User Manual

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ShapeMetriX

BlastMetriX

SMX SurfaceTrimmer

User Manual
for Version 4.11

October 2024

Project ID: 6100 Author: 3GSM	*Subject to change without notice*

CONTENTS

1 Introduction

The automatic reconstruction of a generic 3D model may lead to unwanted surface measurements at border regions. This is due to sky or floor regions showing an increasing parallax. In order to allow user intervention the *SMX SurfaceTrimmer* is used.

This user manual addresses all topics related to the *SMX SurfaceTrimmer* i.e. installation, user interfaces, features and operations. Let us know if we can support you, and give us your valuable feedback. Only this way it remains possible to keep the system both, flexible enough for broad usage and sufficiently specific for your applications.

We wish you success with the *SMX SurfaceTrimmer.*

The Team of 3GSM

Graz, October 2024

2 General

The *SMX SurfaceTrimmer* s part of the *ShapeMetriX/BlastMetriX package* and not available as a stand-alone program. The installation takes place during the installation of *ShapeMetriX/BlastMetriX a*nd is described in the corresponding user manual.

Note:
The *SMX SurfaceTrimmer* software component is used under this name in *ShapeMetriX and BlastMetriX* packages, i.e. there is no dedicated *BMX SurfaceTrimmer*. The same may apply to other software components.

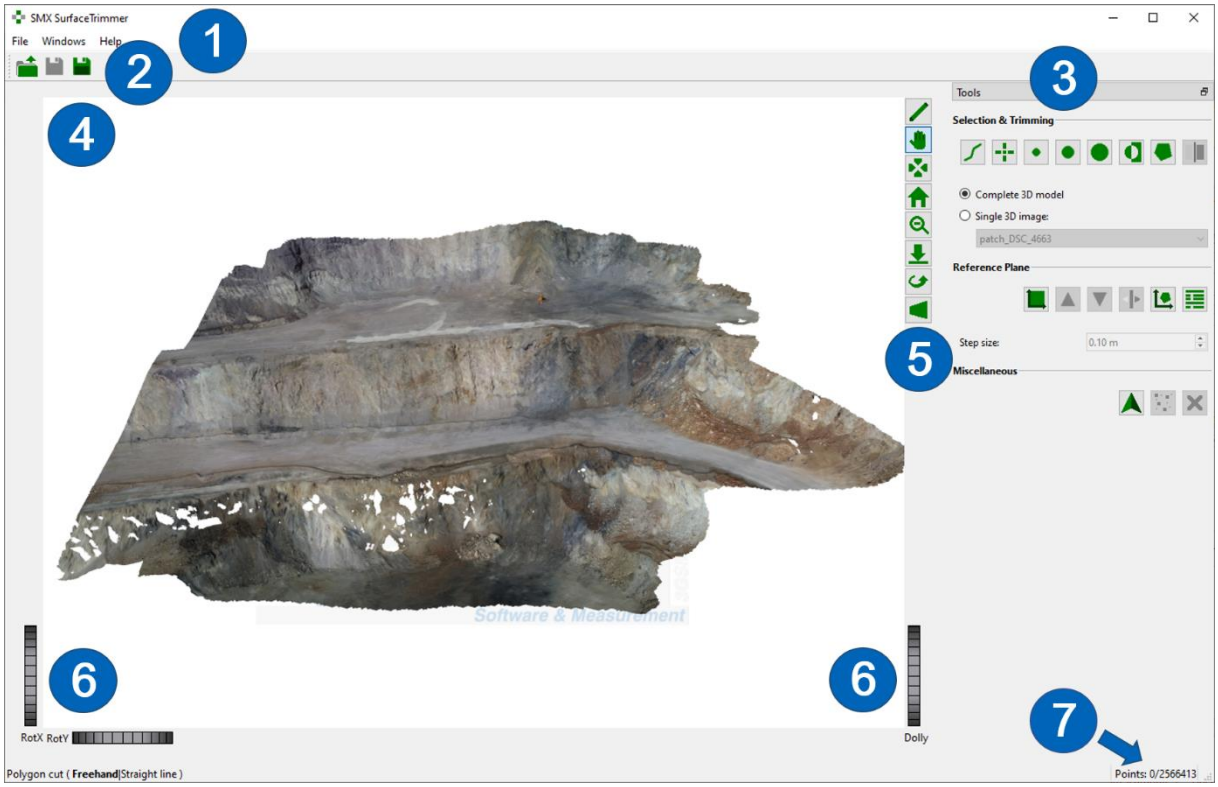
The software provides a conversion of 3D model into former versions by using the command *"Export 3D Model as JM3 v 3.0"* in the menu bar. This export is provided for reasons of compatibility with previous versions of the software. Version 3.0 is compatible with following software versions:

- *ShapeMetriX 3D / BlastMetriX 3D 4.1 - 4.4*
- *ShapeMetriX UAV / BlastMetriX UAV 2.1 – 4.0*

Note:
Some functionalities will no longer be available after conversion (e.g. referencing in the *SMX MultiPhoto*).

