



P2P Tools

## Surface Topographic Parameters – STP Tool

# User's Manual

Version 1.50

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The availability of high-resolution DEM data allows one to accurately characterize surface topography, which further improves watershed delineation and the related hydrologic and environmental modeling. The quantitative DEM-based analyses provide essential hydrotopographic information. This program facilitates the computations of a set of commonly used surface topographic parameters, including slope, aspect, profile curvature, plan curvature, tangential curvature, and mean curvature.

### 1. Slope ( $S$ )

Slope is given by (Hengl and Reuter, 2008):

$$S = 100\sqrt{m^2 + n^2} \quad (1)$$

where  $S$  = slope (%);  $m = \partial z / \partial x$ ;  $n = \partial z / \partial y$ ;  $z$  = elevation; and  $x, y$  = coordinates.

### 2. Aspect ( $A$ )

Aspect can be expressed as (Olaya, 2008):

$$A = -90(1 - \text{sign}(n)) \cdot (1 - |\text{sign}(m)|) + 180(1 - \text{sign}(m)) - \frac{180}{\pi} \cdot \text{sign}(m) \arccos\left(\frac{-n}{\sqrt{m^2 + n^2}}\right) \quad (2)$$

$$\begin{cases} \text{sign}(n), \text{sign}(m) = 1 & n, m > 0 \\ \text{sign}(n), \text{sign}(m) = 0 & n, m = 0 \\ \text{sign}(n), \text{sign}(m) = -1 & n, m < 0 \end{cases} \quad (3)$$

It should be noted that aspect is not defined if slope is zero.

### 3. Curvatures ( $\kappa$ )

Depending on the purpose, different curvatures can be calculated for different directions. Four types are included in the STP program.

#### 3.1. Profile Curvature ( $\kappa_{\text{Prof}}$ )

Profile curvature is in the direction of the gradient and signifies the change of slope angle (Mitášová and Hofierka, 1993).

$$\kappa_{\text{Prof}} = -\frac{m^2 \cdot i - 2m \cdot n \cdot i \cdot j + n^2 \cdot k}{(m^2 + n^2)\sqrt{(1 + m^2 + n^2)^3}} \quad (4)$$

where  $i = \partial^2 z / \partial x^2$ ;  $j = \partial^2 z / \partial x \partial y$ ; and  $k = \partial^2 z / \partial y^2$ .

### 3.2. Tangential Curvature ( $\kappa_{Tan}$ )

Tangential curvature is measured normal to the plane in the direction perpendicular to gradient and it is always tangent to the contours (Mitášová and Hofierka, 1993).

$$\mathbf{K}_{Tan} = -\frac{n^2 \cdot i - 2m \cdot n \cdot j + m^2 \cdot k}{(m^2 + n^2)\sqrt{1 + m^2 + n^2}} \quad (5)$$

### 3.3. Plan Curvature ( $\kappa_{Plan}$ )

Plan curvature is in the direction perpendicular to gradient and measures the change in aspect angle. Normally, this is measured in a horizontal plane (Mitášová and Hofierka, 1993).

$$\mathbf{K}_{Plan} = -\frac{n^2 \cdot i - 2m \cdot n \cdot j + m^2 \cdot k}{\sqrt{(1 + m^2 + n^2)^3}} \quad (6)$$

### 3.4. Mean Curvature ( $\kappa_{Mean}$ )

Mean curvature is the average of profile and tangential curvatures. It shows the mean concavity or convexity, in which accumulations are given by positive values (Olaya, 2008).

$$\mathbf{K}_{Mean} = \frac{1}{2}(\mathbf{K}_{Prof} + \mathbf{K}_{Tan}) \quad (7)$$

## 4. STP Program

The STP software is designed to compute the aforementioned topographic parameters. The outputs can be displayed in tabular and graphic formats. Its user's interface consists of seven command buttons and one combo box.

**Load DEM:** Use this button to load the DEM data in a format of text (\*.txt) or data (\*.dat). Note that all buttons are disabled if a file is not loaded.

**Calculate:** This button triggers all parameter calculations. If it is successful, a message box will pop up. All the aforementioned topographic parameters are calculated and saved in a text format in the same directory as the DEM file.

**Display:** The display button works in conjunction with the parameter combo box. The active parameter in the combo box will be plotted.

**Show Table:** This is used to display the output in a tabular format. All the input and output parameters are listed in the table.

