

## ***Elevation profiler*** (vers. 1 for ArcGIS 9.x)

### **Description**

*Elevation profiler* (see Krebs et al. 2015) is an open source GIS tool designed to work with ArcGIS that automatically calculates transverse or longitudinal elevation profiles of different lengths starting from a digital elevation model (e.g. high resolution Lidar DEM) and a shapefile of points (representing the midpoints of the profile segments). The calculated profiles are then saved in comma-separated tabular data files (.csv). The tool is conceived as a VBA macro, consisting of a form interface and five modules that can be added and executed from the visual basic editor in ArcMap. This VBA macro can be imported without problems in ArcGIS 9.3.1 (released in May 2009) and in previous versions. To import the VBA macro in ArcGIS 10.x a free of charge VBA license has to be requested from ESRI Customer Service.

### **Definitions**

An elevation profile represents the intersection of a vertical plane with the DEM surface. In particular, the Transverse Elevation Profile (TEP) is defined as a two-dimensional cross sectional profile in the vertical plane oriented perpendicularly to the maximum gradient direction, while the Longitudinal Elevation Profile (LEP) is a profile following the line of maximum slope (Krebs et al. 2015). These elevation profiles provide a real-scale visualization of the relief of the terrain and offer multiple possibilities for analyzing the topography and the terrain curvature around spatial points.

### **Interface**

Through a simple form interface the user can choose some parameters that define the characteristics of the required profiles. At first the user has to decide which type of profile (TEP or LEP) he want to obtain. Then with the *minimum length*, the *maximum length* and the *interval* the user decides the list of increasing lengths of the profiles he wants to obtain for each point or site. The *resolution* defines the number of points that will be created on the profile segments. For instance with a resolution of 1 meter a 100 meters long elevation profile will be composed by 101 segment points. The resolution has to be set by considering the cell size, or spatial resolution, of the DEM raster.

## How it works

Starting from the point features defined in the shapefile, and retaining these features as centers of the profile segments, the tool builds an elevation profile around every point. The orientation of the TEP is given by the pairs of opposed endpoints that minimize the absolute difference of altitude when projected on the DEM. On the contrary, the pairs of opposed endpoints maximizing the absolute difference of altitude defines the orientation of the LEP. For every segment point the Elevation profiler extracts the value of the altitude from the DEM by applying a bilinear interpolation. At the end the GIS tool saves all the results in various types of comma-separated tabular data files (.csv). In particular the elevation profiles for every site are saved as columns in a table with a row for every segment point containing the difference of altitude as regards the elevation of the site. The orientation of every profile segment and the spatial coordinates (X e Y) for all segment points are saved in two additional .csv tables.

## Installation

First, all the components of the tool (i.e. the five modules and the form interface) need to be imported in the visual basic editor in ArcMap. To achieve this, simply select 'Import File' in the 'File' drop down menu. Use the browse window to search the folder containing the six components of the tool. Select one of the components and press 'Open' button. Repeat the same procedure to import the five other components. To avoid this tedious import procedure, it is possible to open an ArcMap file with *Elevation profiler* included and ready to use. In this case it is necessary to add the feature and raster files (i.e. the shapefile and the DEM) needed for the calculations.

To open the form interface of *Elevation profiler*, select 'VBA Macros' (or 'Macros' depending on the version of ArcMap) in the 'Customize' (or 'Tools') drop down menu and then select 'Macros'. In the 'Macros' window simply press 'Run' button.

## References

- Krebs, Patrik; Stocker, Markus; Pezzatti, Gianni Boris; Conedera, Marco; 2015. An alternative approach to transverse and profile terrain curvature. *International Journal of Geographical Information Science*, 29(5), pp. 643-666.
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## Figures