3 User interface

The user interface of the *SMX SurfaceTrimmer* (Figure 1) comprises the menu bar, the toolbar, the *Tools* pane, the 3D viewer including the navigation bar, and thumb wheels. The number of points building up the mesh of the 3D model are displayed in the lower right corner of the user interface.



1 Menu bar
2 Toolbar
3 *Tools* pane
4 Viewer
5 Navigation bar
6 Thumb wheels
7 Number of 3D model points

Figure 1: User interface of the SMX SurfaceTrimmer

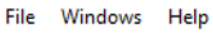
3.1 Context menu of the 3D viewer

The context menu of the 3D viewer allows the change in the display of the 3D model. A click on the right mouse button in the viewer opens a pop up window and several options can be chosen:

Draw as is	The 3D topography is completely overlaid by the digital photograph (3D model)
Wireframe	A triangulated red coloured point cloud is forming the topography
Wireframe Overlay	The 3D model and a red coloured overlay of the wireframe is forming the topography

Points	The point cloud of the scene according to the topography is shown
All Points	All available points of the 3D model according to the photograph are shown
Fullscreen	Switches between the fullscreen display and the windowed display
Show Texture	Displays the 3D model with texture in the viewer
Show Axes	Turns the co-ordinate axes on and off
Show Bounding Box	Turns the bounding box surrounding of the 3D model on and off

3.2 Menu bar



The menu bar has three main menus (*File*, *Windows* and *Help*). The menu commands are accessible using the mouse cursor.

Menu File

Open 3D Model	Opens a 3D model (".jm3" file)
Save	Saves the 3D model (".jm3" file)
Save as	Renames and saves the 3D model (".jm3" file)
Import/Merge	Imports and merges another part of the same 3D model (".jm3" file). Requirement: 3D model of the same *Stereoscopic Image Pair*
Export 3D model as JM3 v3.0	Exports the 3D model into previous versions (see Chapter 2)
Show Statistics	Shows the statistics of the 3D model (collection and single 3D model)
Exit	Closes the *SMX SurfaceTrimmer*

Window

Reset Layout	Resets the layout of the *SMX Surface Trimmer* (default)

Help

User Manual	Opens the manual of the software component
Units	Displays the units used in the software
About	Displays version and release information of the software component

3.3 Toolbar

Open 3D Model

Opens a 3D model (“.jm3” file)

Save

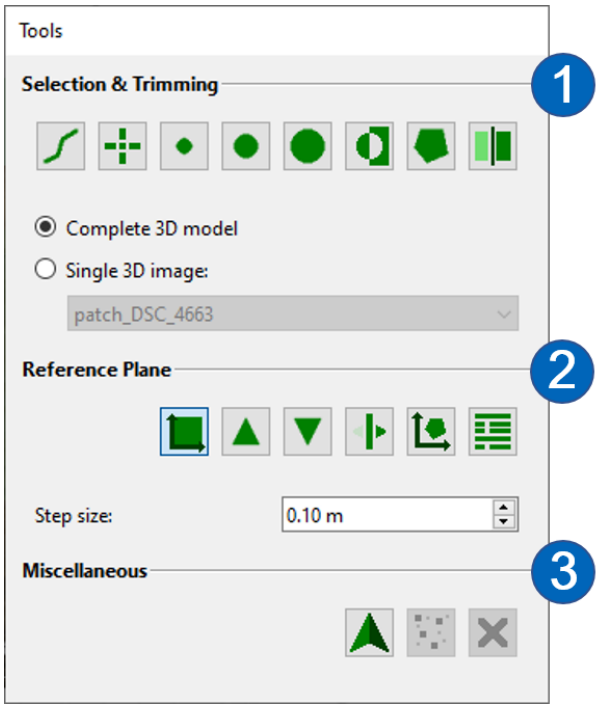
Saves the 3D model (“.jm3” file)

Save as

Renames and saves the 3D model (“.jm3” file)

3.4 Tools pane

The *Tools* pane (Figure 2) provides features for reworking the 3D model, e.g. trimming of the 3D model and readjustment of the Reference Plane (see Chapter 0).



