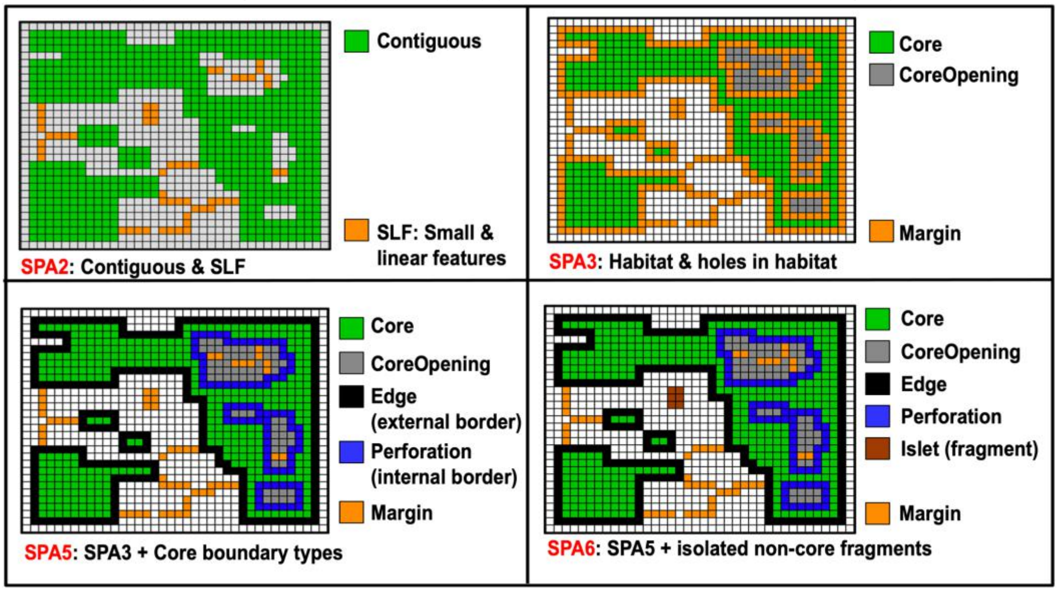
GTB-tools in container: Image Analysis → Pattern
Task: summarize morphology and object configuration

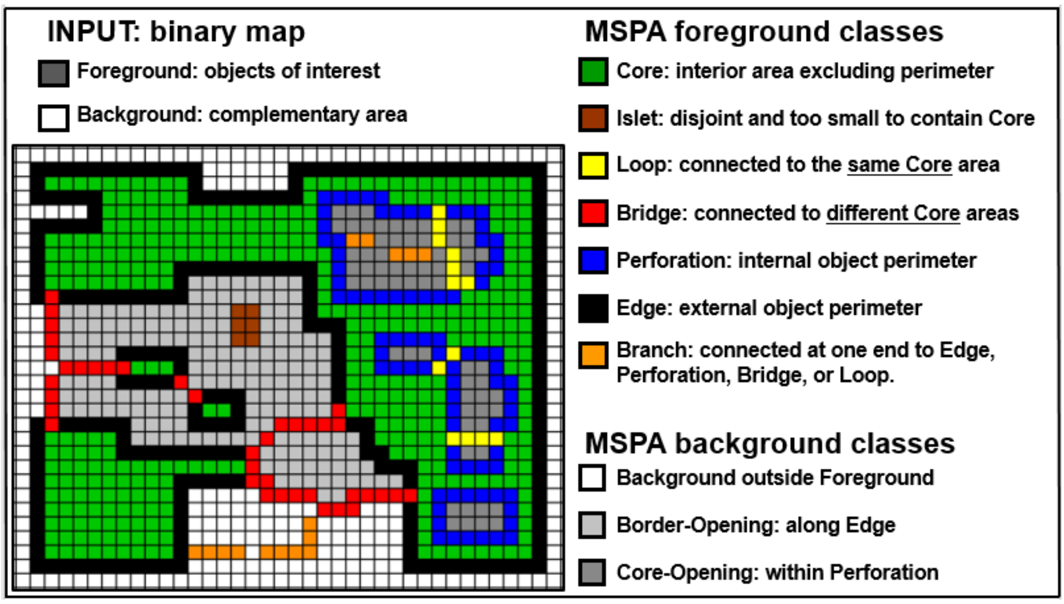
Morphological (← click for product sheet)

Question: what are the morphological features of the foreground objects (2 byte)?