**Figure 1:** The user interface form of the *Elevation profiler*.

**ELEVATION PROFILER**

**a** Profile type  
☒ Transverse  
☐ Longitudinal

**b** Select layer of points  
 Shapefile of points

**c** Select DEM  
 DEM

Segment settings

**e** Min length 10 m  
**f** Max length 60 m  
**g** Interval 10 m  
**h** Resolution 1 m

**i** Nr. of circle points 360

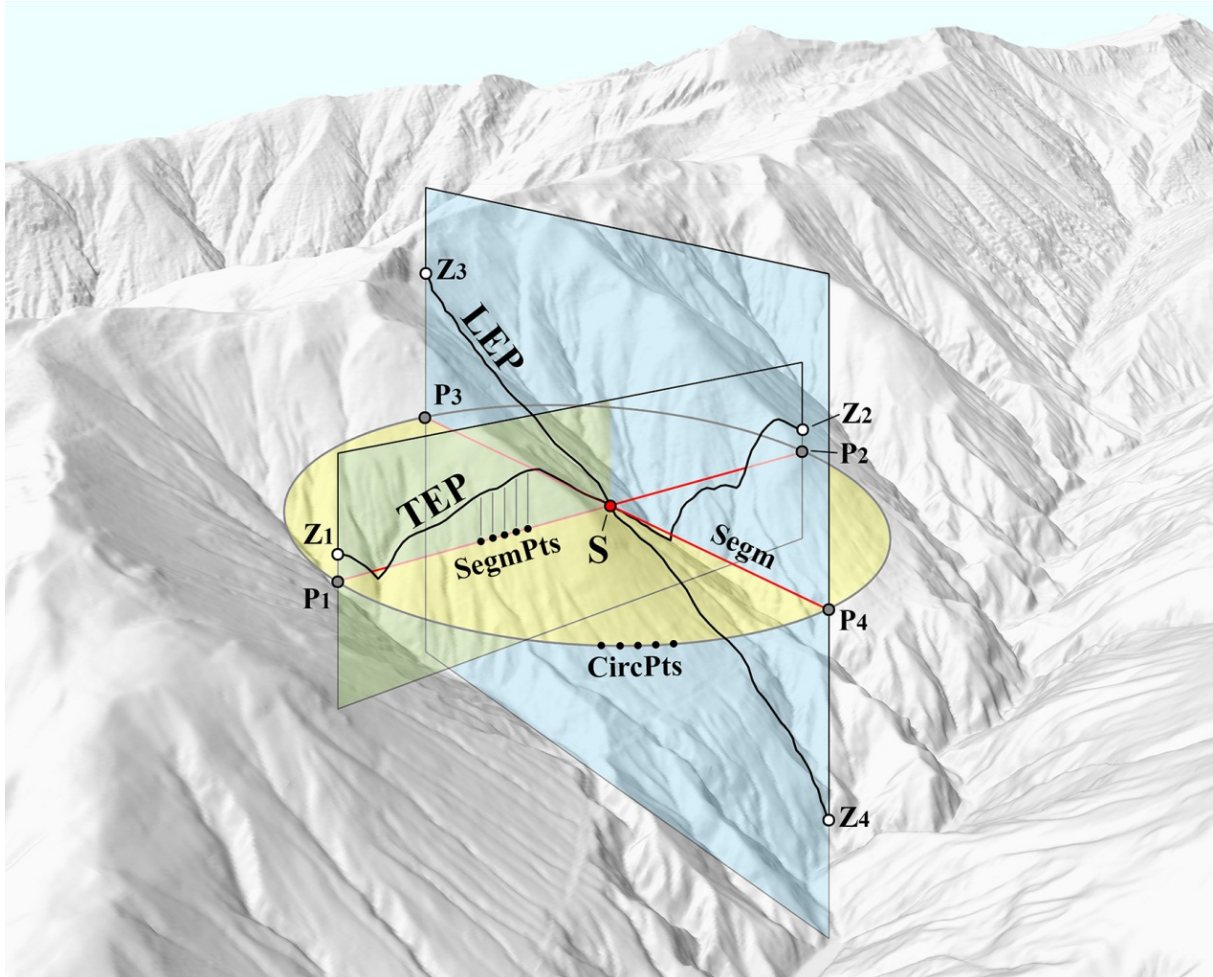
**j** Output folder  
 C:\Output\_Transverse\ Browse