1 Section and trimming
2 Reference Plane
3 Miscellaneous

Figure 2: Tools pane

Selection & Trimming

Select with Polygon

Divides a point cloud into two segments using a polygon

Select Single Point

Selects a single point

Select Small Region

Selects a group of points enclosed by a small sphere

Select Medium Region

Selects a group of points enclosed by a medium-sized sphere

Select Large Region

Selects a group of points enclosed by a large sphere

Invert Selection

Inverts the selection of points to delete

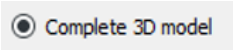
Select Region

Marks a polygonal region in the 3D model

Cut at Reference Plane

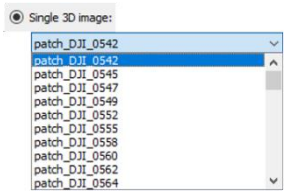
Trims the 3D model at the position of the *Reference Plane*

Complete 3D Model



Activates all 3D subimages that compose the 3D model

Single 3D Image



Activates one 3D subimage

Reference Plane

Show Reference Plane

Shows/hides the *Reference Plane* as a semi-transparent green plane

Move in Normal Direction

Relocates the *Reference Plane* along its upward normal vector by clicking with the left mouse button on the respective buttons

Move against Normal Direction

Relocates the *Reference Plane* against its upward normal vector by clicking with the left mouse button on the respective buttons

Flip Normal

Flips the upward normal vector of the *Reference Plane*

Set Reference Plane from Region

Fits the *Reference Plane* to a marked region

Define Reference Plane

Opens the *Plane* dialog for adjusting the Reference Plane (see Chapter 4.4)

Step Size

Defines the step size of one click on the buttons for relocating the *Reference Plane*

Miscellaneous

Set North Direction

Orientates the 3D model

Reduce Points

Reduces the number of points of the 3D model

Remove whole 3D Model

Removes a single 3D subimage from the collection

3.5 Navigation bar

Hint:
The *SMX SurfaceTrimmer* toggles between the *Edit* and *Navigate* mode by pressing the "*Esc*" key.

Edit

Performs actions within the 3D model such as marking annotations, etc. (active = blue)

Navigate

Controls the motion and inspection of a 3D model (active = blue)

Seek to a Selected Point

Zooms towards the selected location on the 3D model

Move to Home Position

Sets the viewer to its initial position

Zoom out / Zoom in

Zooms out from the current view. Zooms to the previous view again.

Top Down View

Orientates the 3D model from the camera view (top down).

Auto Rotate (fixed or view)

Rotates the 3D model from a fixed point (top down) or from the current point of view

Toggle Perspective/Parallel Projection

Toggles between perspective and parallel projection

Thumb wheels

The thumb wheels are used for rotation and zooming

3.6 Navigation mode

The devices used in the *Navigate* mode are the mouse and/or the keyboard.

Mouse navigation

- Rotation: The left mouse button rotates the 3D model. Just keep the left button pressed and move the mouse around to see the 3D model rotating.
- Context menu: The right mouse button opens a context menu where the representation of the 3D model can be influenced.
- Panning: The middle mouse button is used to pan the 3D model. The same can be done by pressing "*Ctrl*" or "*Shift*" and using the left mouse button.
- Zooming: Pressing the left and middle mouse button at the same time is used to zoom. The same can be done by pressing "*Ctrl*" and "*Shift*" and using the left mouse button. When turning the wheel of a wheel mouse the 3D model is also zoomed.

Hint:
It is preferred to have a mouse with 3 buttons, or a wheel mouse. Usually the wheel acts as the third mouse button.

Keyboard navigation

- Straight motion is performed by pressing the corresponding arrow key *"Left"*, *"Right"*, *"Up"* or *"Down"*.
- Zooming is performed by pressing *"Shift"* simultaneously with the arrow key *"Up"* for zooming in and the arrow key *"Down"* for zooming out.
- Rotation of the 3D model in a desired direction is performed by pressing "*Ctrl*" simultaneously with the corresponding arrow key *"Left"*, *"Right"*, *"Up"* or *"Down"*.

