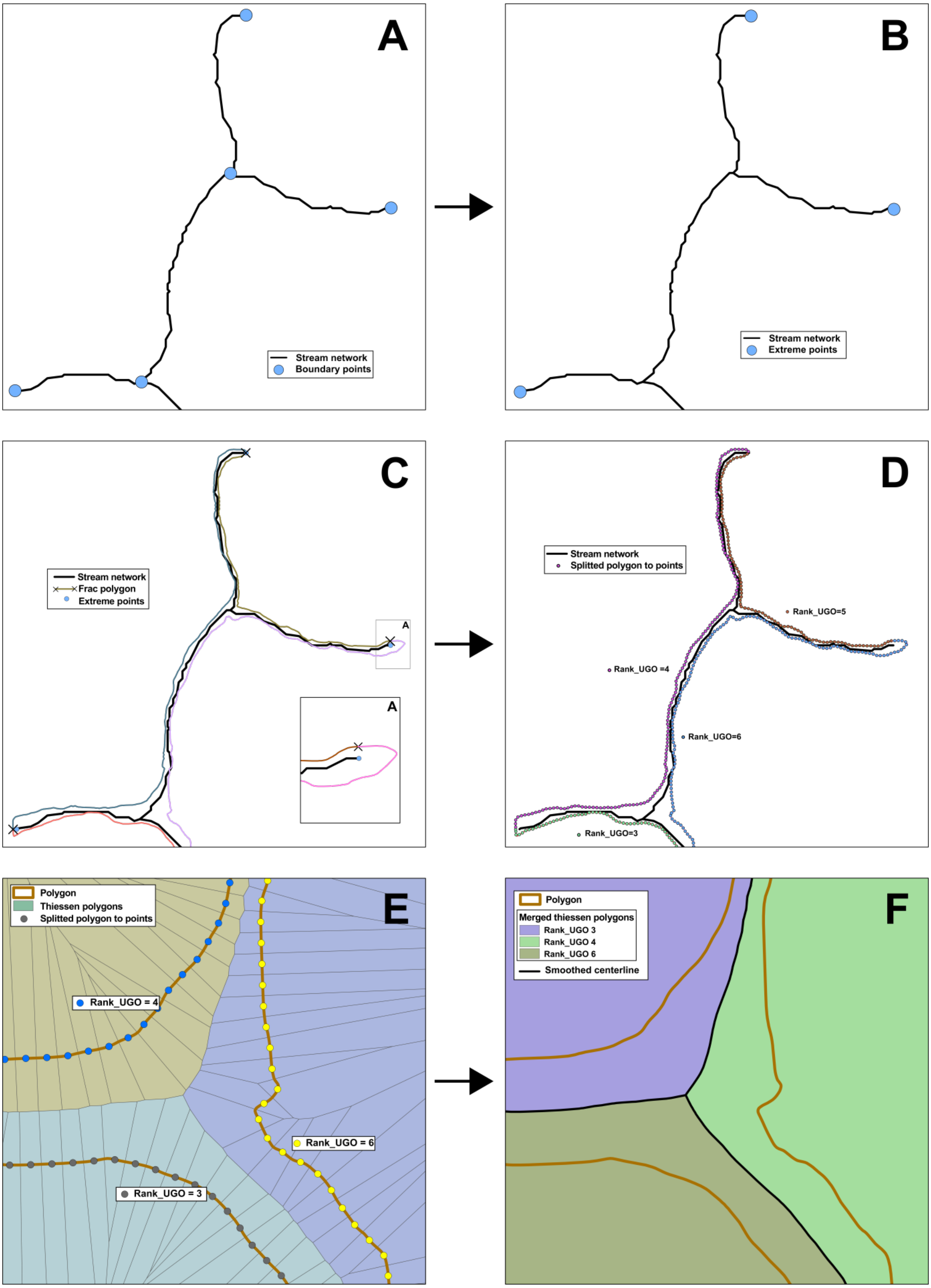

Figure 3 Geomatic process involves wihtin *Centerline* tool

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 *Centerline*, if a field is available, that means that it **must be filled**.