**k** SUBMIT CANCEL

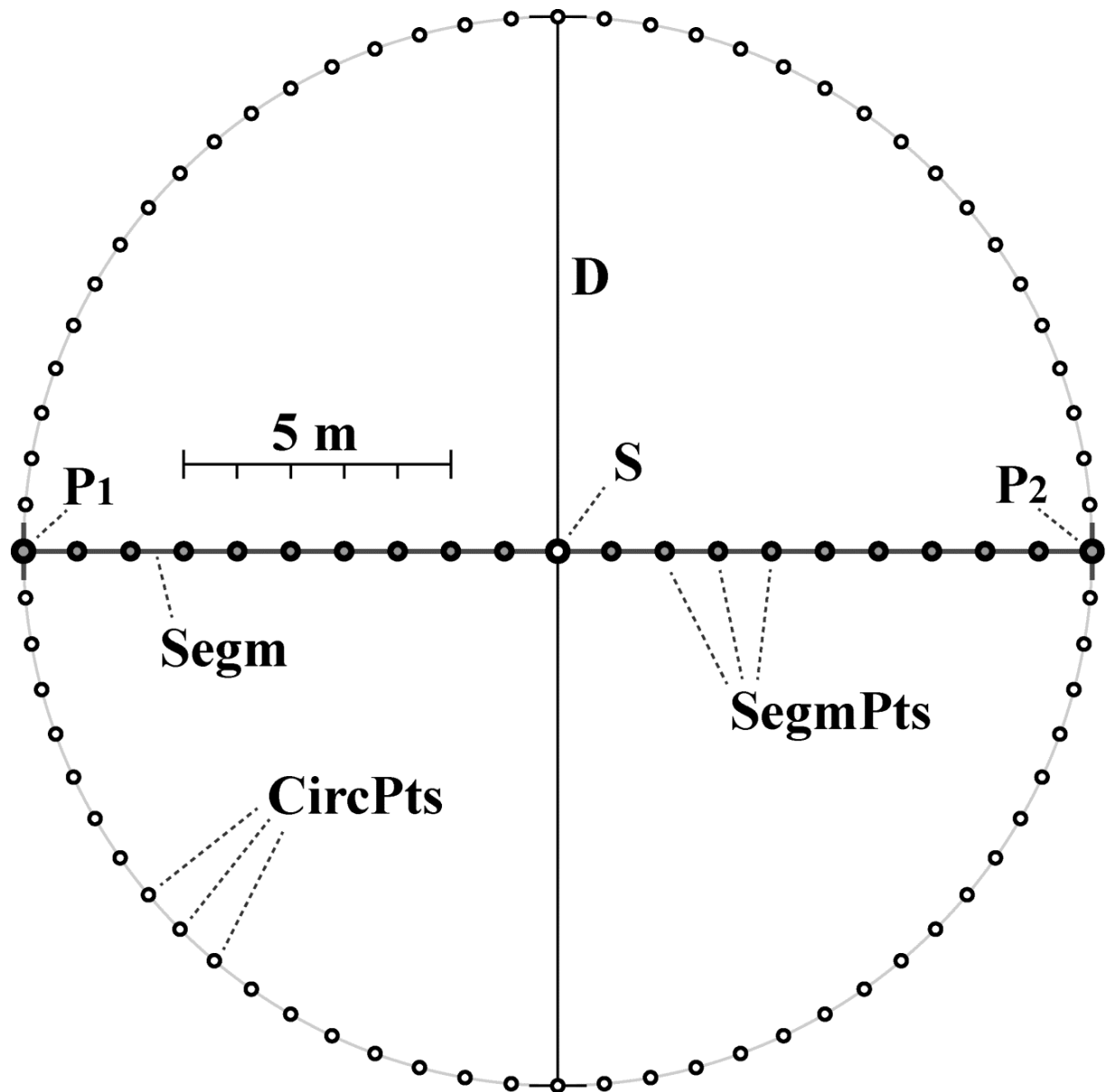
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- a)** Choose the desired type of profile. The transverse elevation profile is a cross profile oriented perpendicularly to the maximum gradient direction. The longitudinal elevation profile is the profile in the maximum gradient direction.
- b)** Select the shapefile with the spatial points around which the elevation profiles should be calculated.
- c)** The refresh button.
- d)** Select the digital elevation model (DEM) to be used.
- e)** The minimum length of the profile segment. This parameter defines the length of the shorter elevation profile that is to be calculated.
- f)** The maximum length of the profile segment. This parameter defines the length of the longer elevation profile that is to be calculated.
- g)** The interval defines by which step the length of the elevation profiles will be increased from the minimum to the maximum length. This value must be a divisor of the difference between the minimum and the maximum length.
- h)** The resolution is the distance between the points on the profile segment (see **SegmPts** in **Figure A.2**). This value must be a divisor of all three previous parameters (i.e. min length, max length and interval).
- i)** The desired number of points on the circle (see **CircPts** in **Figure A.2**). This parameter directly affects the precision of the orientation of the profiles and the time required for calculations.
- j)** The browse button to select a directory to be used to save all the output .csv tabular files.
- k)** Press the submit button to run the process with the defined parameters, or the cancel button in order to close the interface form.

**Figure 2:** The transverse elevation profile (TEP) and the longitudinal elevation profile (LEP) calculated starting from a site (S). To obtain these two vertical profiles, we draw a horizontal circle centered on the site with diameter equal to the desired profile segment length (Segm). The orientation of the TEP is given by the pair of diametrically opposed circle points (P1 and P2) minimizing the difference in altitude when projected on the DEM (Z1 and Z2), while the orientation of the LEP is given by the pair of opposed circle points (P3 and P4) maximizing the difference in altitude on the DEM (Z3 and Z4).

