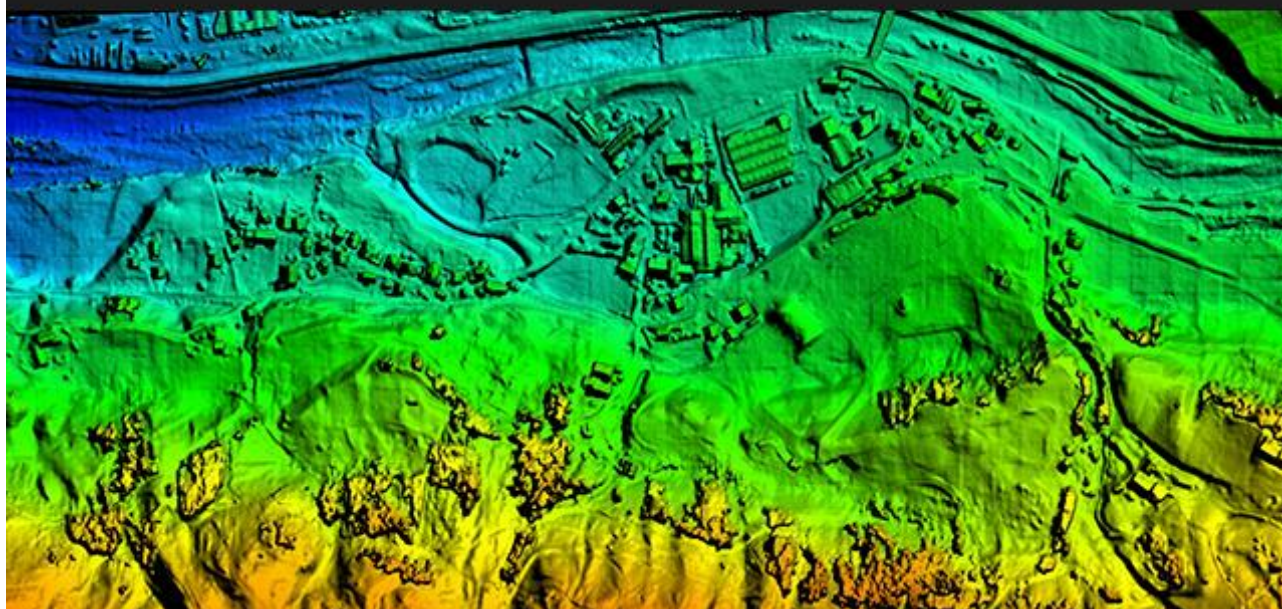


**Menci Software**

# **TerrainTools**



Menci Software  
**TerrainTools**  
[www.menci.com](http://www.menci.com)



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TerrainTools is a software dedicated to 3D terrain models analysis and edit.

With TerrainTools you can evaluate volume, profiles, subtract DEMs, extract DTM (ground) from DSM and so on.

It includes a simplified CAD with basic features and tools.

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## Main features

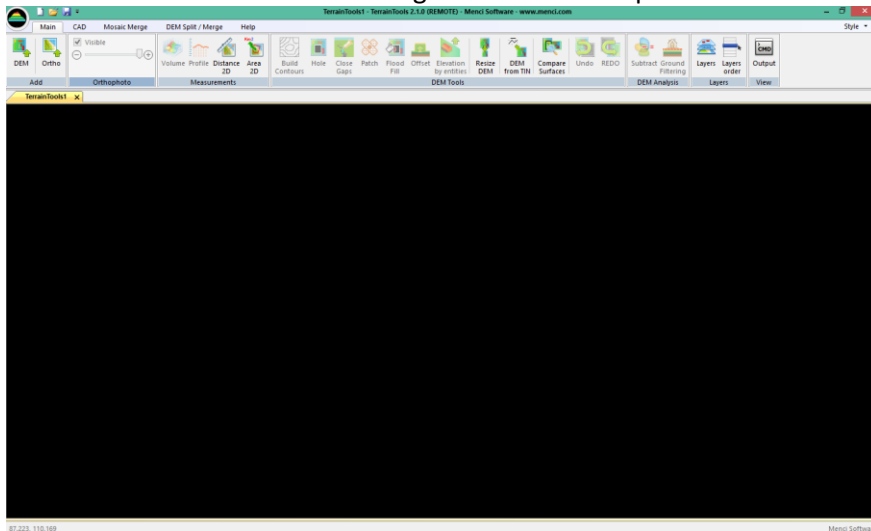
- Import of gtif/tif DEMs
- Import of Geotiff orthophoto
- Blended overlapped view of DEMs and orthophoto
- Volume evaluation (related to interpolated plane or reference elevation)
- Profiles analysis
- Ground extraction by given scenario
- DEMs subtraction
- DEM editing (hole, flood fill, gap fixing, offset, resizing)
- seamlines generation and editing
- orthophoto mosaicing
- 2D distance and area measurements
- Layers management
- Basic CAD features: entities, styles, OSnap
- Results import/export
- TerrainTools requirements
- Operating system: Windows Seven / 8

**A temporary trial license is available to test TerrainTools with your datasets.**

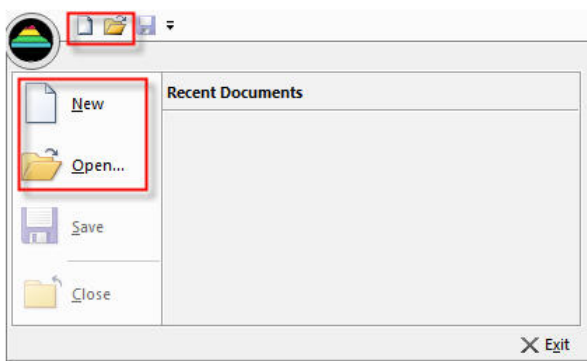
If you are evaluating TerrainTools, you can send your feedback to Menci Software writing to [francesca.ceccaroni@menci.com](mailto:francesca.ceccaroni@menci.com).

## Main window

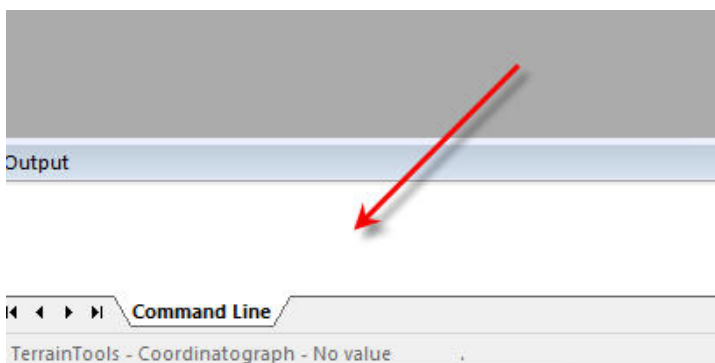
When the software starts following window will be opened.



You can press "New" (for new project) or "Open" if you want to open an existing project.



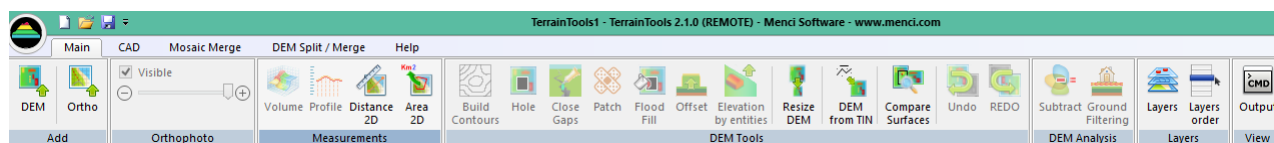
At the bottom there is a "Output window", where CAD status and information messages are displayed.



# TOOLBARS

## MAIN TOOLBAR

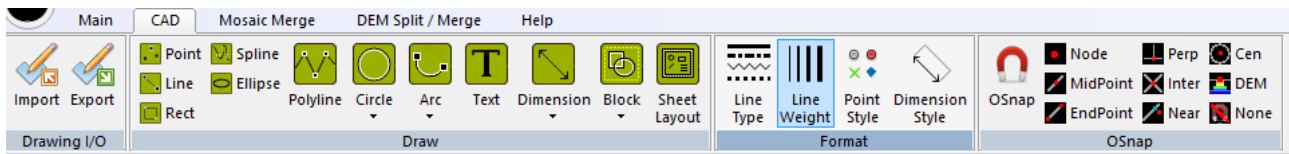
This is the main toolbar



- "Add": you can add DEMs and related orthophoto (optionally) to separated layers
- "Orthophoto": if an orthophoto is loaded the blending slider is activated. You can see the orthophoto blended against DEMs
- "Measurements": you can start several measurements commands
- "DEM Tools": some DEM editing commands
- "DEM analysis": in this section are grouped commands dedicated to DEMs analysis
- "Layers": layers management buttons. You can change layers properties and order.
- "View": hide or show docked windows

**TIP:** fill up the "User Data" form with your data: it will be usefull to identify reports you may send to Menci Software if some problem occurs.

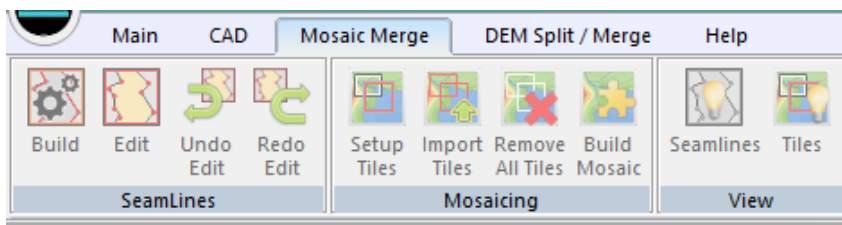
## CAD TOOLBAR



In the CAD toolbar there are following sections:

- "Drawing I/O": import dwg/dxf/shp and export of dwg/dxf file formats. TerrainTools supports Autocad 2000 file formats.
- "Draw": start drawing of points, polylines, rectangles etc..
- "Format": select point and line styles.
- "OSnap": toggle activation of osnap on CAD workspace

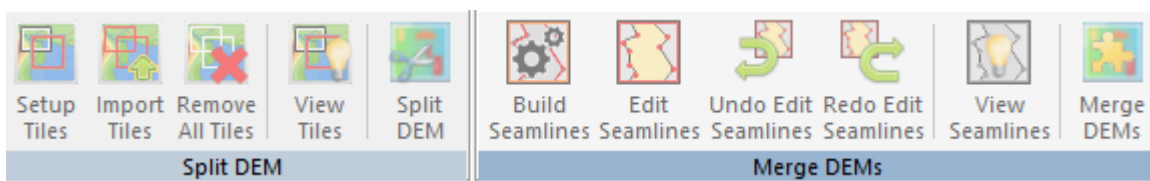
## MOSAIC MERGE TOOLBAR



Tools for overlapping orthophoto mosaicing.

- "Seamlines": Find and edit seamlines between overlapped images
- "Mosaicing": define and draw the tiles to subdivide the final ortomosaic and import tiles defined in a dwg/dxf/shp file; delete tiles if present; start the mosaicing process
- "View": Allow the user to see seamlines and tiles

## DEM SPLIT / MERGE TOOLBAR



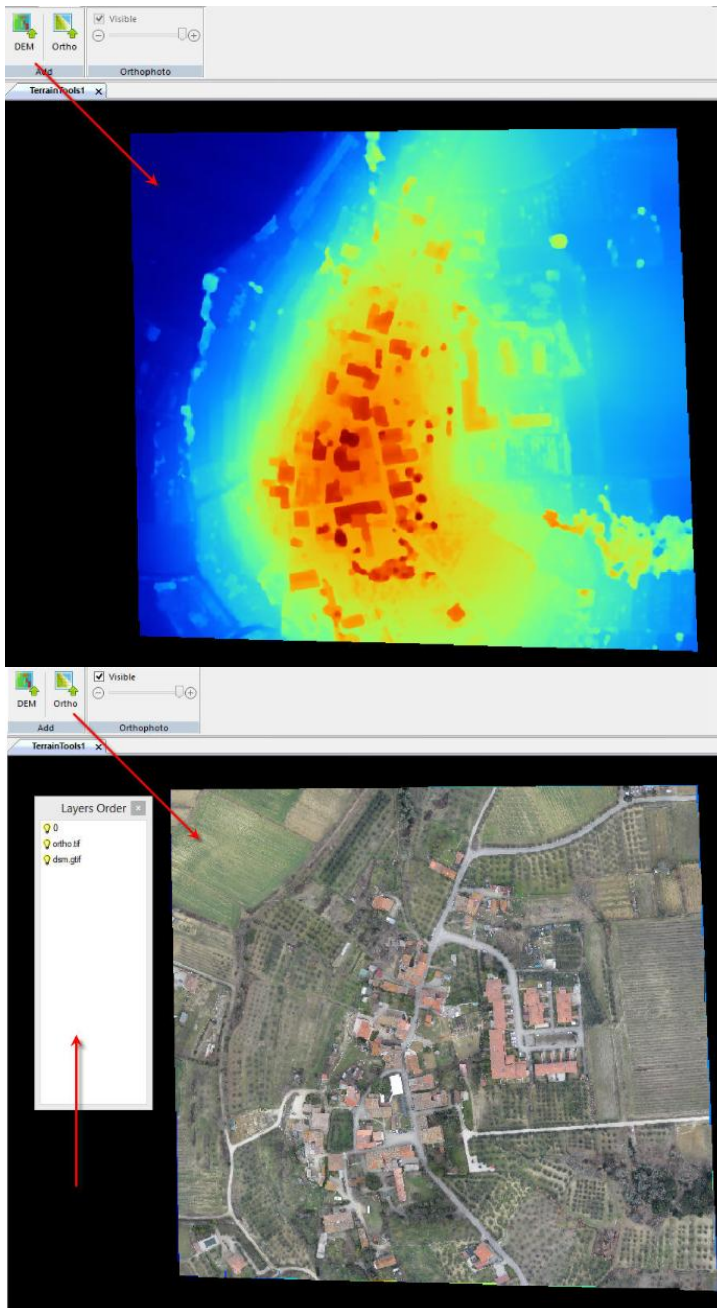
In the DEM SPLIT/MERGE toolbar there are following sections:

- "Split DEM": Split the DEM in smaller ones.
- "Merge DEM's": Merge various DEM into a unique one.