**Quick Tips:** This provides users with brief helpful information on the software.

**Manual:** This allows users to access the user's manual.

**Close:** This button will close the program.

## 5. Program Outputs

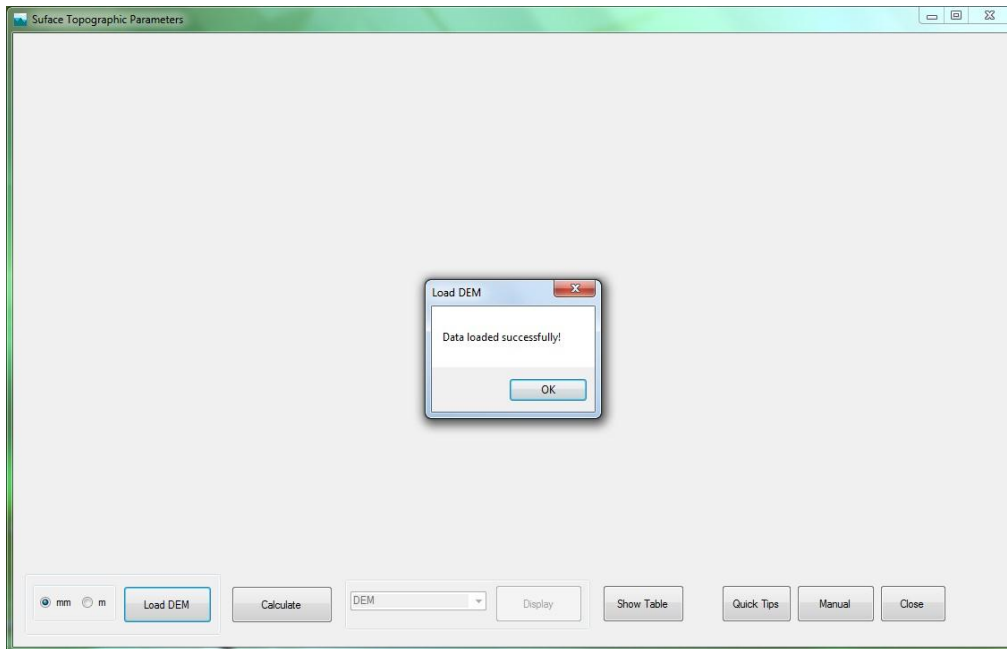


Figure 1 Main interface and data loading

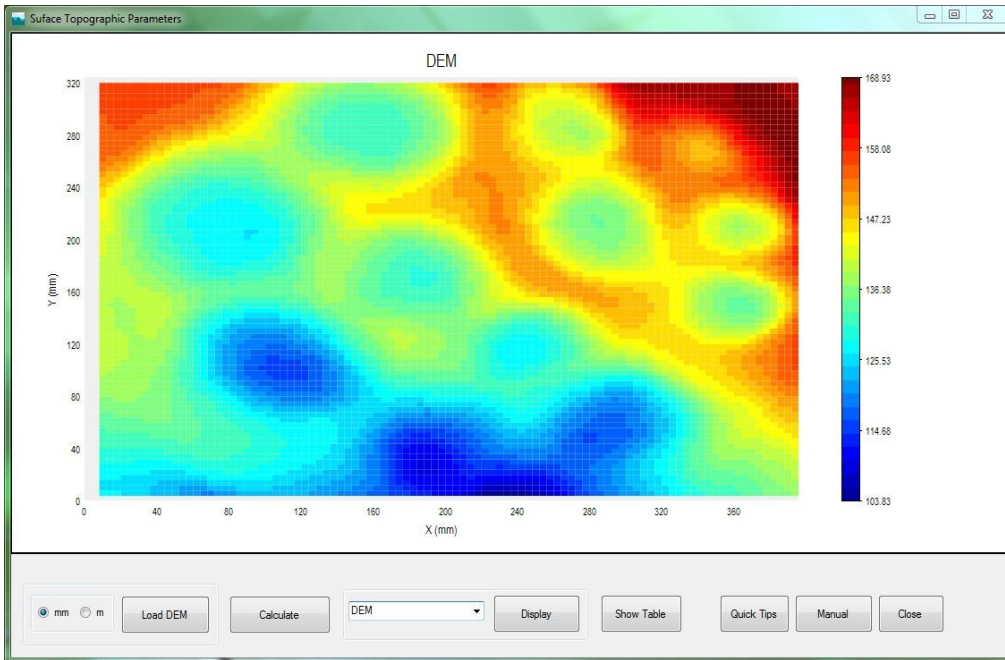


Figure 2 Digital elevation model (DEM)