We use a customized sequence of mathematical morphological operators to describe the geometry and connectivity of the foreground image objects. Based on geometric concepts only, this method can be applied at any scale and to any type of digital maps in any application field. The following options are available:



The chart above shows the Simplified Pattern Analysis (SPA) providing a total of 2 up to 6 morphological feature classes. SPA cannot detect connecting pathways and the EdgeWidth is fixed to 1 pixel.



The chart above shows the Morphological Spatial Pattern Analysis (MSPA) providing up to 23 feature classes, with variable EdgeWidth and detecting different types of connecting pathways. All features and processing options are summarized in the dedicated MSPA Guide or can be found on the MSPA website.

The last menu entry *MSPA Tiling* will perform a MSPA-analysis with an automated buffered tiling of a single image, which is larger than the maximum GTB-supported image dimension for MSPA processing (MS-Windows: 10,000^2 pixels; Linux/macOS: larger than 10,000^2 pixels depending on the available free RAM).
Note: MSPA-tiling is constrained to using an EdgeWidth of 1 pixel. It is also a less than ideal and time-consuming solution, which is not guaranteed to provide exact results. We strongly recommend using GWB for MSPA processing of large images!

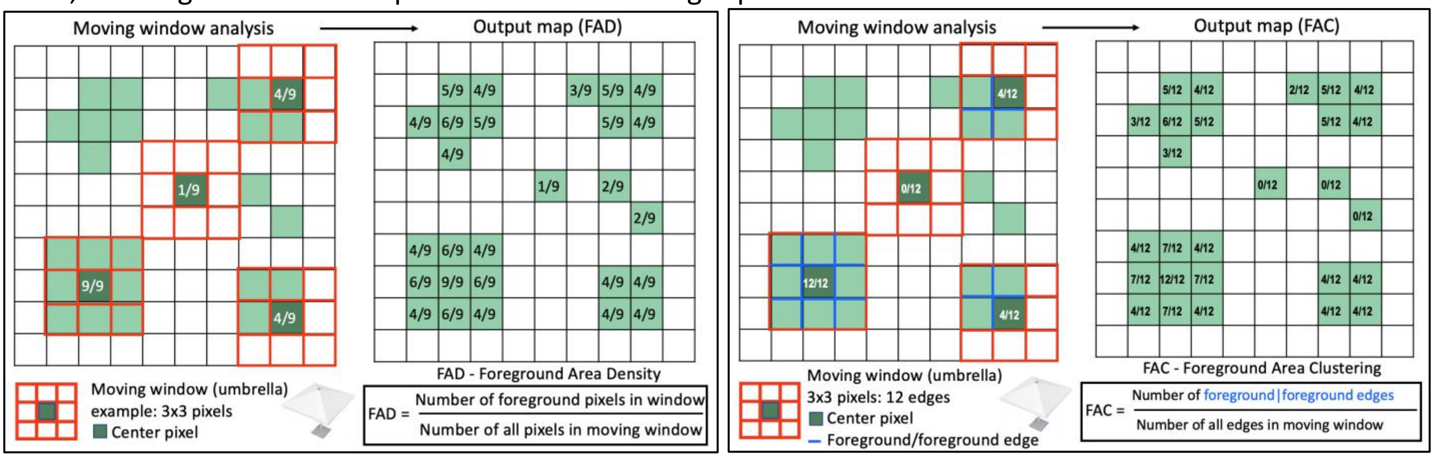
How: load a map with foreground objects (2 byte) and run the SPA or MSPA analysis.

Result:
Statistics: summary of area [pixels] and occurrence frequency in each pattern class.
Map: color-coded map showing location of foreground objects in each pattern class, see above and with all details in the dedicated Morphology product sheet.

Moving Window

Question: which features do we have in the local neighborhood?