4 Operations

The *SMX SurfaceTrimmer* supports several operations which can be called using the features of the *Tool* pane:

- Remove 3D subimages
- Delete a region or selection of points
- Set *Reference Plane*
- Reduce the number of points
- Change the 3D model's azimuth and spatial position

Hints:

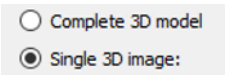
- Use the *"Points"* or *"All Points"* representation which usually facilitates the editing. The representation is changed via the context menu accessible by clicking the right mouse button in the *Navigate* mode (see Chapter 3.1). The software recognises the last saved representation.
- The point representation always shows a coloured point cloud according to the texture.
- The navigation of a 3D model in the *SMX SurfaceTrimmer* with a *"Wireframe", "Wireframe overlay"* or *"Draw as is"* representation is computationally intensive and may result in slow model reaction on the screen. Hence point representation is recommended.
- The *SMX SurfaceTrimmer* software currently does not include an *"Undo"* mechanism. However, as long as the actually displayed results are not saved as long the 3D model remains unchanged.

4.1 Load 3D model

First, load a 3D model by clicking *"File | Open 3D Model"* in the menu bar or using the according icon in the toolbar and choose the intended file with extension ".jm3".

Hint:
The 3D model can be edited only if the *Edit* mode is activated. Ensure being in the *Navigate* mode in order to inspect the 3D model from all sides.

4.2 Switching between 3D subimages



It is possible to choose between trimming parts of the whole (merged) 3D model *("Complete 3D model")* or parts of a single 3D subimage *("Single 3D Image")* in the *Tools* pane. If the "*Complete 3D model*" is active, all performed operations affect the whole 3D model (Figure 3 left). If the "*Single 3D Image*" is active, all performed operations affect only the currently selected 3D subimage (Figure 3 right).

The entire 3D model is highlighted when the "*Complete 3D model*" has been selected. In the "*Single 3D Image*" mode only the currently active 3D subimage is highlighted while the inactive 3D subimages are shaded. Note that

only parts of a single 3D subimage can be removed by trimming in either mode. To remove a 3D subimage completely from the 3D model refer to the function *"Remove Whole 3D Image"* below.

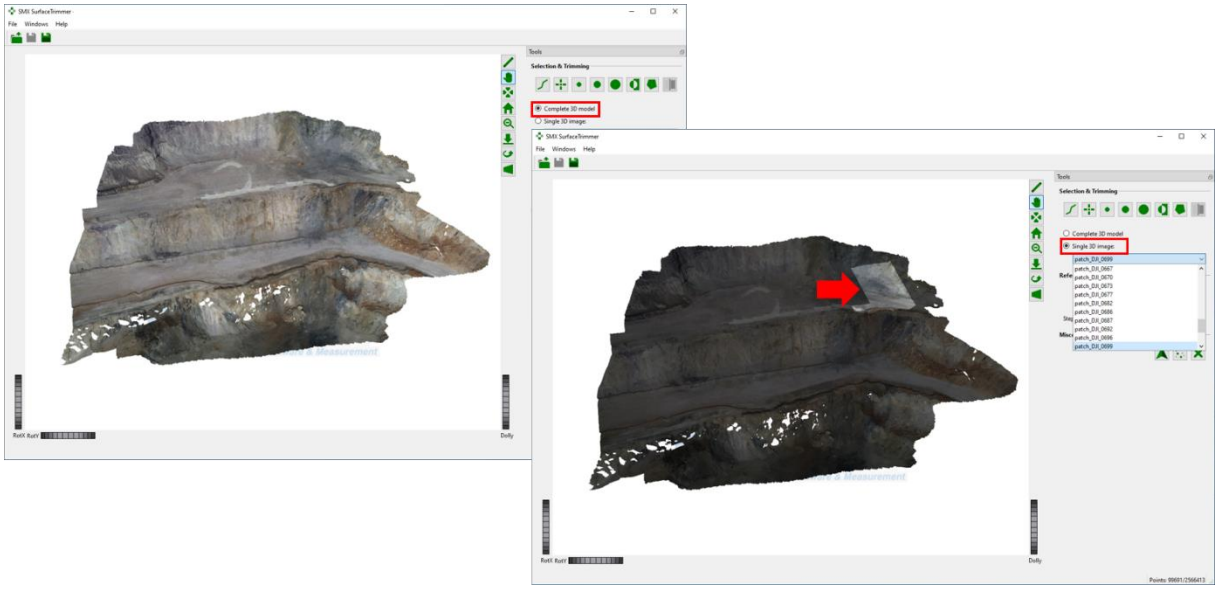


Figure 3: Left: complete 3D model. Right: Single 3D image (subimage)