## SETUP NEW PROJECT - BASIC INFORMATION

### ADDING DATA

Once a project is created the CAD workspace is empty. You can add a DEM and any related orthophoto.

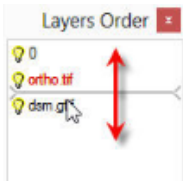


When two or more layers are present on CAD, the layer order window is displayed on the left.

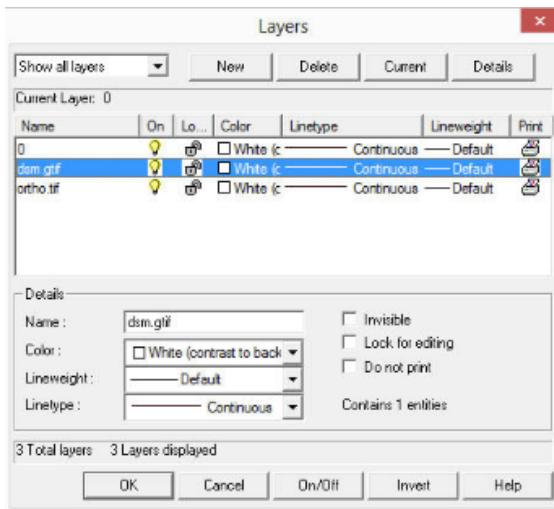


## LAYER ORDER AND PROPERTY

You can change the layers order by dragging up or down a layer name.

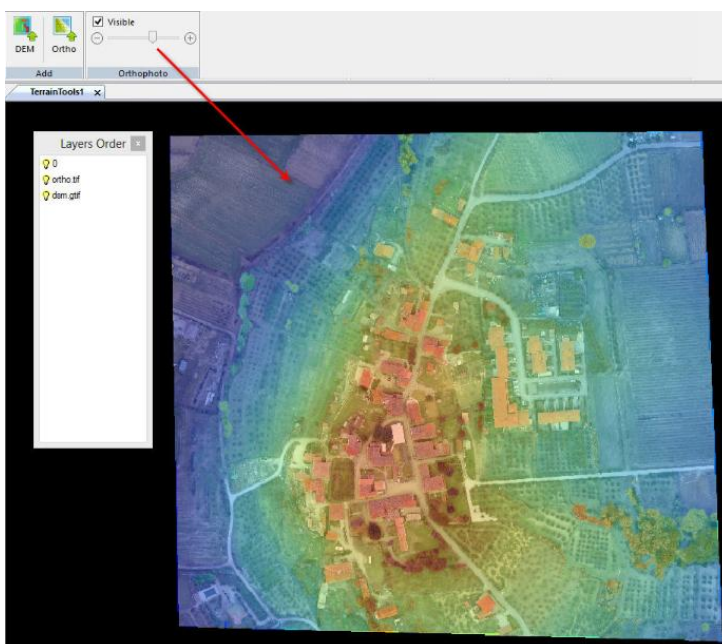


To hide a layer simply click on the related bulb. Advanced layer's properties can be edited by "Layer" button.



## BLENDING

An orthophoto view can be blended over the overlapped DEMs, moving the slider "Orthophoto".



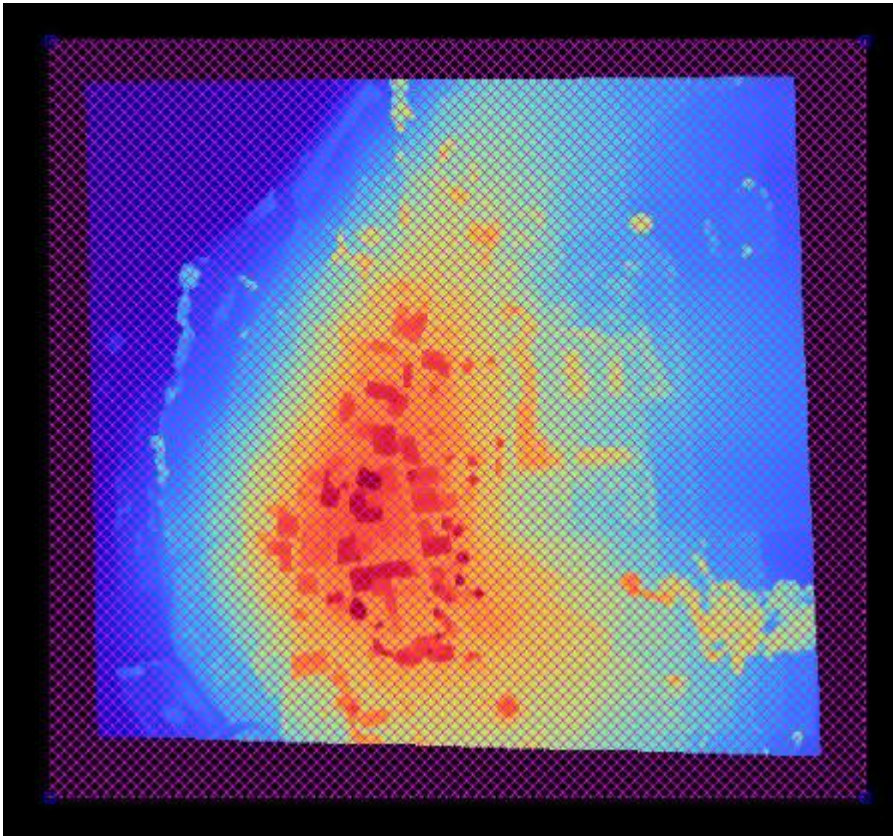


## SELECT AND DELETE ENTITIES

To delete a DEM or an orthophoto, or any other entity, simply select it by clicking on and press "canc" key (or right click and 'erase').

Moreover the selection can be done both cross and window. When you select by crossing, everything the bounding box touches is included in the selection set, including things only partially within the bounding box and entity inside lower layers.

When you select by window, only the objects entirely within the bounding box are included in the selection set.

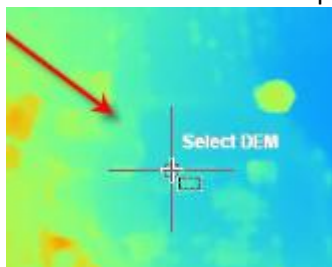


When an entity is selected you can unselect it simply pressing the 'Esc' key.

## MULTI-STEP COMMANDS

Some commands are composed by several selection steps (for example profile extraction). The cursor will help you to do the right action.

The same information are provided into CAD output window at bottom.

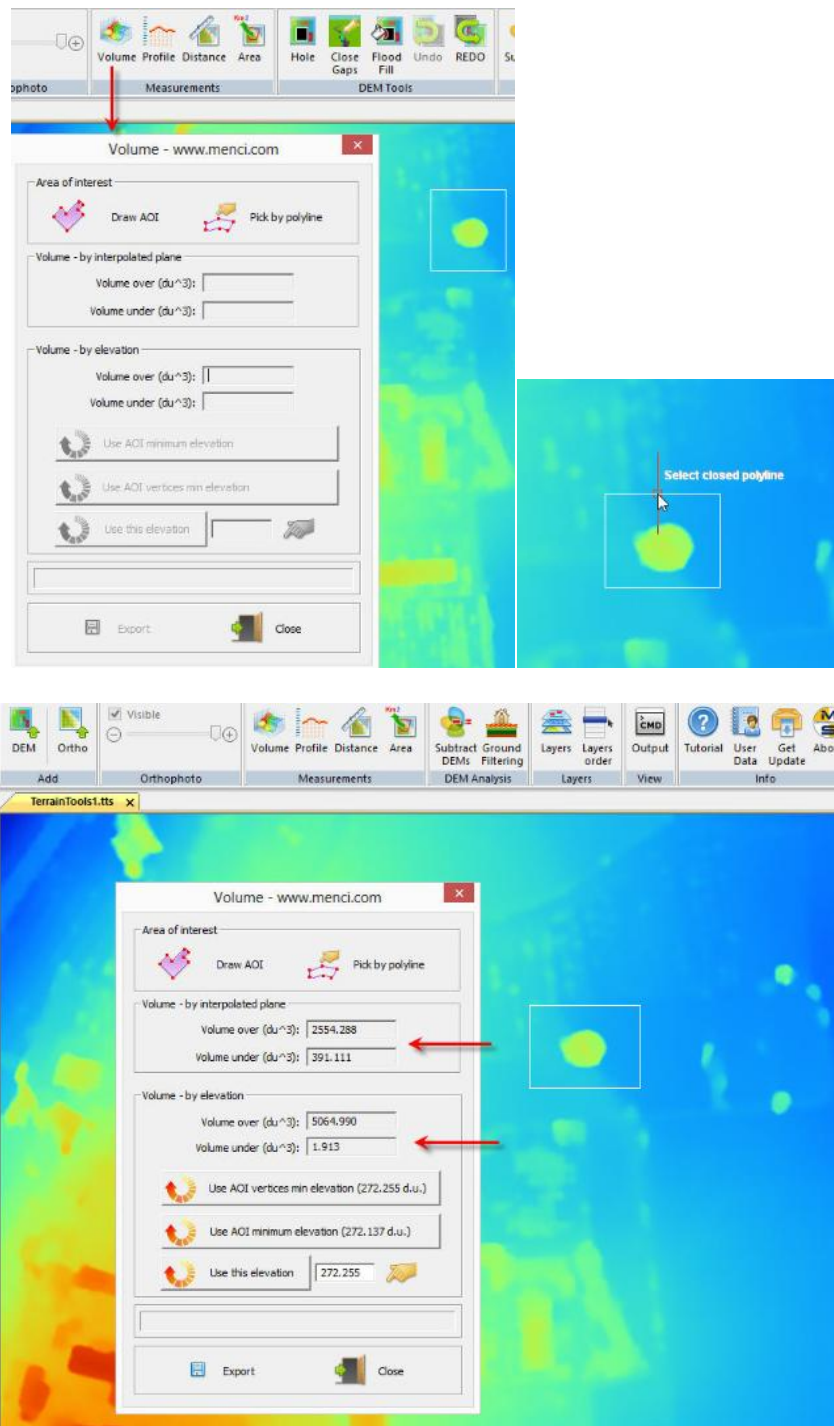


The reference DEM selection is requested only if there are more than one DEM into CAD.

## MAIN TOOLBAR - Evaluate Volume

You can find the "VOLUME" Button in the *Main toolbar* in the *Measurement Panel*.  
TerrainTools allows to evaluate the volume of a DEM in a given area of interest (AOI).

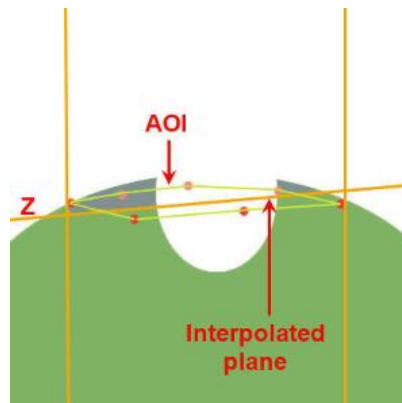
The AOI can be drawn with a closed polyline or can be temporary defined before the evaluation (draw AOI).  
The first choice is preferred when the computation is done on more than a DEM, to compare results on the same area.



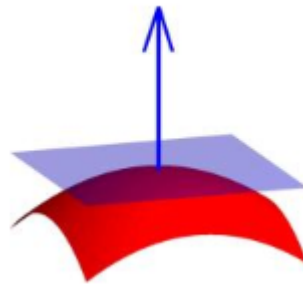
The "over" volume is the quantity of 3D space of DEM enclosed by AOI that is over the current reference elevation plane.

The "under" volume is the quantity of 3D space of DEM enclosed by AOI that is under the current reference elevation plane.

The volume by "interpolated plane" is evaluated using the plane fitted between AOI vertices coordinates.

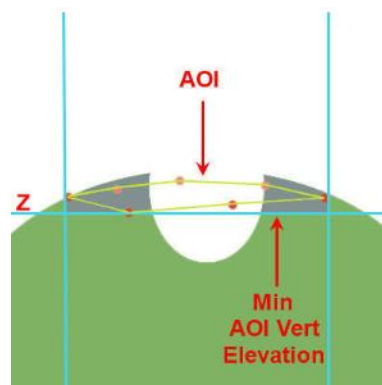


The volume "by elevation" the normal of used reference plane is (0,0,1).

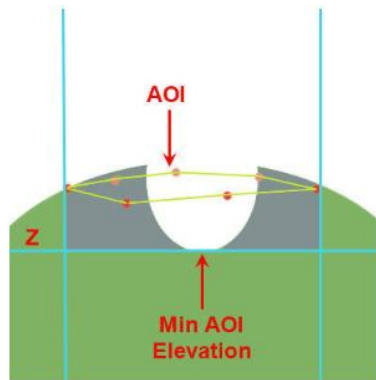


In this case you can move the plane along the normal, changing the reference elevation.

The "AOI vertices minimum elevation" place the plane at the minimum elevation between area of interest's vertices.



In "AOI minimum elevation" is used the minimum elevation of DEM that is included into the AOI.



Otherwise is possible to setup and use a custom elevation (that can be picked directly on DEM).