We conduct a focal or moving window analysis over each pixel of interest. Think of it as opening an umbrella over a foreground pixel, do the assessment for the area covered under the umbrella (local neighborhood), and assign the result to the center pixel of the umbrella in the output map. The process is repeated over each foreground pixel and illustrated at four example locations using a 3x3 neighborhood (umbrella) in the following chart, showing FAD in the left panel and FAC in the right panel:



The area in the local neighborhood is analyzed either by counting pixels (above left), or by counting the edges between neighboring pixels (above right).
Note: these and many more moving window metrics are available in the command line program GWB.

a) Counting pixels - Question: what is the proportion of cells of interest in the local neighborhood?

This section provides the two pixel, or cell density metrics *Landscape Mosaic* and *Density*. Here, we count the proportion of cells with a specific attribute with respect to the number of cells covered by the umbrella/window.

For those metrics, missing cell values are not included in the calculation, and the calculation result is missing if all cells in the window are missing.

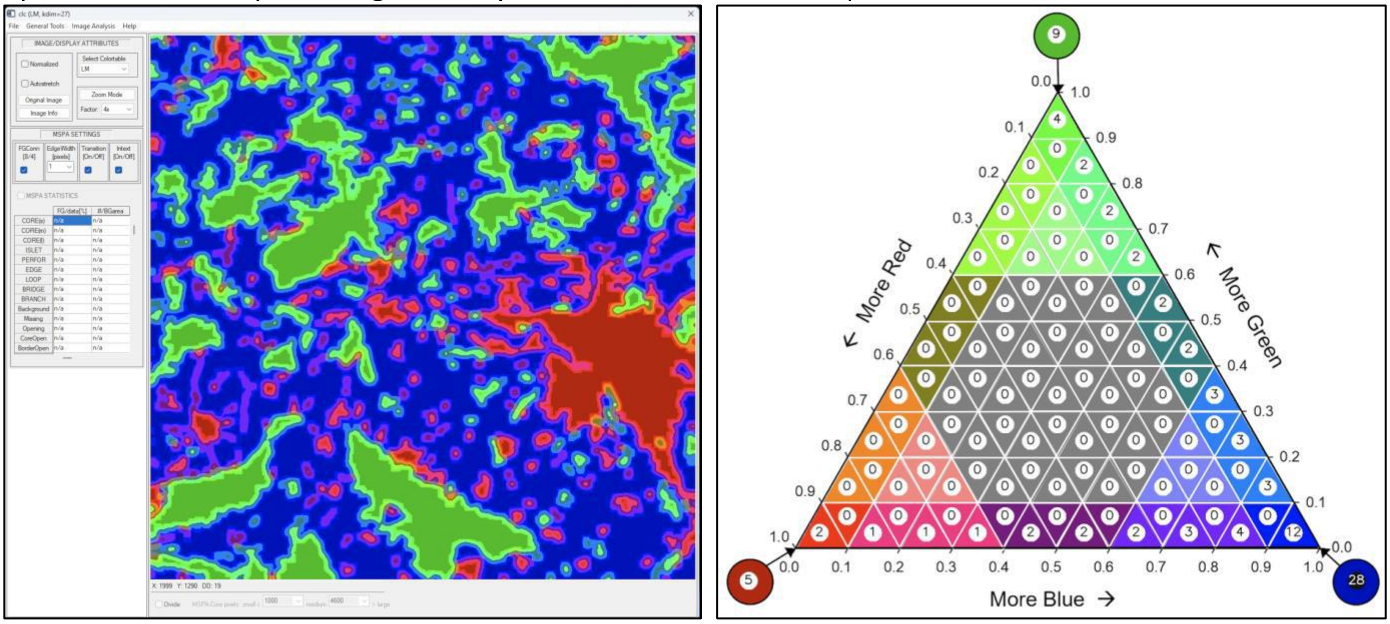
Landscape Mosaic (← click for product sheet)

Question: what is dominant landcover type in the local neighborhood?