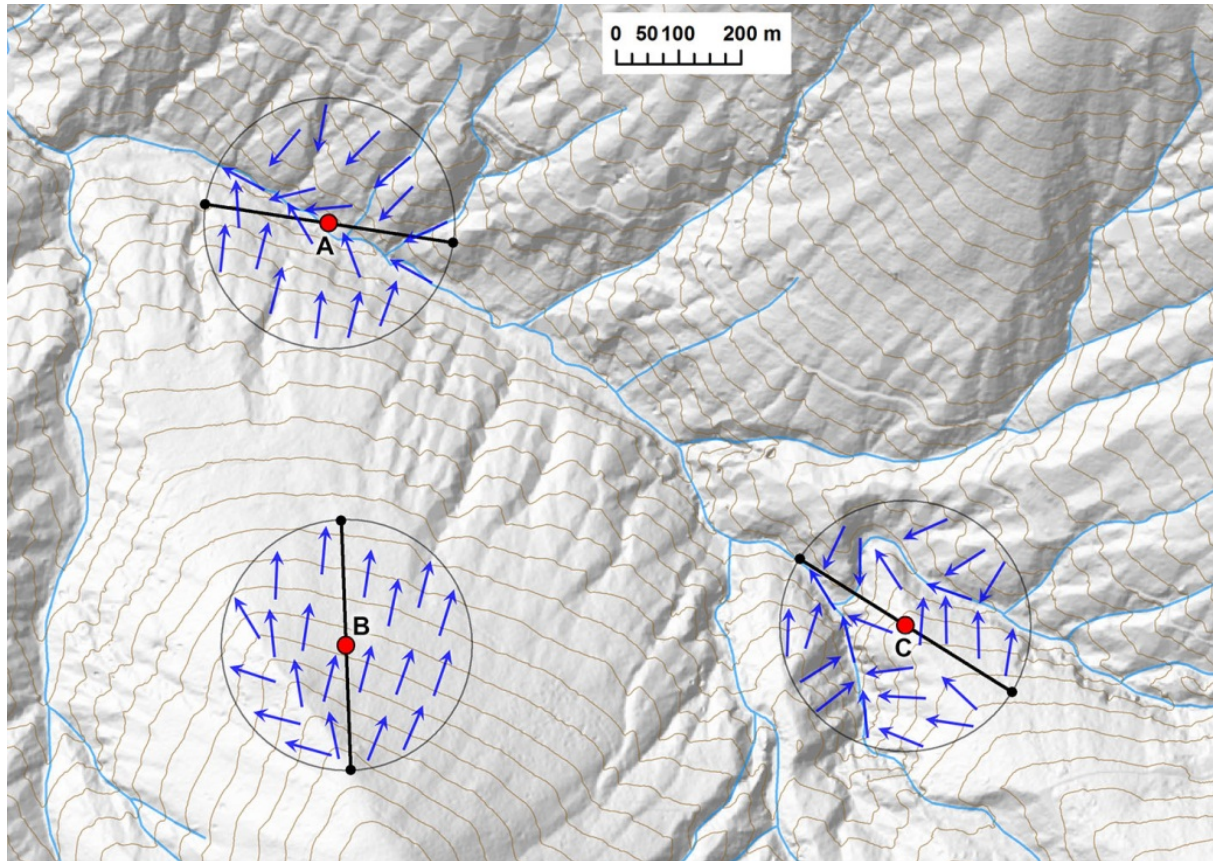


**Figure 3:** The procedure used to calculate a profile segment (**Segm**). In this example, the segment is 20 meters long, composed of 21 points (**SegmPts**), and its orientation is calculated with an imprecision of  $<5^\circ$ . Starting from the XY coordinates of the site (**S**), we build a circle with a 20 m diameter (**D**). On this circle, we place 72 points (**CircPts**), that is, one point every five degrees of rotation ( $72 \times 5^\circ = 360^\circ$ ).





**Figure 4:** Map showing the 400 meters long diameters along which the longitudinal elevation profiles (LEP) for the points A, B and C are calculated. LEP orientation is not dependent on the direction of the maximum slope gradient measured in a single point, but is instead related to the overall flow direction in the circle determined by the profile diameter (see the blue arrows). The contour interval is 30 meters.



**Figure 5:** Map showing the 400 meters long diameters along which the transverse elevation profiles (TEP) for the points A, B and C are calculated. TEP orientation is related to the overall direction of the contour lines in the circle determined by the profile diameter (see the brown arrows). The contour interval is 30 meters.