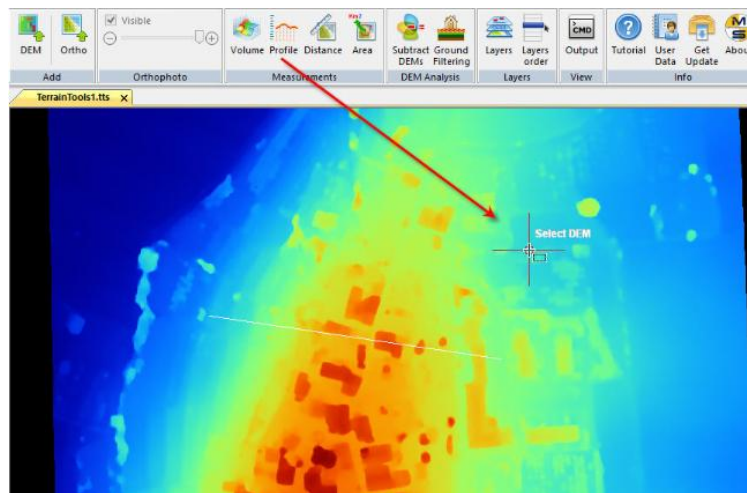
The volume results are expressed in the same unit of the DEM and can be exported to a CSV text file.

## Profiles

With this command you can extract and view profiles on DEMs.

If you plan to reload a profile data, the best way is to draw a polyline on a DEM and then select it for profile extraction.

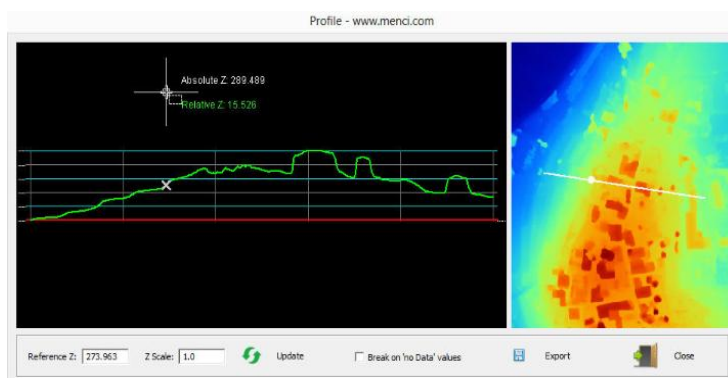
You can draw a temporary polyline instead. After the command is started you have to select the current DEM (if more than a DEM are present).



Then select a polyline or press right click to start drawing a temporary one (in this case you have to pick at least 2 points).



Finally the profile got by projection of polyline on the DEM is displayed in a XZ and in a XY views.



The red line in the draw is the reference Z. Moving the mouse over the profile, the absolute (related to DEM) and relative (related to reference Z) elevations are displayed.

The match between XZ and XY representations of profile is highlighted by the cursor.

Optionally you are able to edit the Z scale in order to fit the drawing to a better

representation.

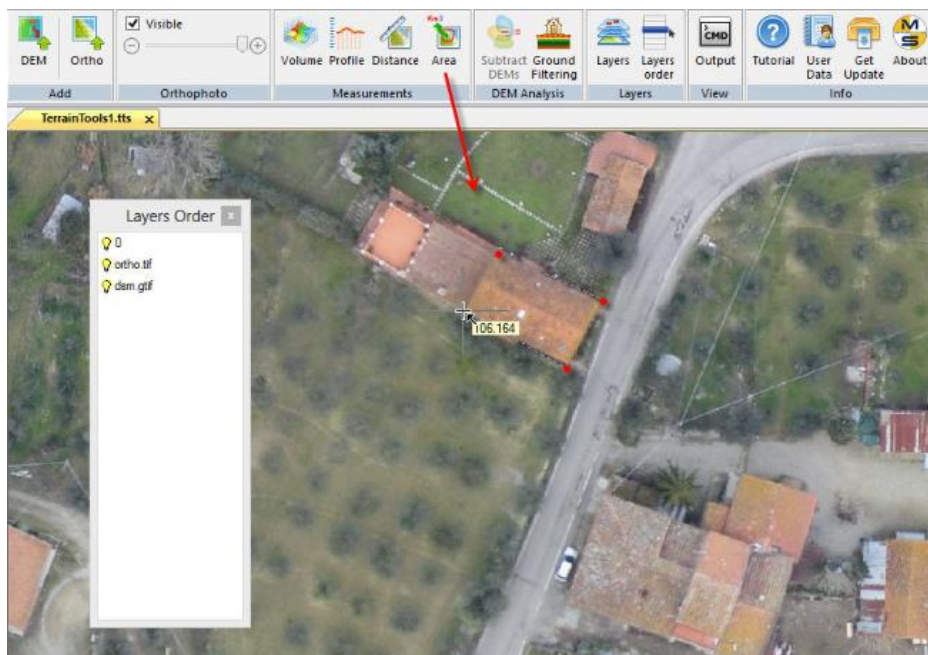
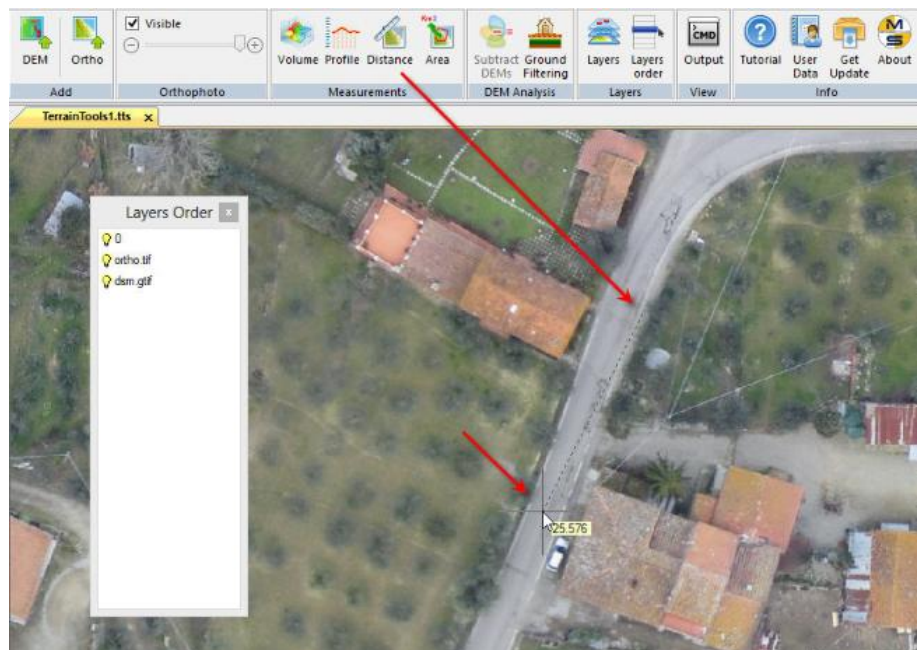
If you want a discontinued profile including holes and no data value parts, select the "Break on 'no Data' values" check.

The drawing can be exported to dwg/dxf files.



## Distance 2D and Area 2D

To do 2D measurements like linear distance and area you can use following commands.



## DEM Tools Panel

With TerrainTools is possible to fix and edit DEMs.

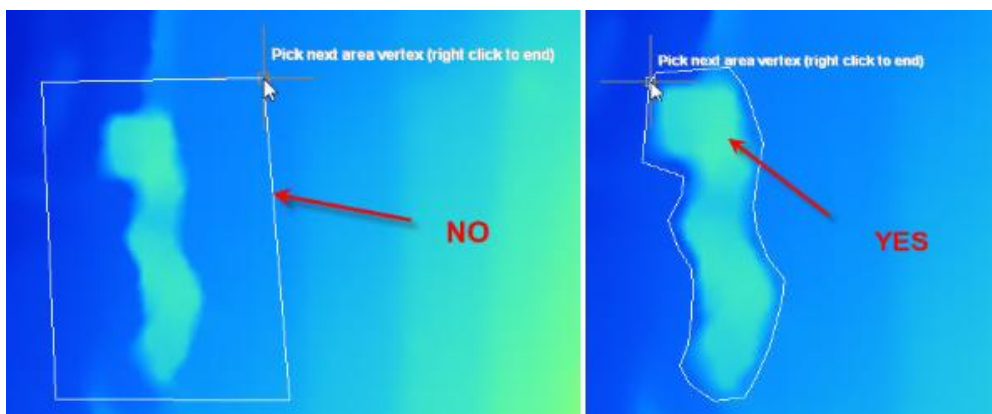
Currently 10 editing tools are included:

- Build Contours: Create contours lines
- Hole: create holes in a DEM
- Close Gaps: interpolate the holes using border elevations
- Patch: fix DEMs area by smart interpolation
- Flood Fill: fill DEMs undefined area by selected elevation
- Offset: add a given offset to DEM area elevation
- Elevation by entities: use a closed polyline to interpolate the elevation inside the area
- Resize DEM: Resize DEM at given GSD
- DEM from TIN: Build DEM from entities
- Compare Surfaces: Compare a DEM with another DEM or ASCII or LAS file.
- Undo/Redo.

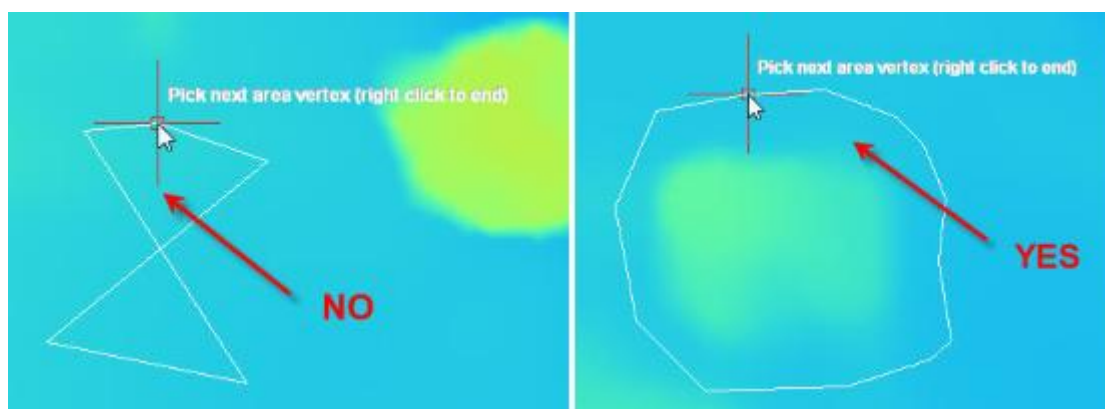
When you save to project any editing operation is definitely applied to original imported DEMs.

## DEM TOOLS GENERAL INFORMATION

- Commands are composed by several steps (e.g. area selection and command application): current step instruction are written closer to the mouse cursor and into the command line window. Numeric input eventually needed can be wrote inside command line window.
- To start an editing command the previous one must be closed.
- All commands support undo/redo operations. The undo queue is deleted when the project is closed.
- Commands are applied on every visible DEMs (for example an hole on two overlapped DEMs will pierce both them).
- Some commands require an area. Here some generic rules:
  - when you close the area (right mouse button) with less than 3 points, the area is not valid and the command is skipped.
  - don't create huge selection area: a large amount of memory is required to apply commands on a big area and interpolation results are not reliable
  - don't approximate too much the area if the subject to fix is complex

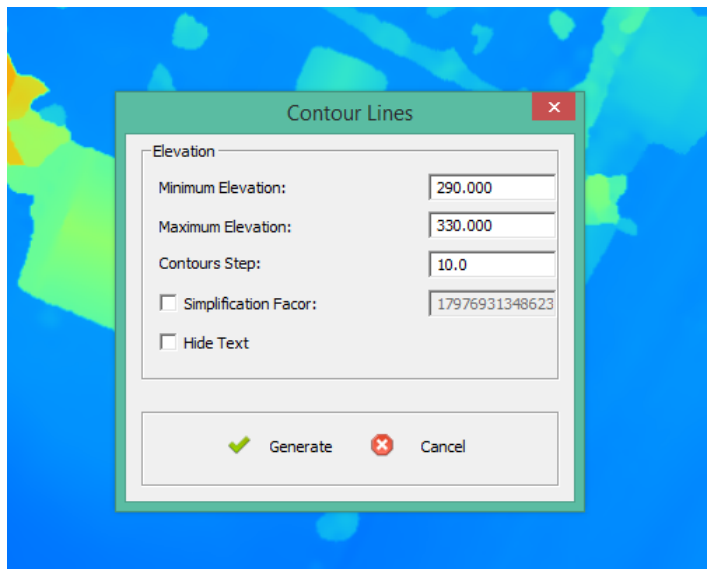


- select only what you need
- select convex area only

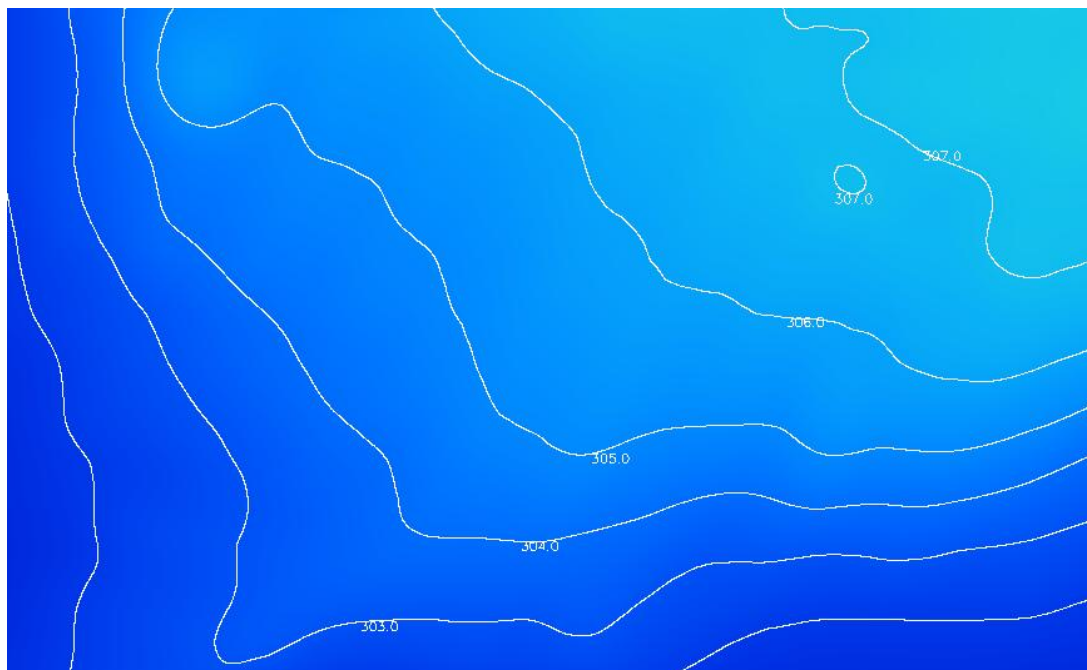


## Build contours

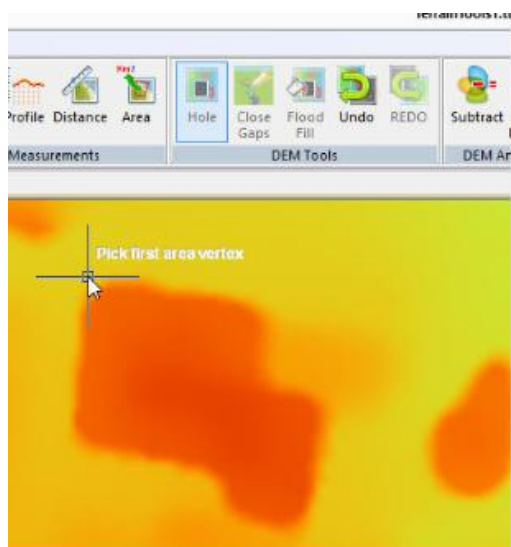
First select Minimum and Maximum Elevation and Contours Step.  
So you can decide to use a Simplification Factor and hide text.  
Then click to Generate.