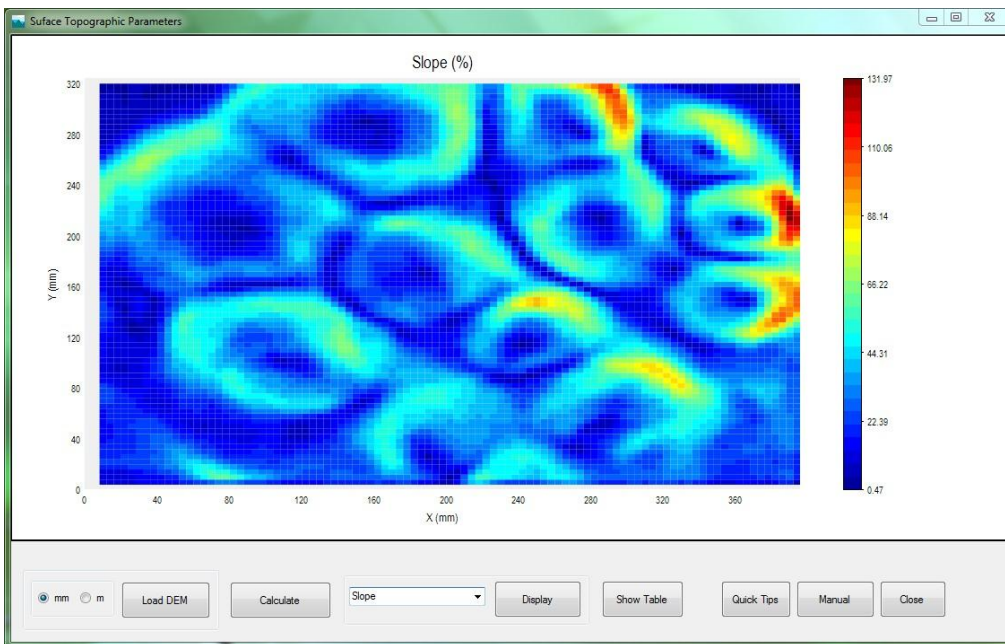


Figure 3 Slope distribution

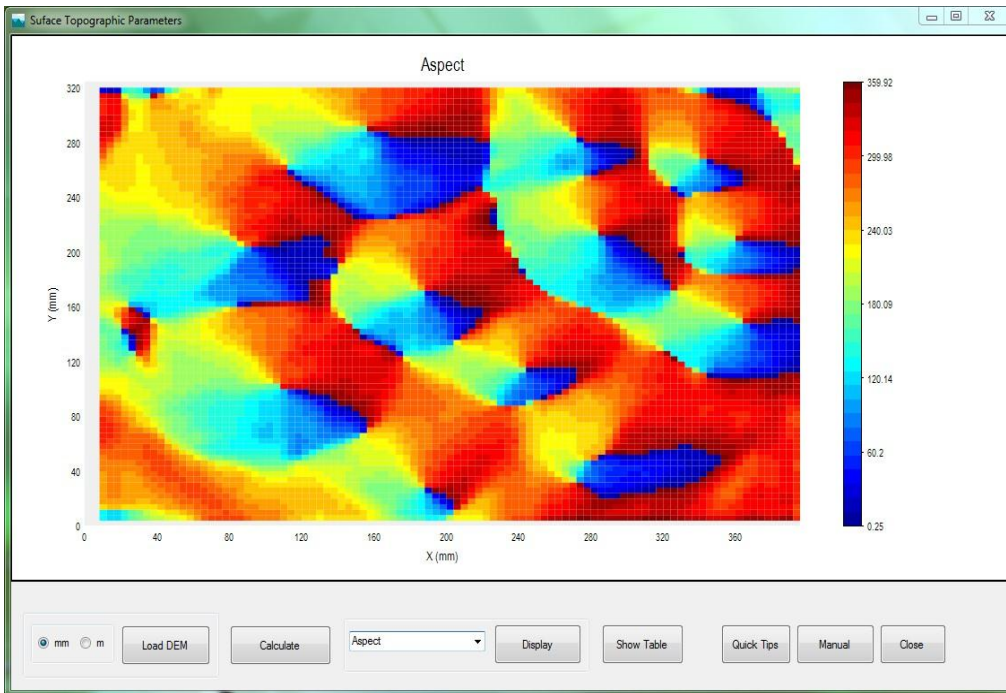


Figure 4 Aspect distribution

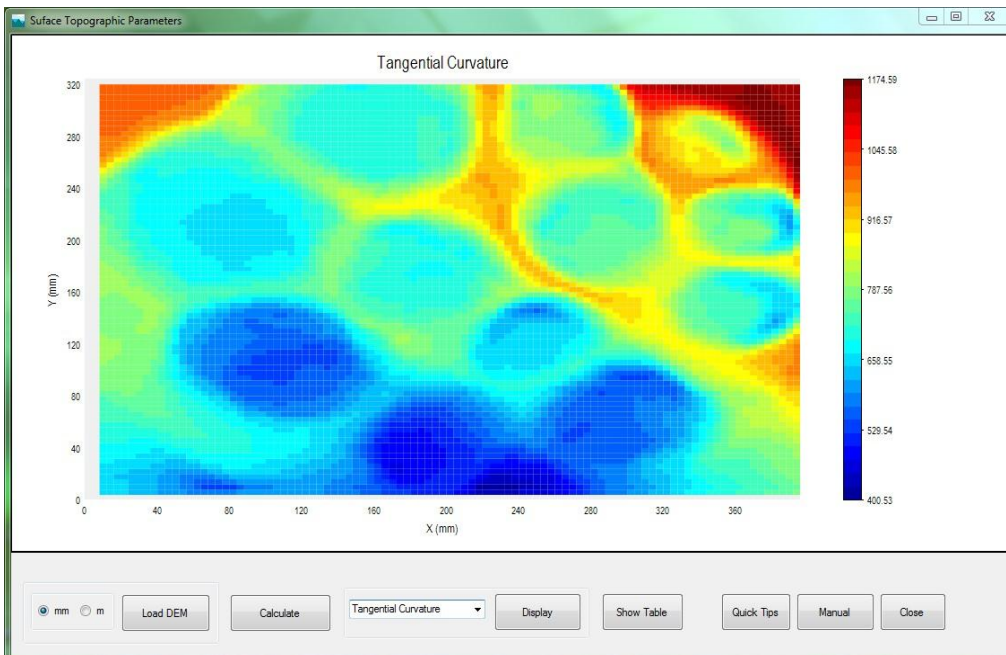


Figure 5 Tangential curvature distribution

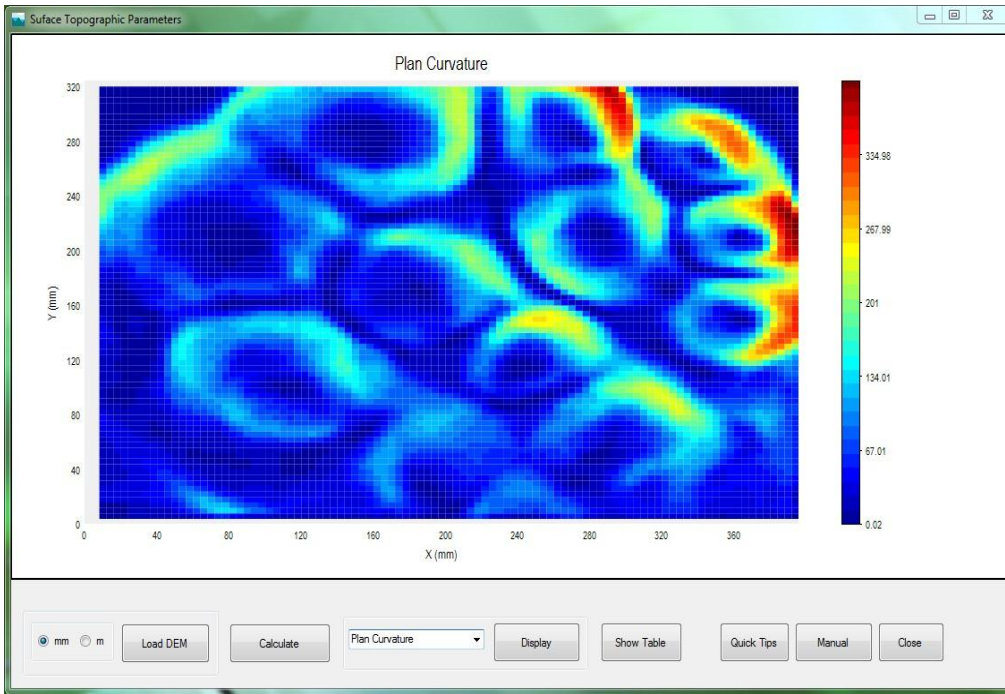


Figure 6 Plan curvature distribution