The Landscape Mosaic (LM) is a tri-polar classification of a location accounting for the relative contributions of the three landcover types Agriculture, Natural, Developed in the window surrounding that location. The classification model is designed to identify anthropogenic activity (landcover classes falling in the categories Agriculture and Developed) in relation to natural landcover. The analysis scale is driven by the size of the moving window (umbrella). The Landscape Mosaic and its heatmap summary can be used as a state variable to measure the degree of landcover heterogeneity, locate areas exhibiting dominant and/or highly intermixed landcover. Due to its setup for provision of a normalized measure, the Landscape Mosaic can also be used to directly quantify changes in landcover dominance over time as well as directly compare the degree of landcover heterogeneity and composition of different sites.

How: load a LM-compatible input map (a Byte array with no more than 3 target classes with the assignment AND (1-Agriculture, 2-Natural, 3-Developed, plus an optional class for missing values: 0 Byte) and run the LM analysis.

Result:
Statistics: heatmap summary or proportion of occurrence frequency in each LM class.
Map: color-coded map showing Landscape Mosaic classes for each pixel at the user-selected observation scale.



The chart above shows an example of the Landscape Mosaic processing. The left panel shows the mosaic classes: each pixel or cell on the map has a certain contribution of Agriculture, Natural, Developed landcover within its local neighborhood of 27 x 27 pixels. The right panel shows the occurrence frequency distribution of all pixels: for example, the green circle at the top of the triangle implies that 9% of all pixels in the Landscape Mosaic map are fully natural, meaning their local neighborhood is composed of natural landcover only. Many pixels in the map have a certain contribution of Agriculture, Natural, Developed landcover in their local neighborhood, which is represented by a respective sub triangle within the Landscape Mosaic triangle. Further details on processing options and application examples can be found in the Landscape Mosaic product sheet.