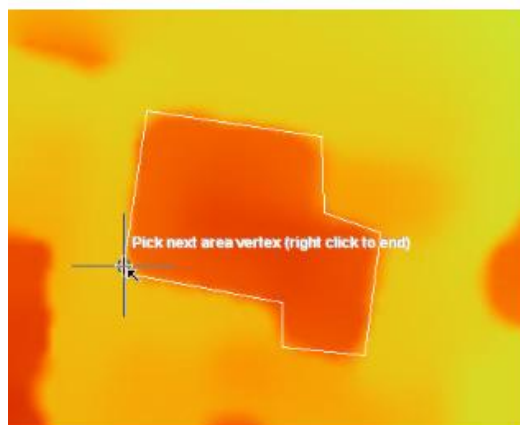
Contour Lines with the given step will be generated.



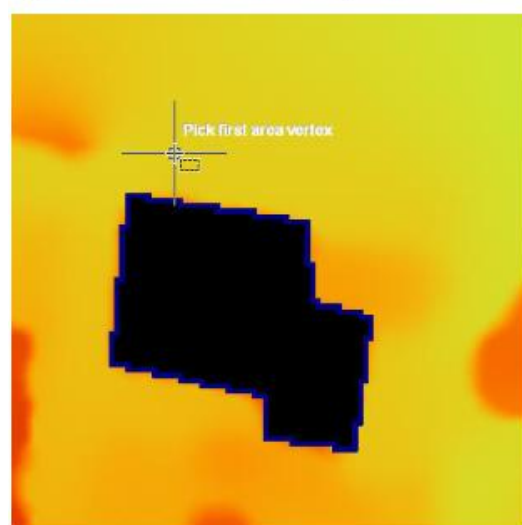
## DEM Hole



Select the area of new hole, by clicking 3 or more vertexes.



Right click close current hole and open the next one.

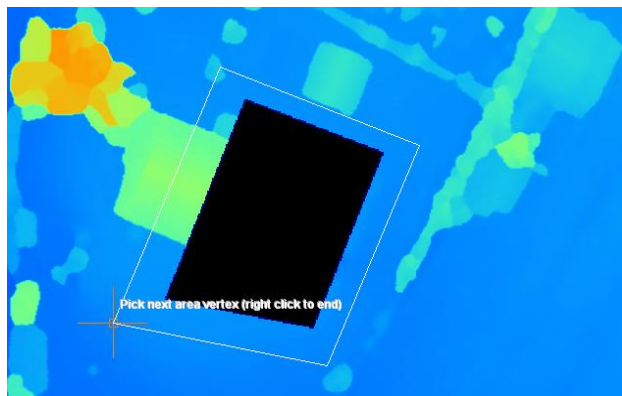


To close the command click right mouse button twice. Select a new area instead.

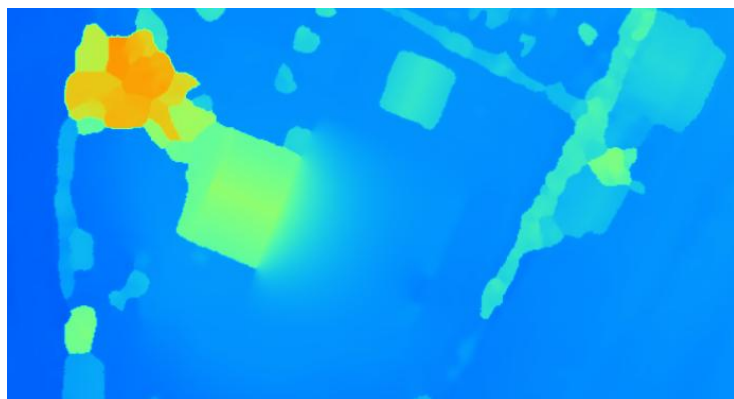
## Close Gaps

Close gaps command fill holes using an interpolation of surrounding elevations.

The border elevations only are considered to complete the command.  
As the hole command the first step is the area definition.



When right mouse button is pressed the hole is filled up.



Repeat the operation with other holes or close the command by pressing right mouse button twice.



## Patch

This command fix a DEM's area. It uses area's border surrounding elevations to interpolate elevations included in the selected polygon.

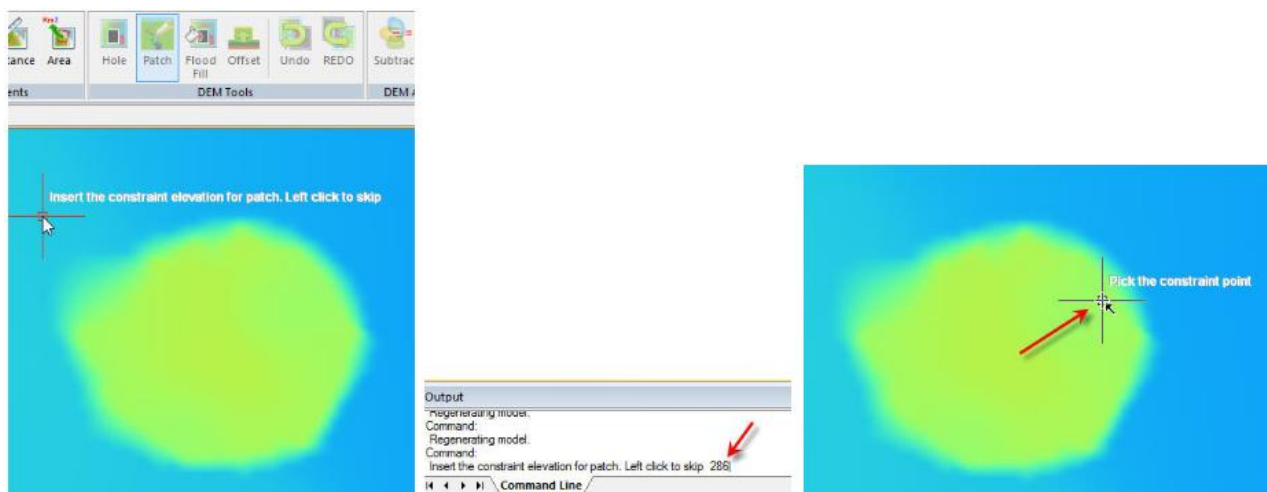
It has two main purposes:

- close gaps: when a DEM has holes it can be used to fill them with interpolated values.
- remove objects from DEM surface (e.g. removing trees or building from a DSM)

The command supports a constraint elevation point: if you input point absolute elevation and click its coordinates, interpolation will be done following the point.

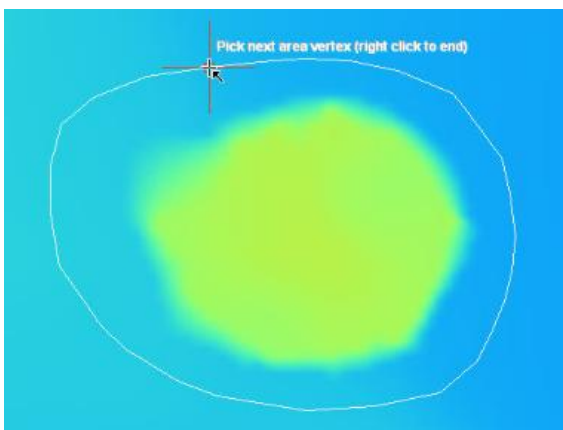
Only points clicked inside the patch area are considered for next interpolation.

TIP: all elevations inside the patch area can be changed by command (this is the main difference with close gaps command, which acts on undefined elevation only).



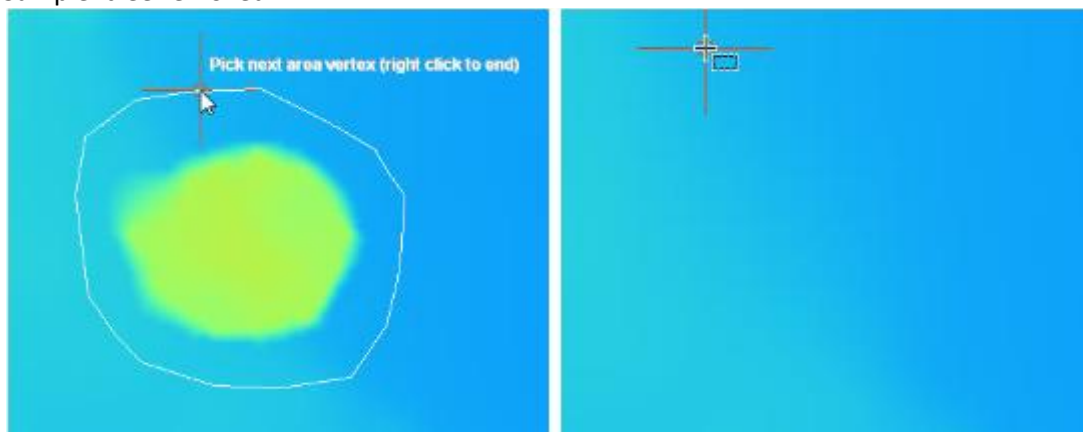
If you don't need any constraint point you can skip steps 1 and 2 by click left mouse button.

Then pick the command area. The area border must lie on a "valid" place: nearby elevation are used as reference to change what is included in the area, so the area surround must be reliable.

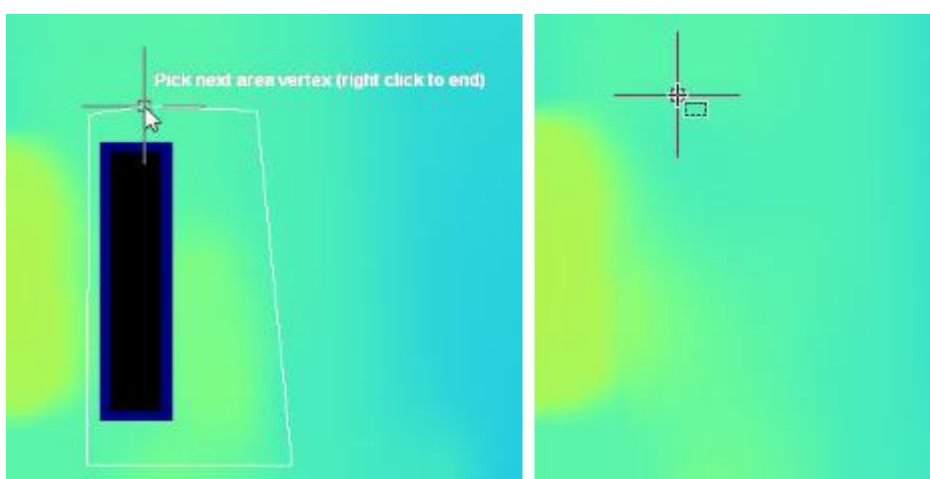


Patch command will be automatically closed once it is applied to DEM.

Sample: tree removed



Sample: fill an hole



## Flood fill

Flood fill command allows to fill an hole with a preselected elevation.

It is usefull to fill gaps or reconstruction holes.



The first step is to get the reference elevation by clicking it on DEM with SHIFT key pressed.

You can type the elevation in the command line window too.



Then click inside the hole to fill it.

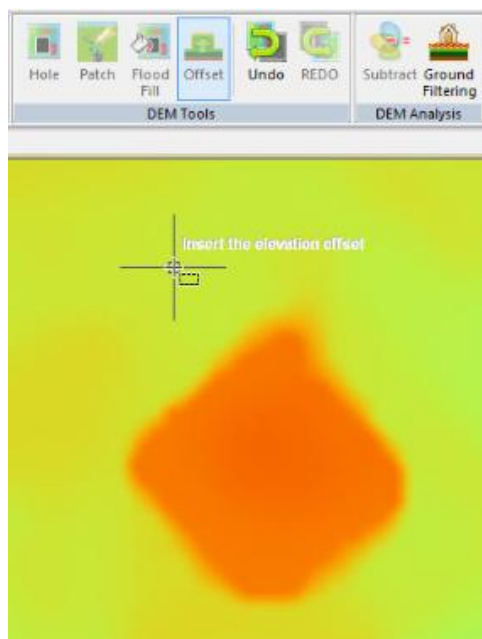


Repeat the opeation with other holes you want to close with the same elevation value.