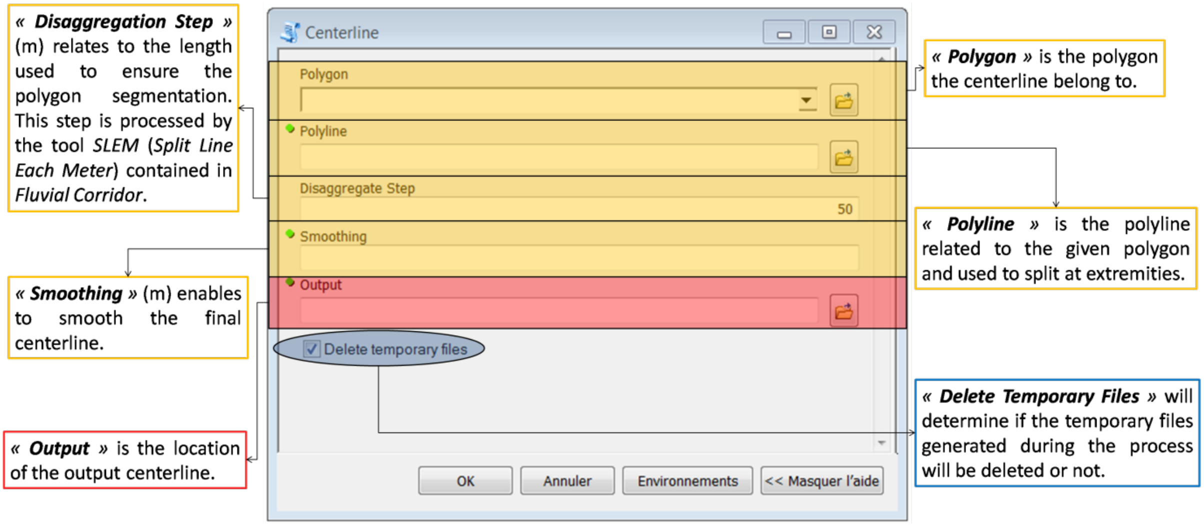

Figure 4 Screen user interface of the *Centerline* tool

Centerline tool does not involve a lot of parameters. In a first hand, user must provides the tow features required for a run : the polygon user wants to extract the centerline and the related polyline used to split the input polygon at extremities. The constant user defined step used to split the polygon boundaries is then asked. This parameter directly affects the output centerline accuracy and the computation time. A smoothing parameter has to be filled in the "*Smoothing*" field.

Note : Multi-part input polygon

The input polygon must contains only one subpart. Thus, when user fills the field "*Polygon*", a short process begins in which the polygon is converted into "*Multi Part To Single Part*" (ArcGIS function) to detect possible subparts. Number of entities is then counted and if there is only one part, user can fill next fields. If several subparts are counted, a warning message appears (Fig. 6). This checking process freezes the screen user interface during a few seconds during which one it is recommended to not fill other fields.

Note : Batch execution

In order to use the *Centerline* tool over a set of polygon (e.g. a set of fluvial reaches), it is possible to use it in "Batch" mode.

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 thanks to the *Centerline* tool. Study area is the Durance watershed upstream to the Sisteron dam, in French southern Alps. This catchment extends over $6314km^2$, with a hydrographic network of $\sim 616km$. Used valley bottom has been extracted with the *Valley Bottom* tool of the *FluvialCorridor* package. Parameters used for the valley bottom extraction have been set empirically in order to obtain a single part valley bottom polygon.
With a constant user defined step of 20m, computation time for such a study area is 5min 30sec.