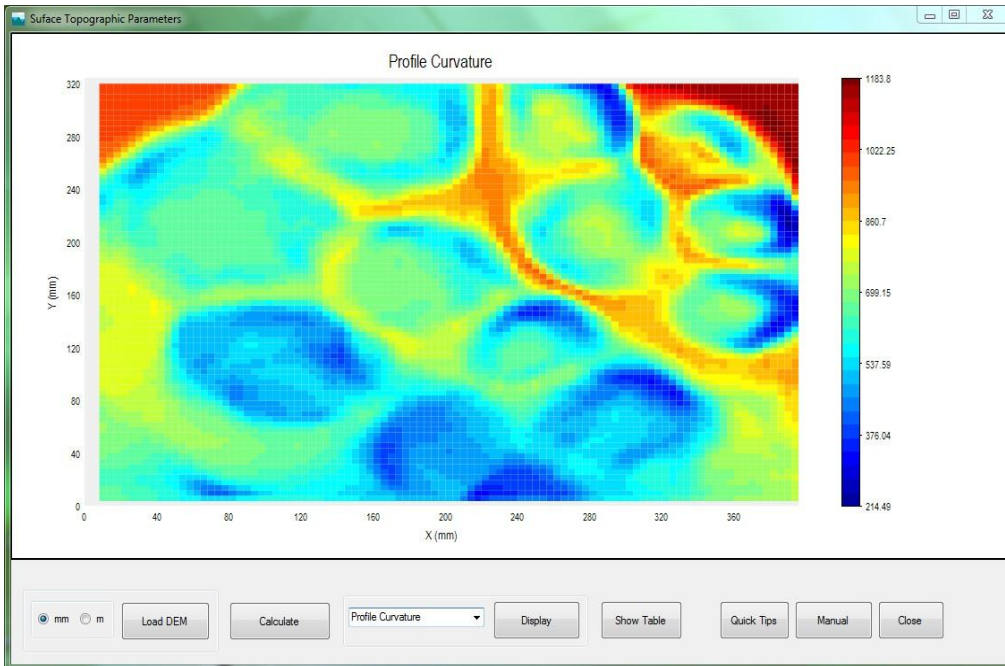


Figure 7 Profile curvature distribution



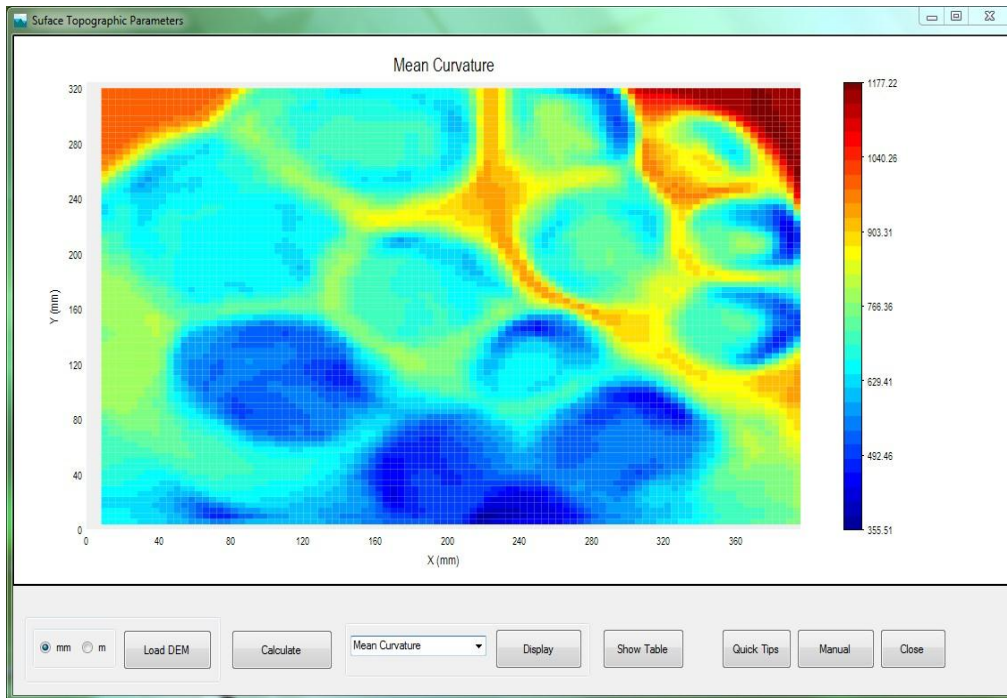


Figure 8 Mean curvature distribution

## References

- Hengl, T., and Reuter, H. I. (2008). *Geomorphometry: Concepts, Software, Applications. Developments in Soil Science Series*, vol. 33, Elsevier.
- Mitášová, H., and Hofierka, J. (1993). “Interpolation by regularized spline with tension, II Application to terrain modelling and surface geometry analysis.” *Mathematical Geology*, 25, 657–669.
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