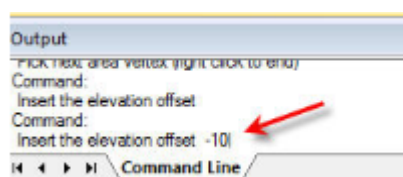
Close the command by pressing right mouse button twice.

## Offset

The offset command add an offset to DEM's elevations included in a given area.

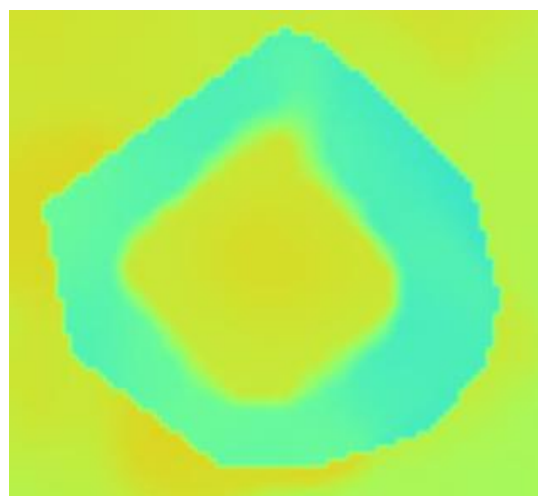
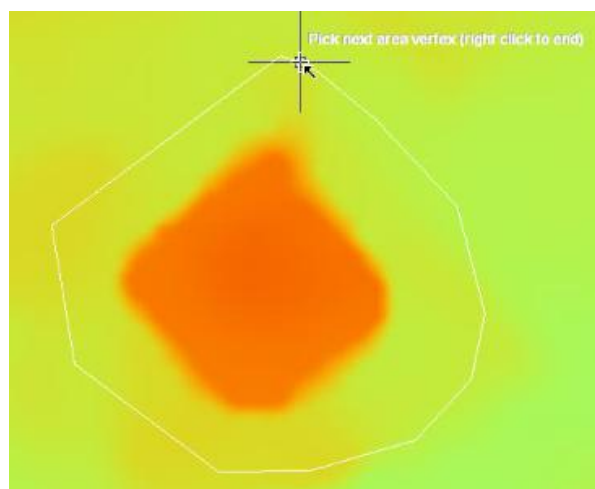


First of all input the offset elevation (e.g. -10)



Then pick the area to be edited.

Press right mouse button to apply the offset.

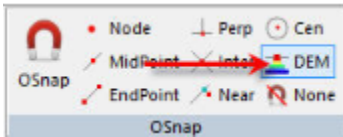


The offset command restarts automatically. Press right mouse button twice (ord ESC key) to close it.

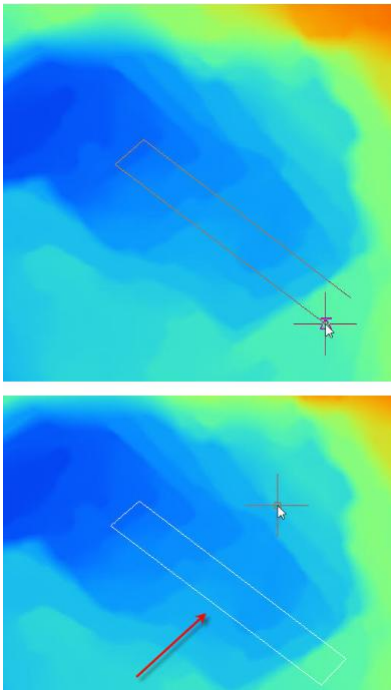
## Elevation by entities

Through this command you can interpolate the elevations included inside a closed polyline.

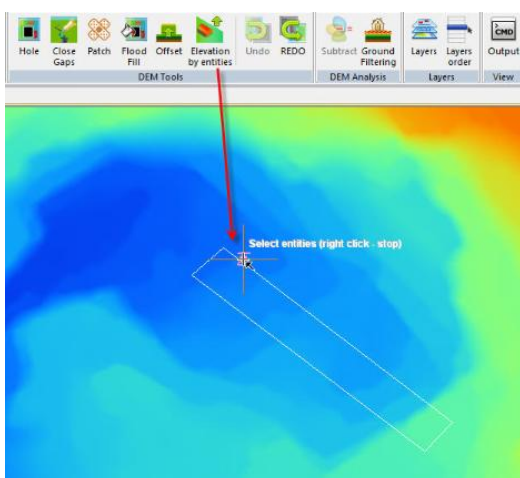
Activate the DEM OSnap



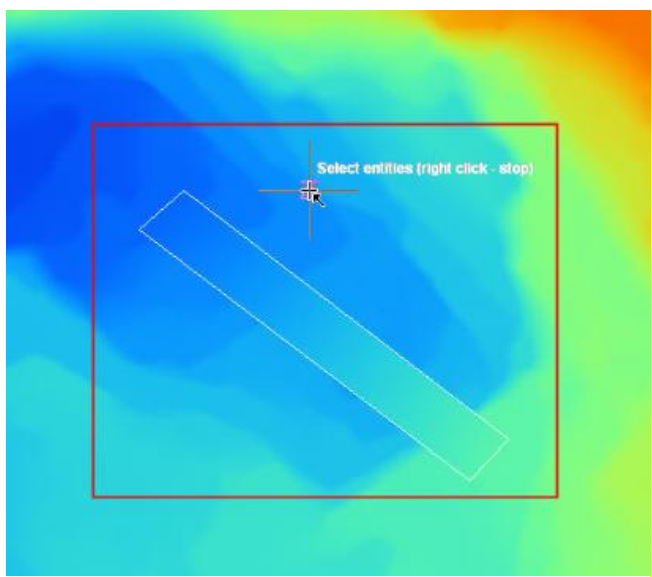
Then draw a closed polyline



Finally open the Elevation by entities command and click on the polyline to select it



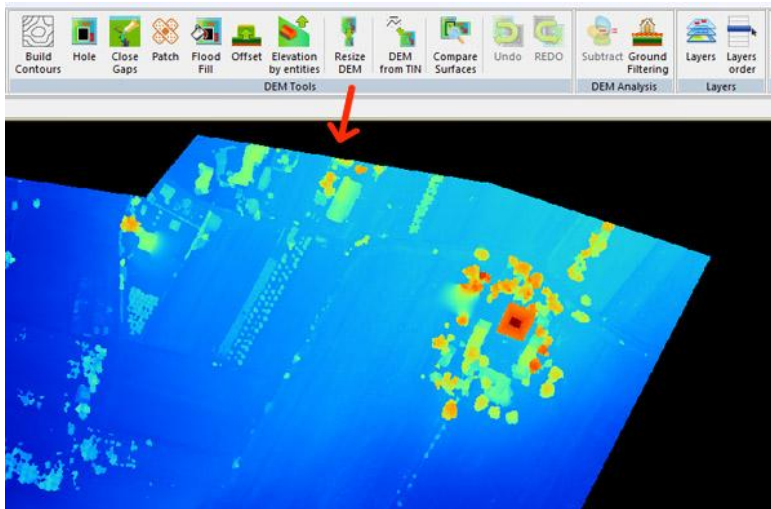
Once you press right click the elevation inside the closed polyline will be interpolated using the vertexes' elevation.



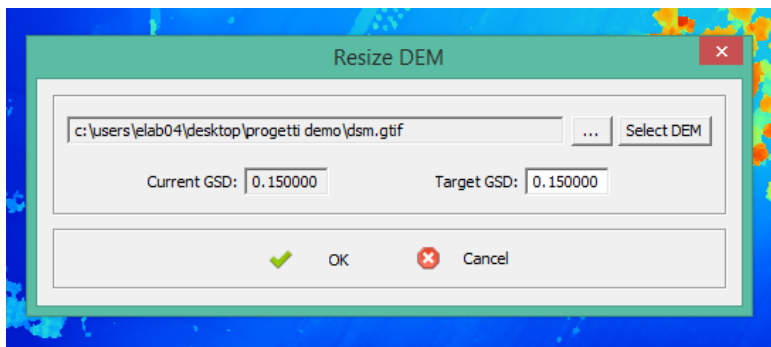


## Resize DEM

Through this command you can resize DEM.



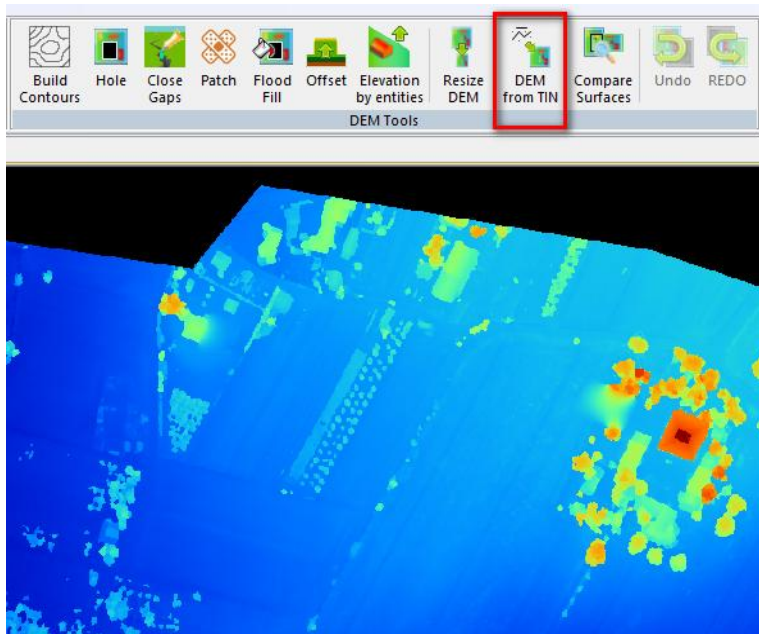
By clicking on the command you can select the target DEM from screen or by browsing it.



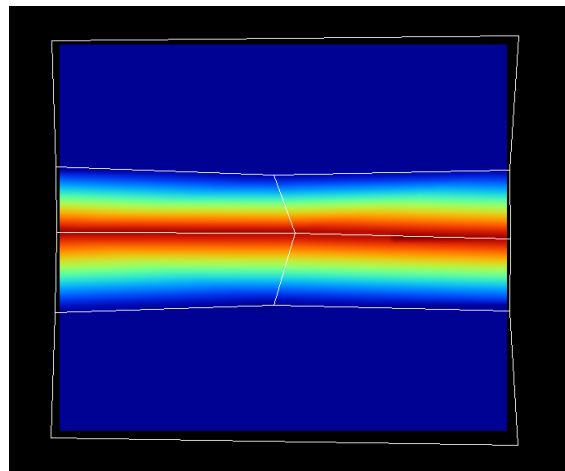
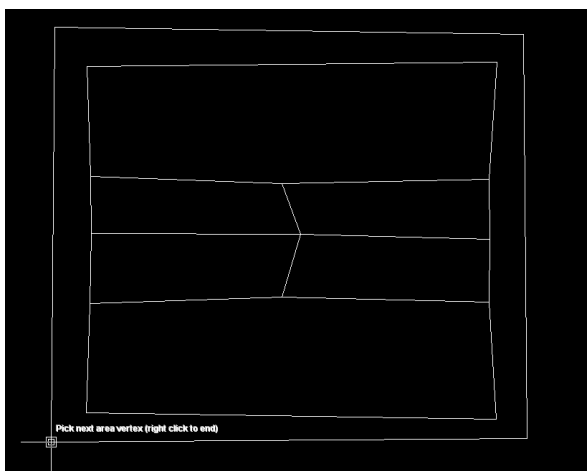
Once you have selected the DEM you can decide the target GSD to scale it.  
Press OK.  
Now you have to name the new file.

## DEM From TIN

Through this command you can create DEM from CAD entities.

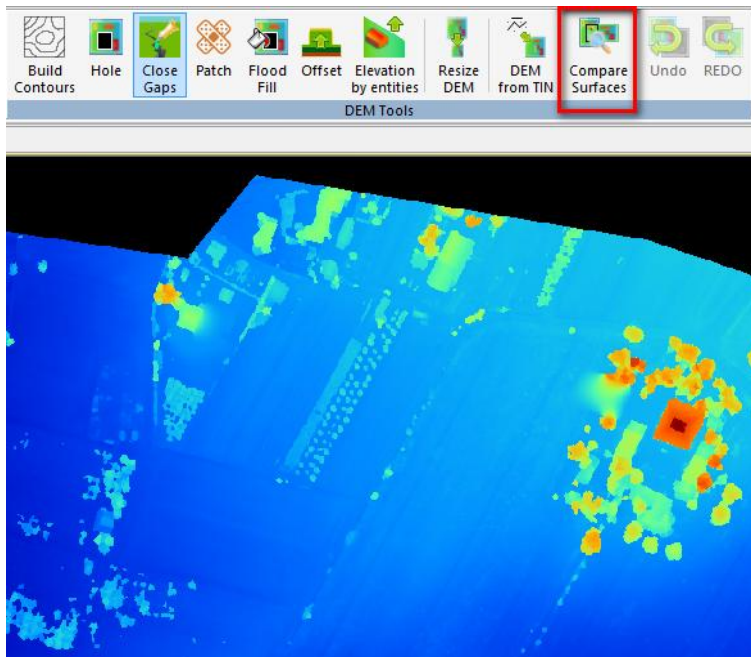


Once the entities with elevation are selected a new DEM will be generated.