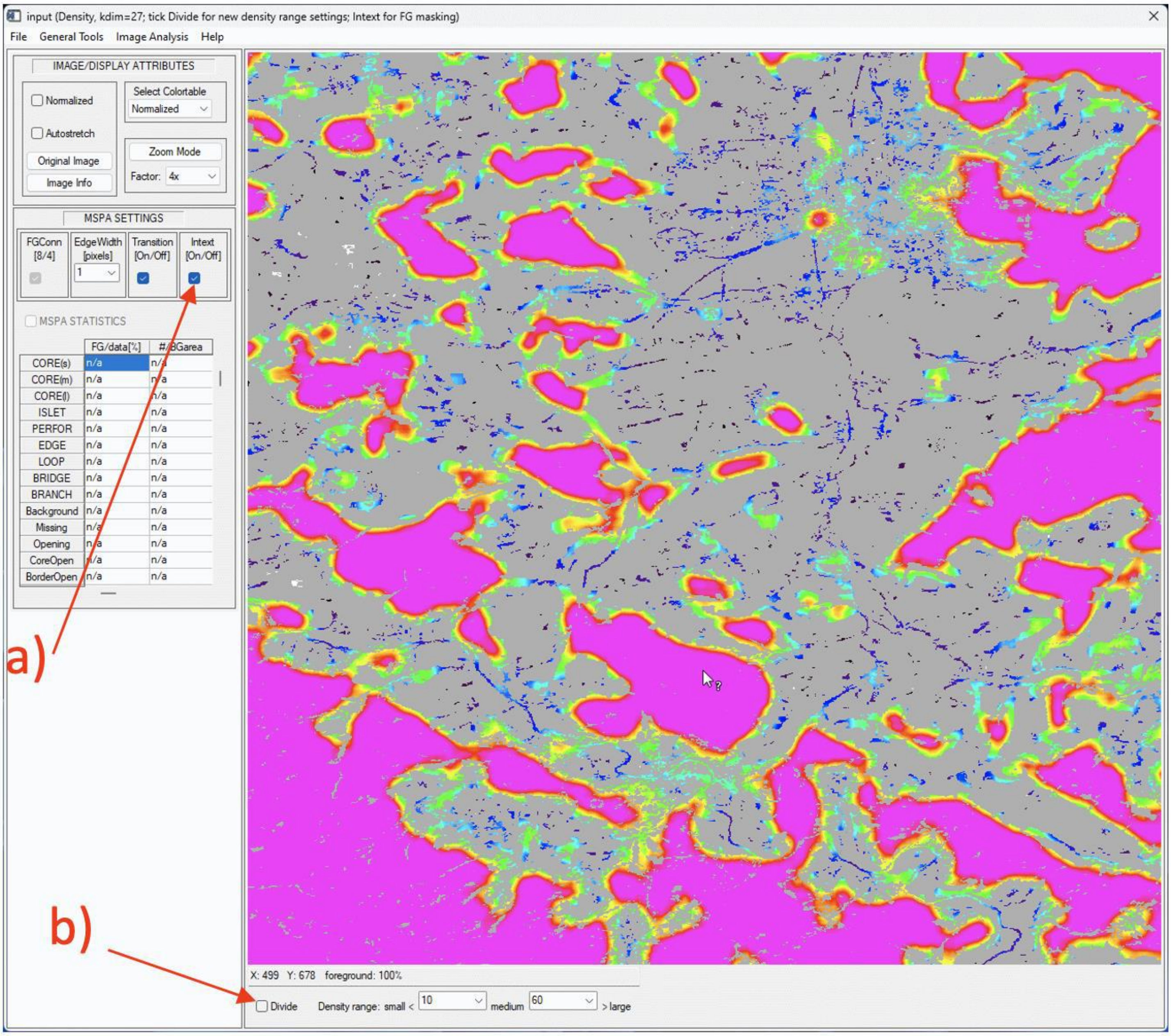
Density

Question: what is the proportion of foreground pixels in the local neighborhood?

We conduct a moving window analysis calculating the foreground area density (FAD), which is the proportion of foreground pixels (pixels with a value of 2 byte) with respect to the total number of pixels under the umbrella.

How: load a map with foreground objects (2 byte) and run the Density analysis.

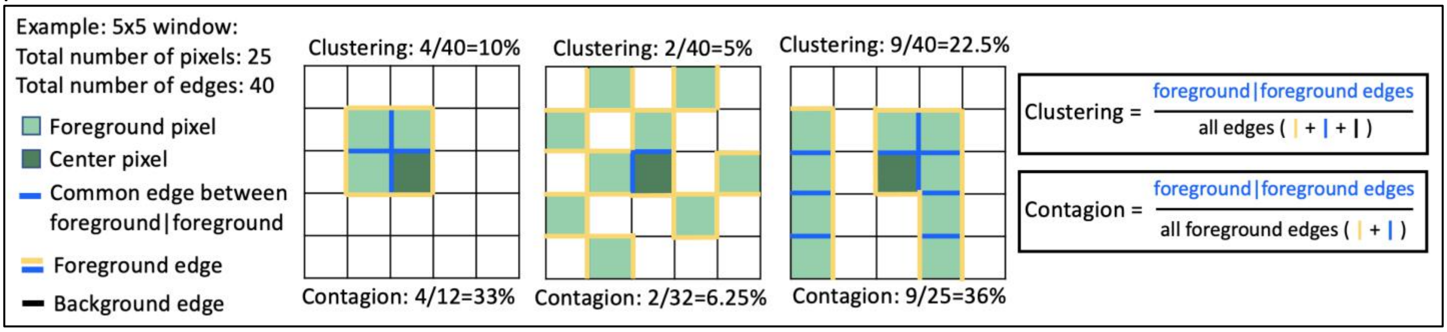
Result:
Map: color-coded map showing Density (FAD) over each location on the map.



The map above shows an example of the foreground area density analysis calculating the proportion of foreground cells in the local neighborhood. Click the MSPA-parameter 4 *Intext* (a) to mask the result for the foreground area only, and/or use the box *Divide* (b) below the viewport to group the FAD values into custom density range of small, medium, and large.

b) Counting edges - Question: what is the proportion of foreground edges in the local neighborhood?

This section provides the two metrics *Clustering* and *Contagion*. Here, we count the proportion of foreground-foreground edges with respect to either the total number of foreground edges (Contagion), or all edges covered by the umbrella/window (Clustering). An edge is the horizontal or vertical line intersection between neighboring pixels.



The chart above shows the difference between the metrics Clustering and Contagion illustrated for three constellations on a 5x5 map. The total of 40 edges inside the 5x5 window is composed of edges having either foreground on both sides (marked in blue), or edges having foreground on one side only (marked in yellow), or edges not having foreground on either side (marked in black).