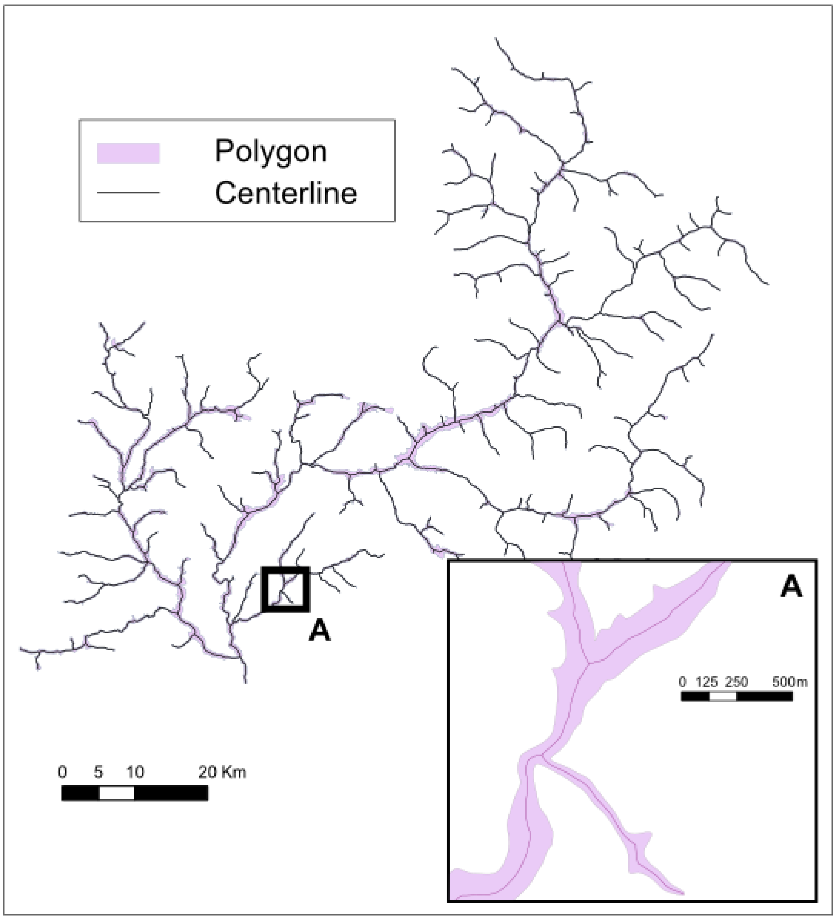

Figure 5 Results of the *Centerline* tool on the Durance catchment upstream the Sisteron Dam.

III.2. Non exhaustive list of cautions and limitations

A few biases can occur during the *Centerline* tool. They can be due to :

- the polygon and polyline input layers
- the values of the different asked parameters

a. Incorrect polygon

Framework used in *Centerline* requires the input polygon to be :

- a single part. If not, a warning message will appear and the process will be stopped (Fig. 6).

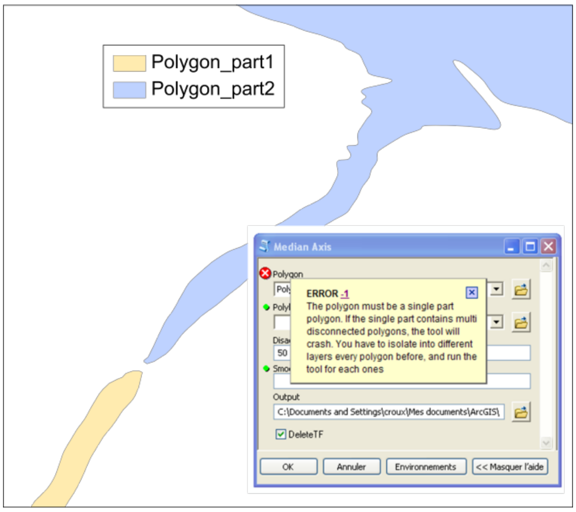

Figure 6 Discontinuous polygon leads to a warning message and stops the process.

- homogeneous (i.e. input polygon must not contain wholes. In that way, parameters of the *Valley* Bottom tool must be set precisely. User can also use the *Eliminate Polygon Part* ArcGIS tool.