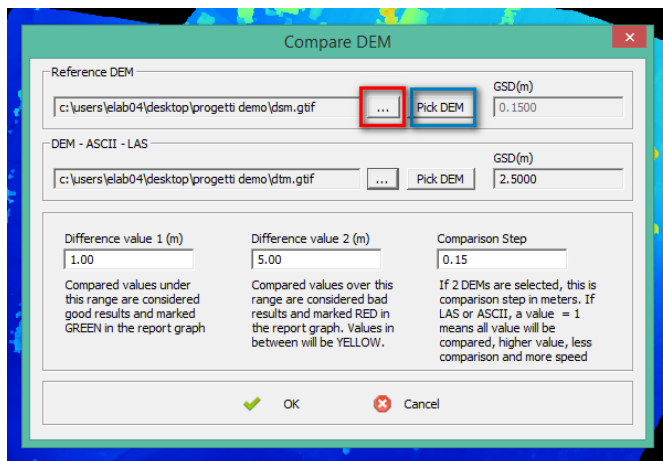
## Compare Surfaces

Through this command you can compare a DEM with another DEM or ASCII file or LAS file.



By Clicking on the button, the file selection window will open.

Here you can select Objects through browsing RED square in the picture (...) or by picking it from the screen (Pick DEM - Blue rectangle) if it's loaded in Terrain Tools.



For each DEM you can see its GSD and choose the "Comparison Step".

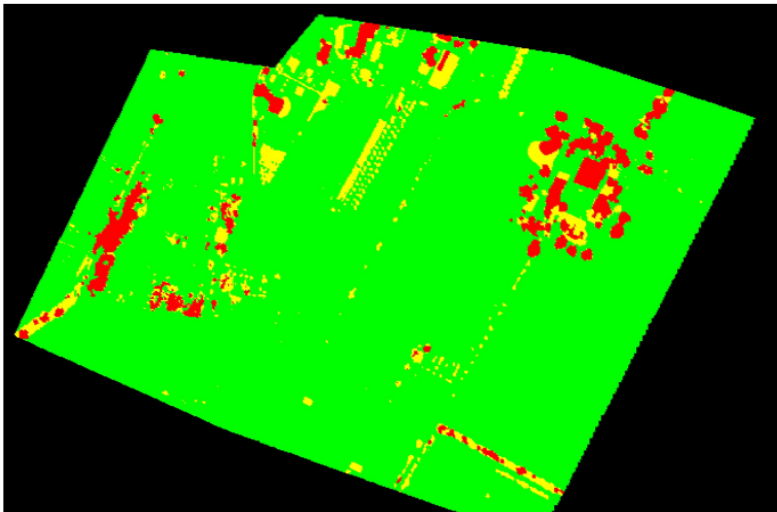
**Difference Value 1 (m)** : Compared values under this range are considered good results and marked **GREEN** in the report graph.

**Difference Value 2 (m)**: Compared values under this range are considered bad results and marked **RED** in the report graph.

Values in between will be **YELLOW**.

A report will be generated using the given values with some information about the comparison.

Number of compared points:	178140
Number of values over 1.00 m (yellow):	9645
Number of value over 5.00 m (red):	8538
Average differences between surfaces is:	0.6312 m
Standard deviation is:	1.8852 m
Results are located in:	
c:\users\elab04\desktop\progetti demo\dsm_comparison.pdf	



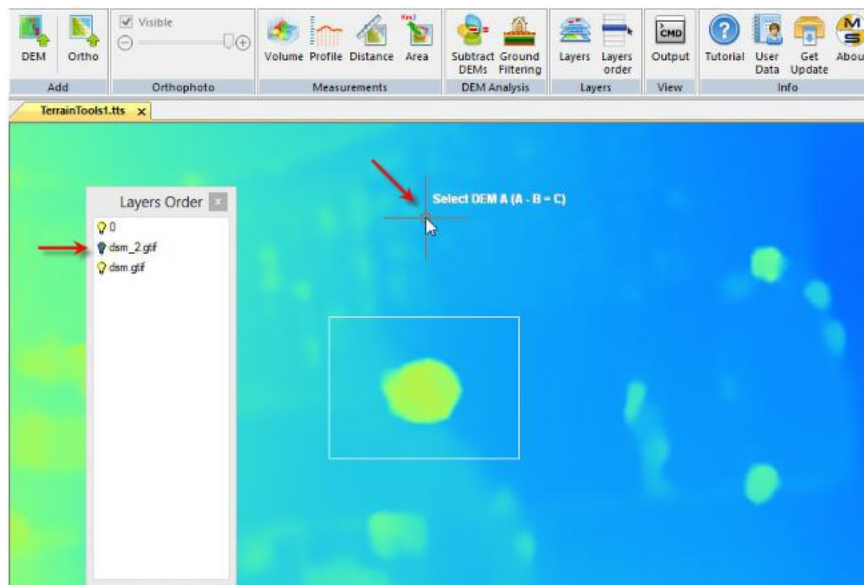
## DEM Analysis Panel - Subtract

DEM subtraction is a useful command to easily evaluate and highlight differences between overlapped DEMs.

For example two DEMs related to different moments (time 0 and time 1) can be compared.

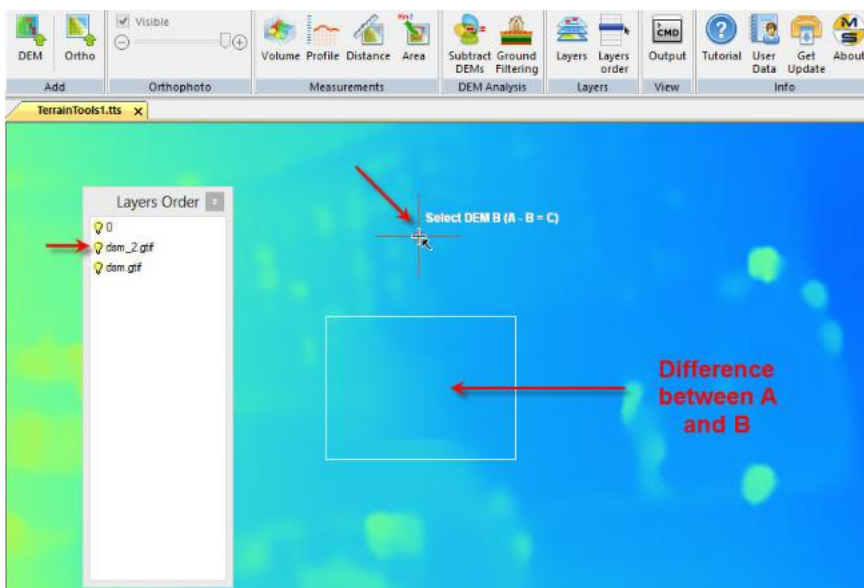
Once the second DEM is inserted into the project, the Subtract button will be enabled. In example above a tree (DEM A) was cutted down (DEM B).

Turn off the DEM you consider the subtrahend (B) and turn on the minuend (A).

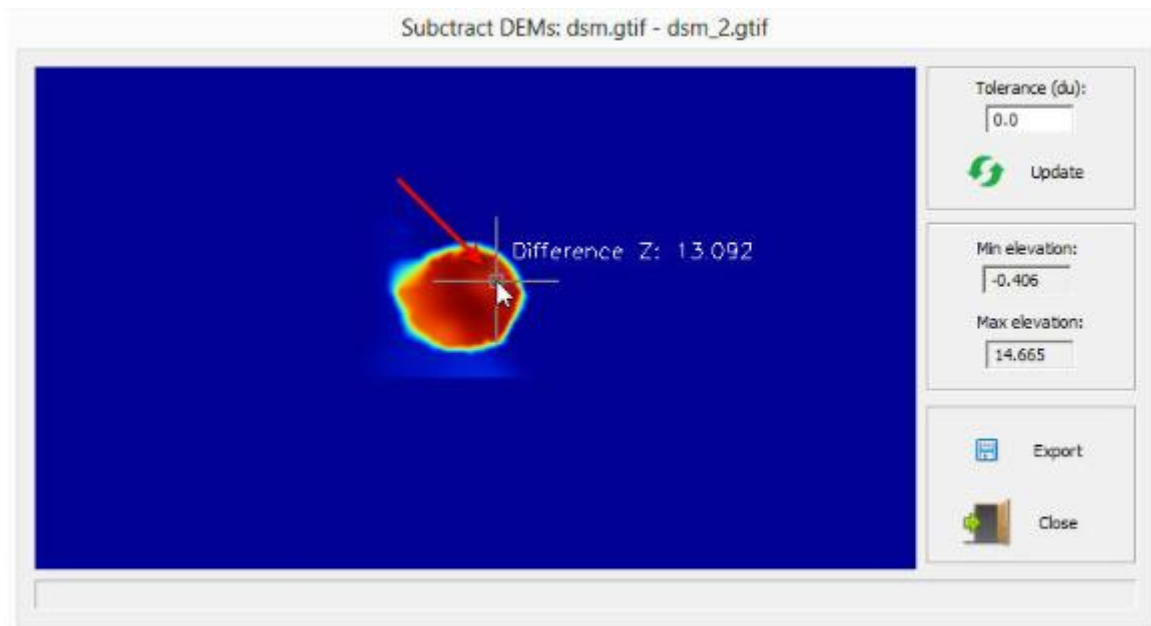


Then click on minuend DEM to select it.

Turn on the other subtrahend DEM and click on it to get the difference.



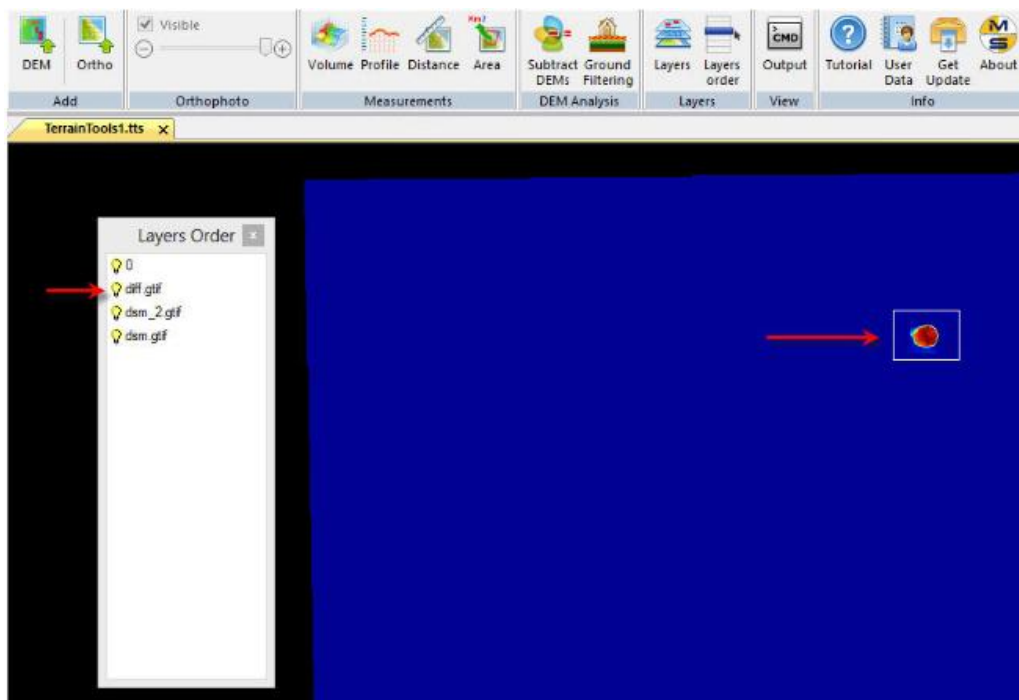
The result is displayed as a third DEM including Z elevation differences between overlapping area of A and B.



The Tolerance is the minimum difference to be considered as a "real" difference. All differences smaller than the tolerance will be considered zero.

Near the mouse cursor is displayed the picked difference value.

This result can be exported as gtif file and then imported in the project as a normal DEM, for further analysis (for example volume or profiles).

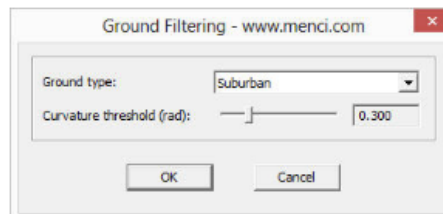




## Ground filtering

The ground filtering is a process to extract a DTM (digital terrain model) from a DSM (digital surface model). See the glossary of terms to know what those kind of DEMs represent.

DTMs are used as base data for several production processes (for example orthophoto/orthomosaic generation and contour lines).



The first step is to select the DSM you want to process (only if more than a DSM are present). Then you have to select the "scenario" that better suite your dataset (country, suburban, urban and metopolitan).

The right scenario depends by density and size of over-ground object inside the AOI.

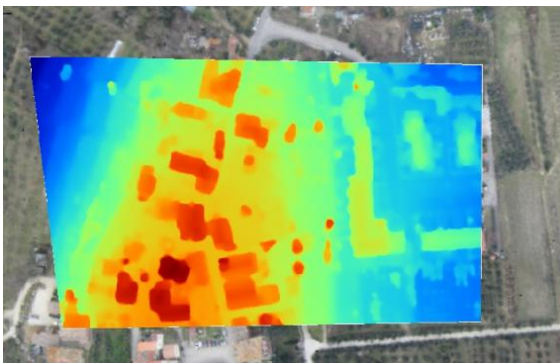
Another customizable parameter is the "curvature threshold" angle, expressed in radians.

The curvature threshold means the limit under which slopes are considered "ground".

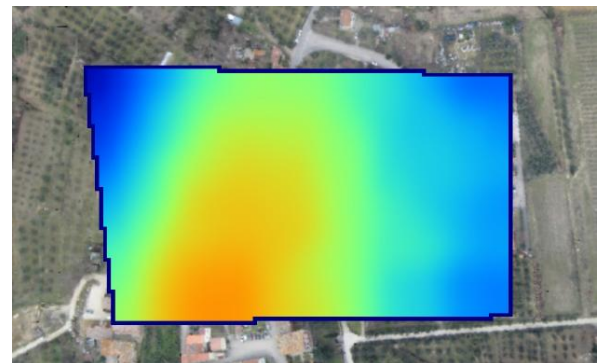
If a slope is bigger than the curvature threshold, the object that includes this slope is considered like an over-ground item (tree, building, etc.).