Clustering
Question: what is the degree of foreground clustering within the area of the local neighborhood?

Clustering, or Foreground Area Clustering - FAC, calculates the number of foreground-foreground edges with respect to the number of all edges covered by the umbrella/window. The reference level for Clustering are all edges within the area covered by the moving window/umbrella.

How: load a map with foreground objects (2 byte) and run the Clustering analysis.

Result:
Map: similar to the FAD map shown above but now for Clustering.

Contagion
Question: looking at foreground only, how much is it clumped in the local neighborhood?

Contagion calculates the number of foreground-foreground edges with respect to the total number of foreground edges covered by the umbrella/window. The reference level for Contagion is limited to all forest edges within the moving window/umbrella.

How: load a map with foreground objects (2 byte) and run the Contagion analysis.

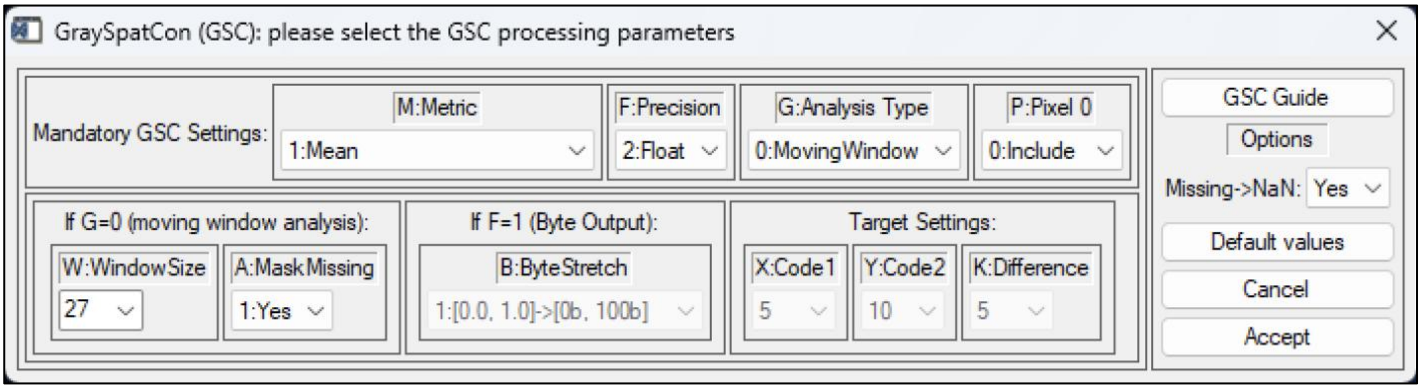
Result:
Map: similar to the FAD map shown above but now for Contagion.

GraySpatCon (← click for online Guide)

Question: which features do we have in the local neighborhood?

GraySpatCon (GSC) provides a wide range of pattern metrics used by landscape ecologists, including metrics suitable for categorical or continuous raster input data represented as byte values in the range [0, 100][1]. GSC implements a moving window analysis of a two-dimensional image (or a map) comprised of pixels (grid cells). It moves a square window across the image, one pixel at a time, accumulating and discarding information along the way. Based on the pixel values in the window on the input image at a given pixel location, a metric is calculated and assigned to that location on the output image. Thus, the output pixel value codes the input context of that pixel location, and the spatial resolution of the input image is preserved. The spatial scale of the analysis is defined by the size of the moving window.

How: the input map requirements, metrics, parameters, and processing options are summarized in the GSC Guide (Help → GTB Documentation → GSC Guide) and can be configured in a dedicated popup window:



Result:
For a global analysis, the result is a plain text file listing the GSC-parameters used and the global metric value. For a moving window (non-global) analysis, the result is a set of two files:

- a plain text file with the GSC-parameters used, and
- a (Geo)TIFF formatted image of the same dimension as the input image but showing the selected metric value at pixel level and in the format specified by the GSC processing parameters

[1] Continuous data are often available as quantized ("binned") data in that range; otherwise, they must be rescaled for use with *GraySpatCon*. Input byte value 255 indicates missing data.