  For a non homogeneous polygon, the tool will consider the polygon as a multi-channel unit (Fig. 7). Such a result could involve some problems if user wants to apply the next steps of the *FluvialCorridor* toolbox (e.g. *Sequencing*).

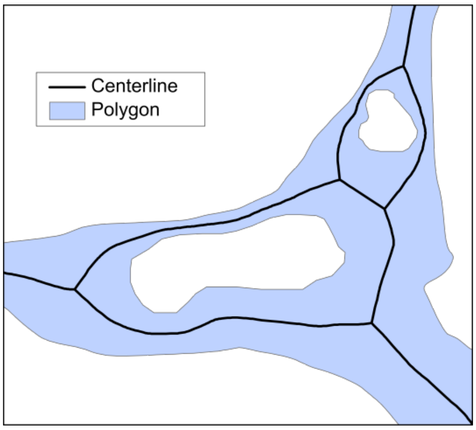

Figure 7 Inhomogeneous polygons are considered as multi-channel but can make *FluvialCorridor* workflow impossible.

b. Too coarse disaggregation step

A too to coarse step of segmentation will result in a wrongly defined centerline. In extreme cases, the output centerline could be discontinuous (Fig. 8).

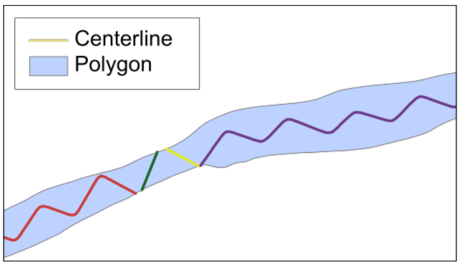

Figure 8 A too coarse disaggregation step leads to a discontinuous centerline.

c. Extremities lags

Accuracy of the input polyline used to extract extreme points also affects the output centerline quality (Fig. 9)

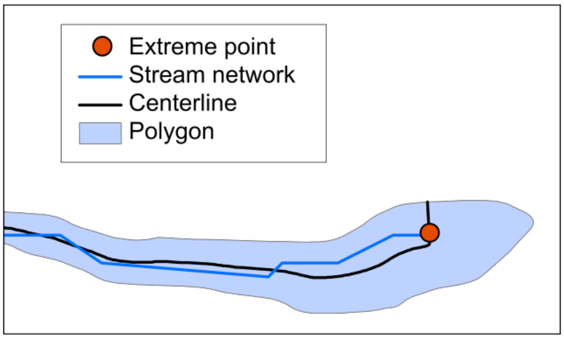

Figure 9 Lags between ends of polylines and real extremities of the polygon

ANNEX 1

List of temporary files created during the *Centerline* tool

Name	Description
ExtremePoints	Set of points with the extreme points of the input linear network.
PolyToLine	Conversion of the input polygon into lines.
NearTable	Table with the minimal distance between *ExtremePoints* and *PolyToLine*.
FracTEMP	Raw split *PolyToLine*.
FracTEMPToPoints	Conversion of *FracTEMP* into points.
FracVB_TEMP	A temp feature of the splitted *VBToLine*.
FracPoly	*PolyToLine* split with the *ExtremePoints* shapefile.
PolySplitTEMP	Temp split *FracPoly* (*SLEM* tool).
PolySplit	*PolySplitTEMP* sorted with the “*Rank_UGO*” and “*Distance*”fields.
PolySplitToPoint	*PolySplit* converted into a set of midpoints.
ThiessenPoly	Thiessen polygonization with the points of *VBToPoints*.
JoinTEMP	Spatial join between Thiessen polygons and *VBToPoint*.
Join	*JoinTEMP* sorted with the “*Rank_UGO*” and “*Distance*”fields.
Dissolve1	Dissolved *Join* with the “*Rank_UGO*” field.
DissolveToLine	*Dissolve1* converted into lines.
RawCenterline	Intersection of *DissolveToLine* and the input polygon.
Centerline_TEMP	Smoothed *RawCenterline*.
Centerline	Final centerline.