Combining the scenario with the curvature threshold parameters you can refine the ground filtering process.

**Start DSM:**



**Extracted DTM:**



# CAD TOOLBAR

TerrainTools includes a basic but effective CAD environment.

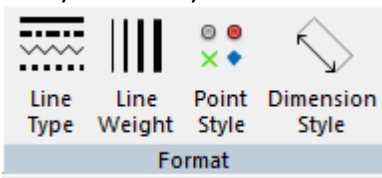
In the CAD tab of the main toolbar at the top, you can find some usefull commands:  
Import and export of cad drawing entities to common dxf/dwg file formats



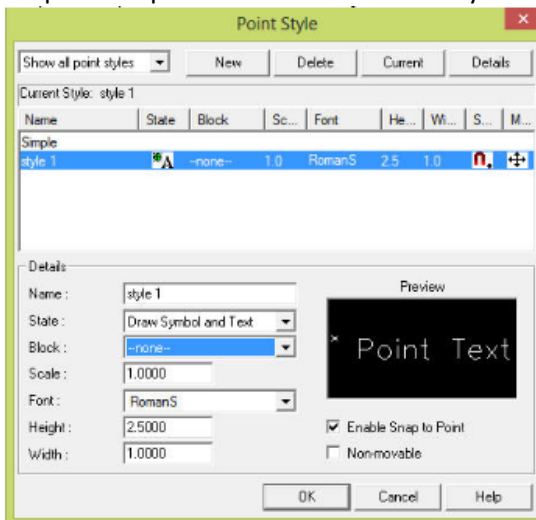
Basic entity drawing (points, polylines, rect, text, etc.)



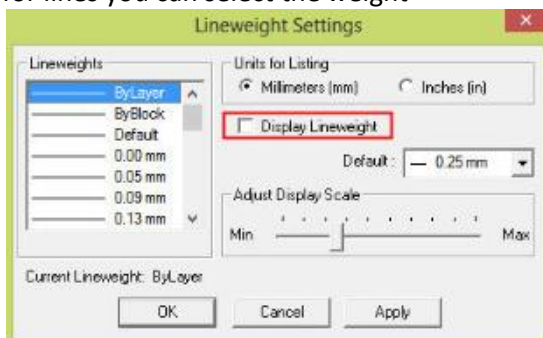
Entity format style



For points is possible to define a new style



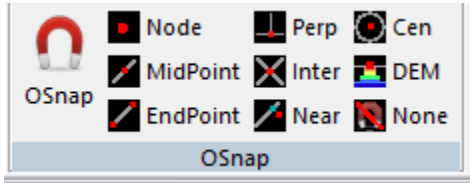
for lines you can select the weight



## OSnap Panel

The Object Snaps (Osnaps for short) are drawing aids which are used in conjunction with other commands to help you draw accurately.

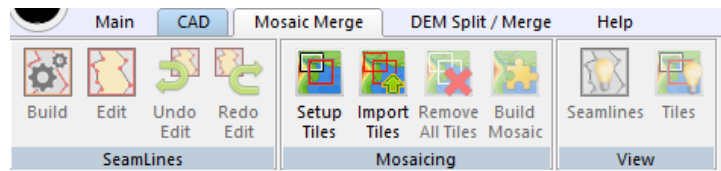
Osnaps allow you to snap onto a specific object location when you are picking a point.



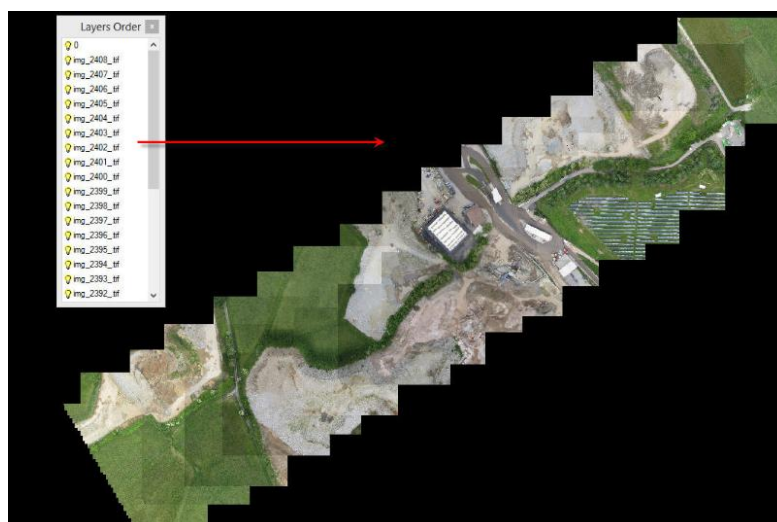
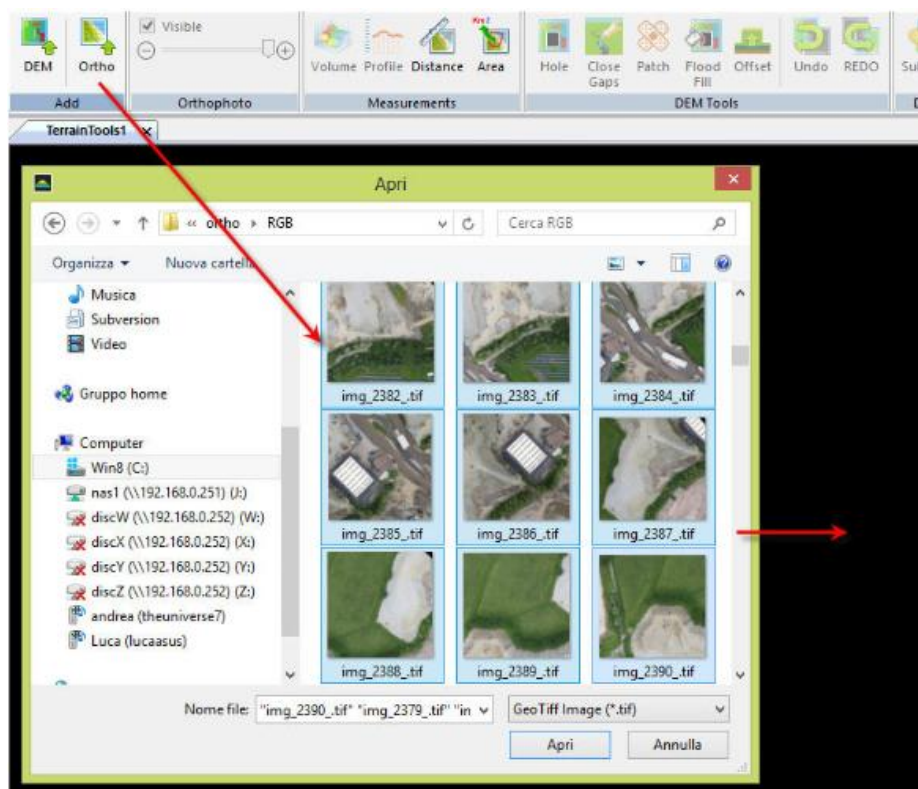
- The Node Osnap snaps to the center of a Point object
- The Midpoint Osnap snaps to the mid points of lines, arcs and to the mid point of polyline segments
- The Endpoint Osnap snaps to the end points of lines, arcs and to polyline vertices
- The Perpendicular Osnap snaps to a point which forms a perpendicular with the selected object
- The Intersection Osnap snaps to the physical intersection of any two drawing objects
- The Nearest Osnap snaps to the nearest point on a drawing object
- The Center Osnap snaps to the centre of a circle, arc or polyline arc segment
- The DEM Osnap snaps to the elevation of the DEM.
- None: De-activate all the active OSnaps

## MOSAIC MERGE TOOLBAR

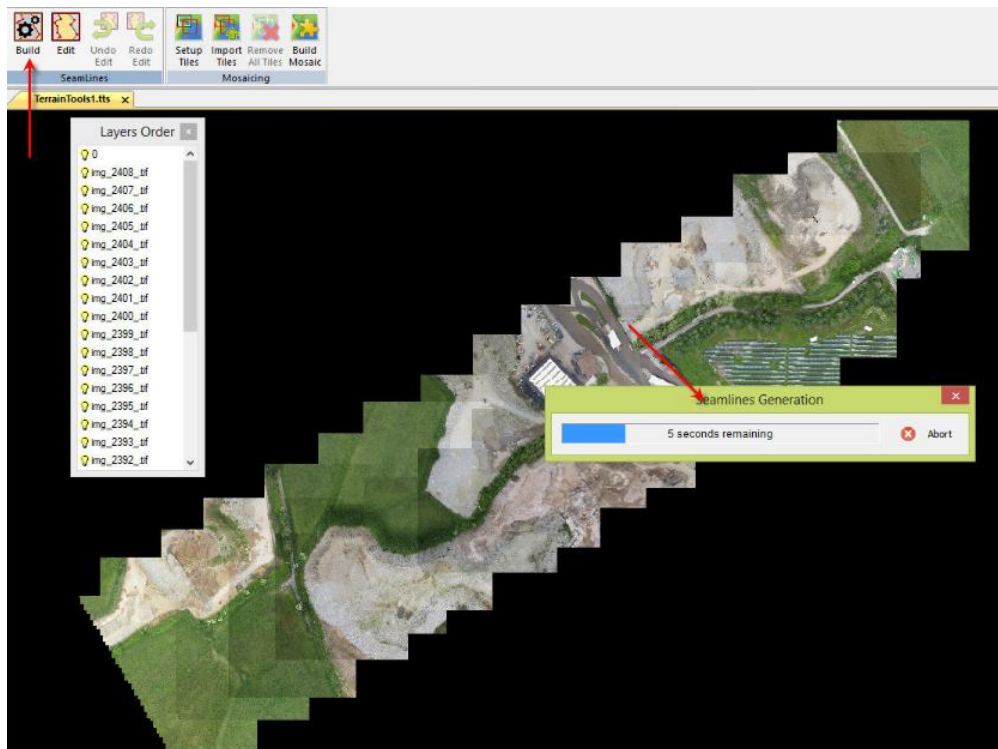
In the "Mosaic Merge" tab there are commands to develop a orthomosaic from a number of separated overlapped orthophotos.



First of all original orthophotos must be added to current project.



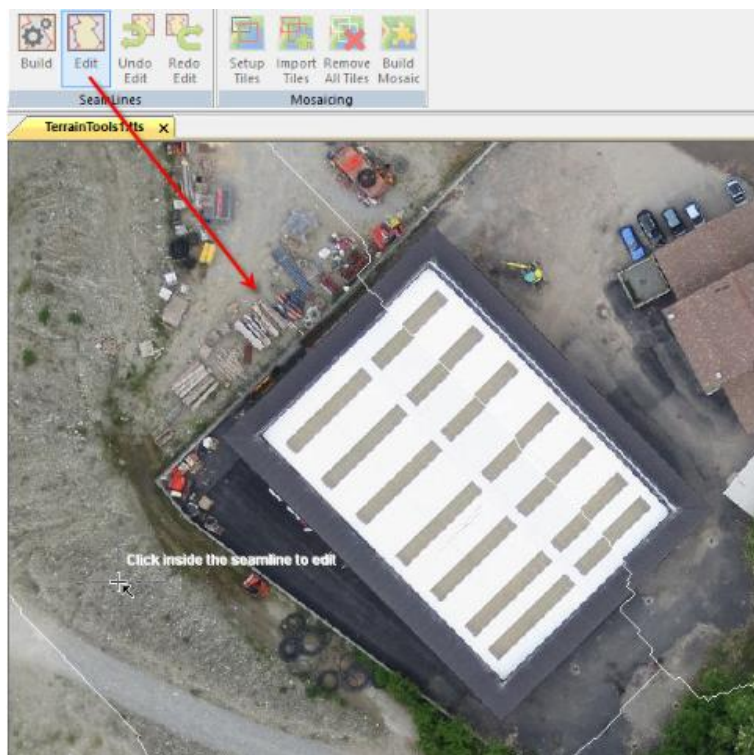
Then you can switch to Mosaic Merge tab and start to build the seamlines.

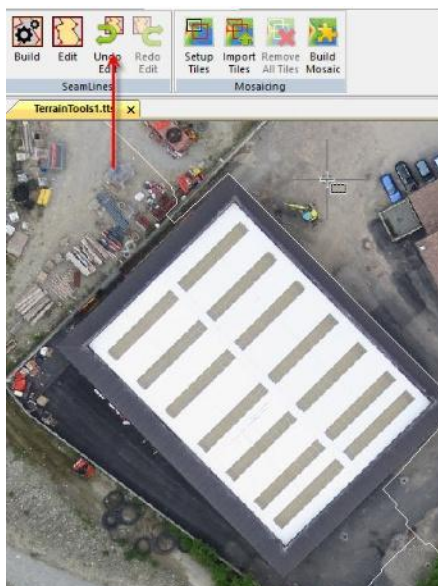


Once the seamlines are created, you need to check if any of them requires a manual fixing in order to better fit the blending effect.



For example some elements have to be included in an image only, so you can start the manual editing button, click inside the area to be enlarged, update the boundary line and confirm the changes with right mouse button.





When you press the right mouse button twice, the command is closed and undo/redo button will be available.

After seamlines are well created you can proceed with mosaic. You can subdivide the final mosaic in 2 or more tiles if you need it.



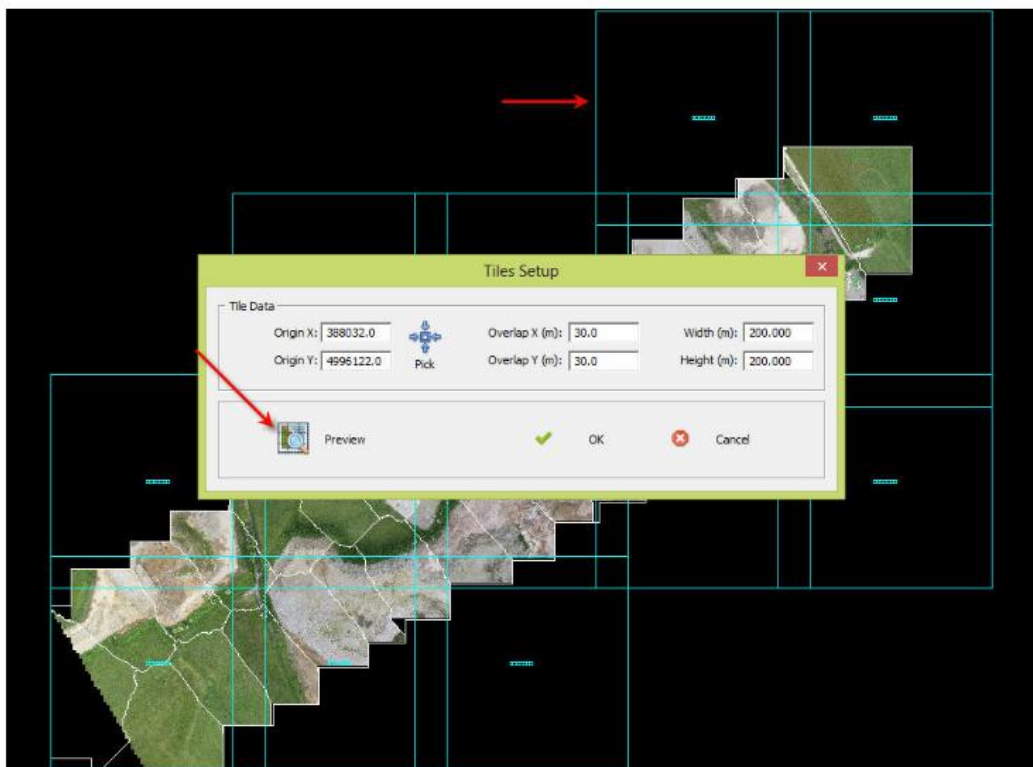
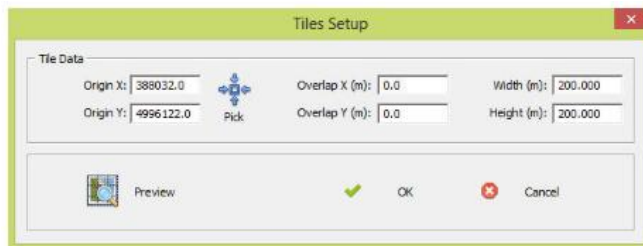
## Setup tiles

There is the possibility to import through the command "IMPORT TILES" from external DWG/DXF or shape files.

Into imported file each tile entity must be included in a different layer with the same tile's name.

With the button "SET UP TILES" you can deal with tiles width, height and overlap.

The tile origin can be picked directly by CAD, using "Pick" button.

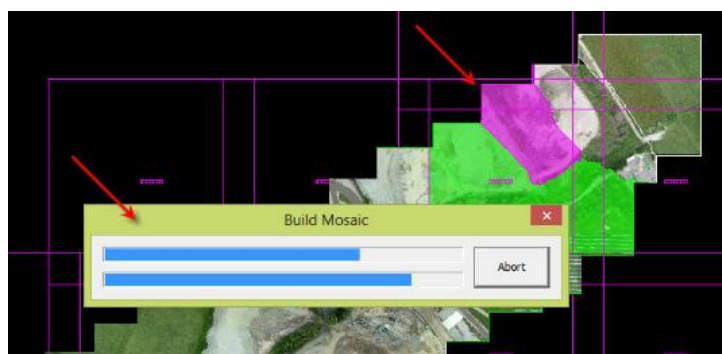
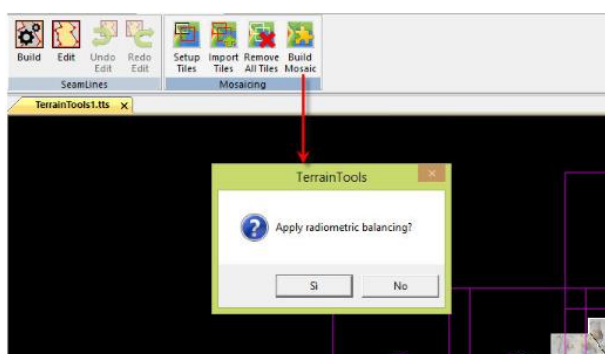


After the tiles setup by pressing the preview button it's possible to view the tiles in the screen (as you can see in the picture above - red arrows).

By pressing ok the following screen will show up.



Finally start the mosaicing process by pressing the BUILD MOSAIC button. You can apply or not the radiometric color balancing to the final mosaic.



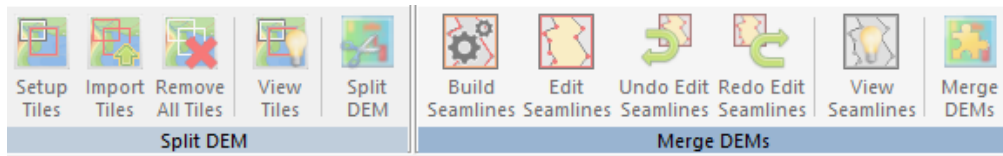
Then you can check the current process step by map tile color.

The orthomosaic results are directly inserted into CAD.



With the buttons in the "VIEW" panel it's possible to activate or de-activate the seamlines and the tiles.

## DEM SPLIT / MERGE TOOLBAR



Through the section it's possible to SPLIT or MERGE DEMs.

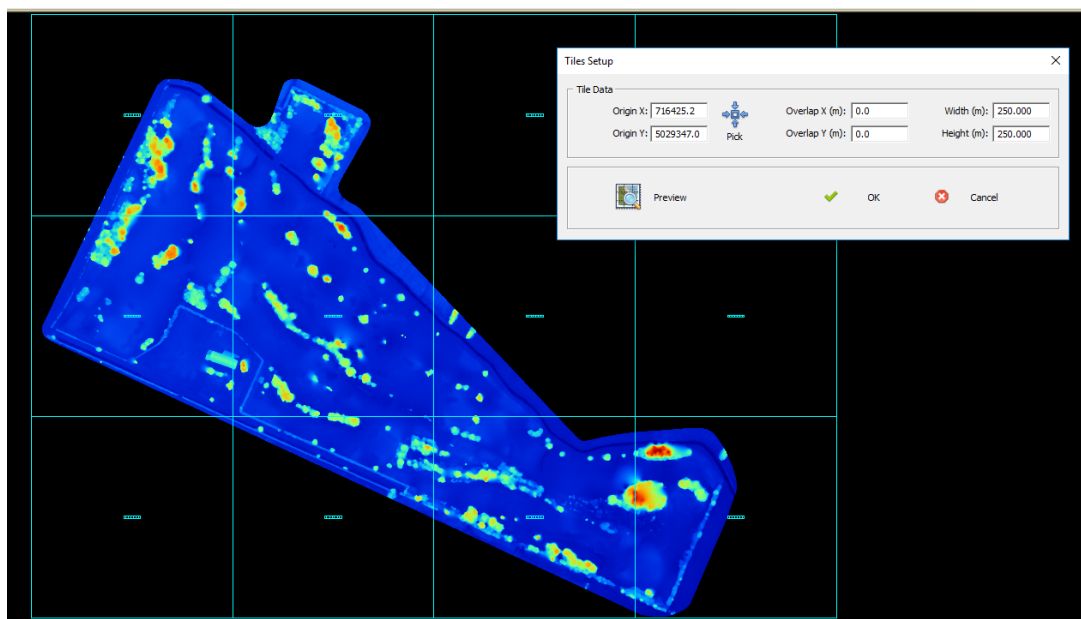
### Split DEM Panel

There is the possibility to import through the command "IMPORT TILES" from external DWG/DXF or shape files.

Into imported file each tile entity must be included in a different layer with the same tile's name.

With the button "SET UP TILES" you can deal with tiles width, height and overlap.

The tile origin can be picked directly by CAD, using "Pick" button.



After the tiles setup by pressing the preview button it's possible to view the tiles in the screen (as you can see in the picture above).

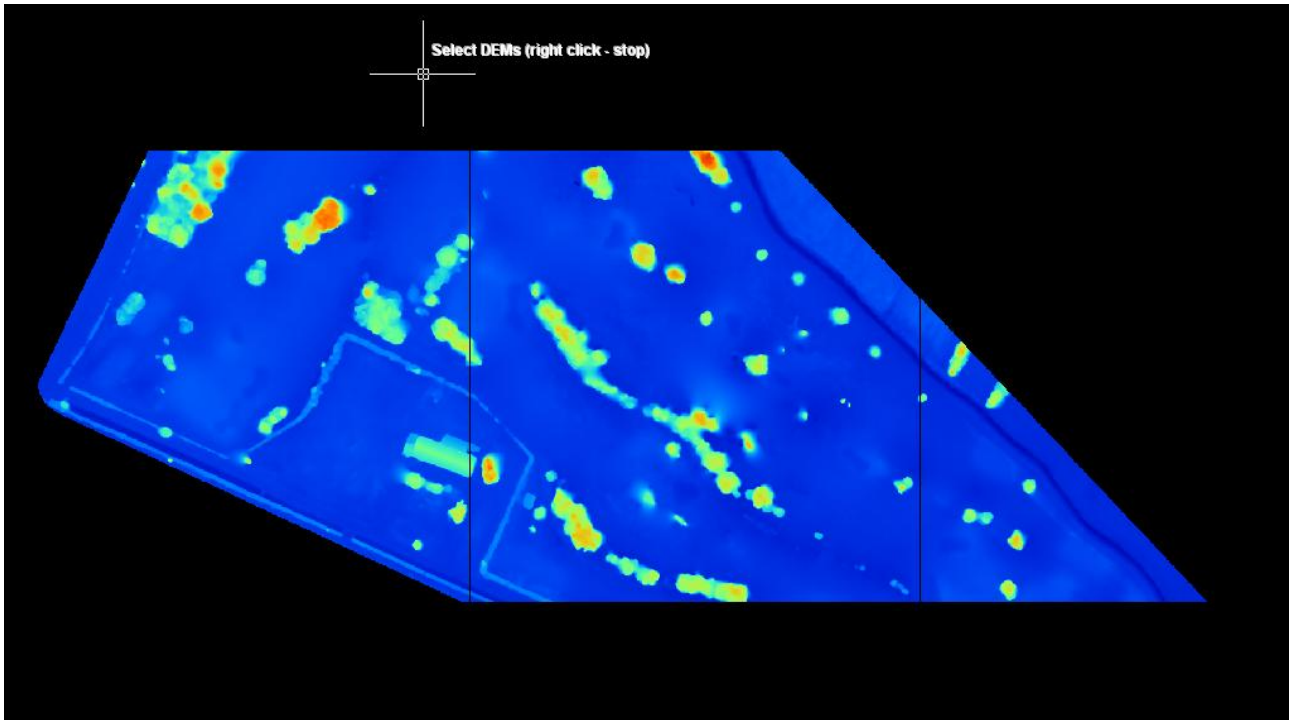
Finally start the splitting process by pressing the "Split DEM" button.

With the button in the "VIEW TILES" it's possible to activate or de-activate the tiles

## Merge DEMs Panel

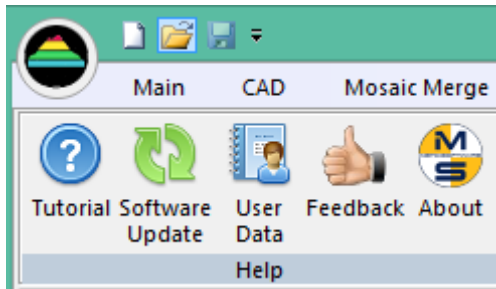
First of all seamlines need to be built by pressing button "BUILD SEAMLINES".

After this step click on the MERGE DEMs button, select the ones you want to merge and name the new DEM.



With the button in the "VIEW SEAMLINES" it's possible to activate or de-activate the seamlines.

## HELP TOOLBAR



In the HELP panel you can find:

- **Tutorials:** Terrain Tools User Guide
- **Software Up date:** You will be re-direct to a web page where you will find the new update of the software.
- **User Data:** Here you can fill the field with you informations. Those data will be used to complete any report you will send to Menci Software.
- **Feedback:** Here you can leave a feedback about our software.
- **About:** our contact information.

## Short Glossary

**DEM:** a Digital Elevation Model is a digital model or 3D representation of a terrain's surface.

**DSM:** a Digital Surface Model represents the surface and includes all objects on it (buildings, trees, ...).

**DTM:** a Digital Terrain Model represents the bare ground surface without any objects like plants and buildings.

**Orthophoto:** an orthophoto, orthophotograph or orthoimage is an aerial photograph geometrically corrected ("orthorectified") such that the scale is uniform: the photo has the same lack of distortion as a map. Unlike an uncorrected aerial photograph, an orthophotograph can be used to measure true distances, because it is an accurate representation of the Earth's surface, having been adjusted for topographic relief, lens distortion, and camera tilt.

**Orthomosaic:** a mosaic got by merging orthophotos using seamlines and optionally the radiometric balancing.

**Seamlines:** boundary lines used in mosaicking process. Overlapping raster datasets can be blended along the seamlines by a specified width.

**Normal:** In geometry, a normal is an object such as a line or vector that is perpendicular to a given object.

**GSD:** ground sample distance is the distance between adjacent pixel centers projected on the ground.