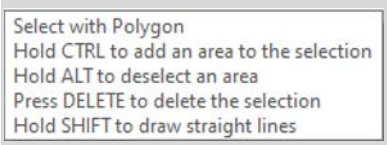
4.3 Trimming of 3D models

Delete a region with a polygon

1. Activate the mode for drawing a polygonal line by clicking the icon *"Select with polygon"* in the *Tools* pane
2. Enclose the region to delete by dragging the cursor across the 3D model while keeping the left mouse button pressed (Figure 4). Release the mouse button and the selected region is highlighted in red (Figure 5).
3. Delete the desired region by pressing the *"Delete"* key or middle mouse button (Figure 6)
4. Save the 3D model by clicking *"File | Save"* or alternatively *"File | Save as"* in the menu bar or use the corresponding icons in the toolbar

Hint:

Move the cursor on top of the *"Select with polygon"* icon and a notification (tool tip) appears:



Hint:

Press "*Shift*" while keeping the left mouse button pressed to draw a straight line.

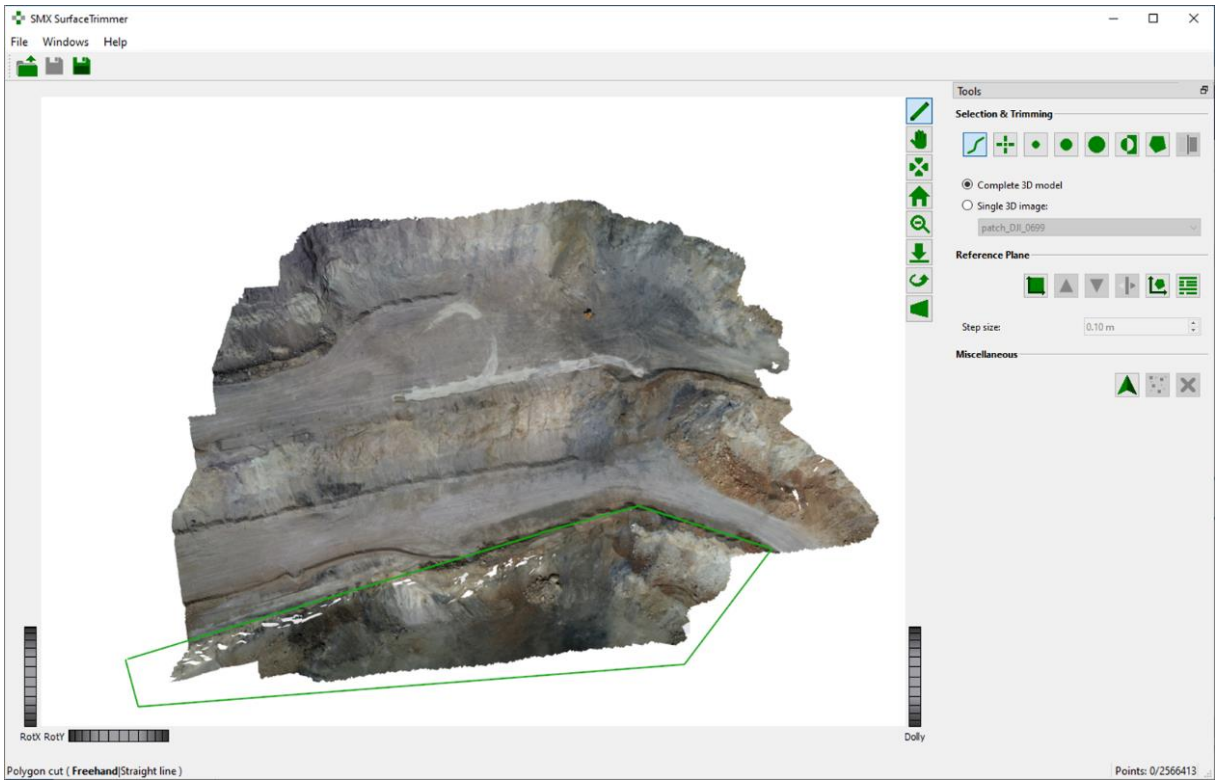


Figure 4: Region to delete enclosed by a polygon (green solid line)

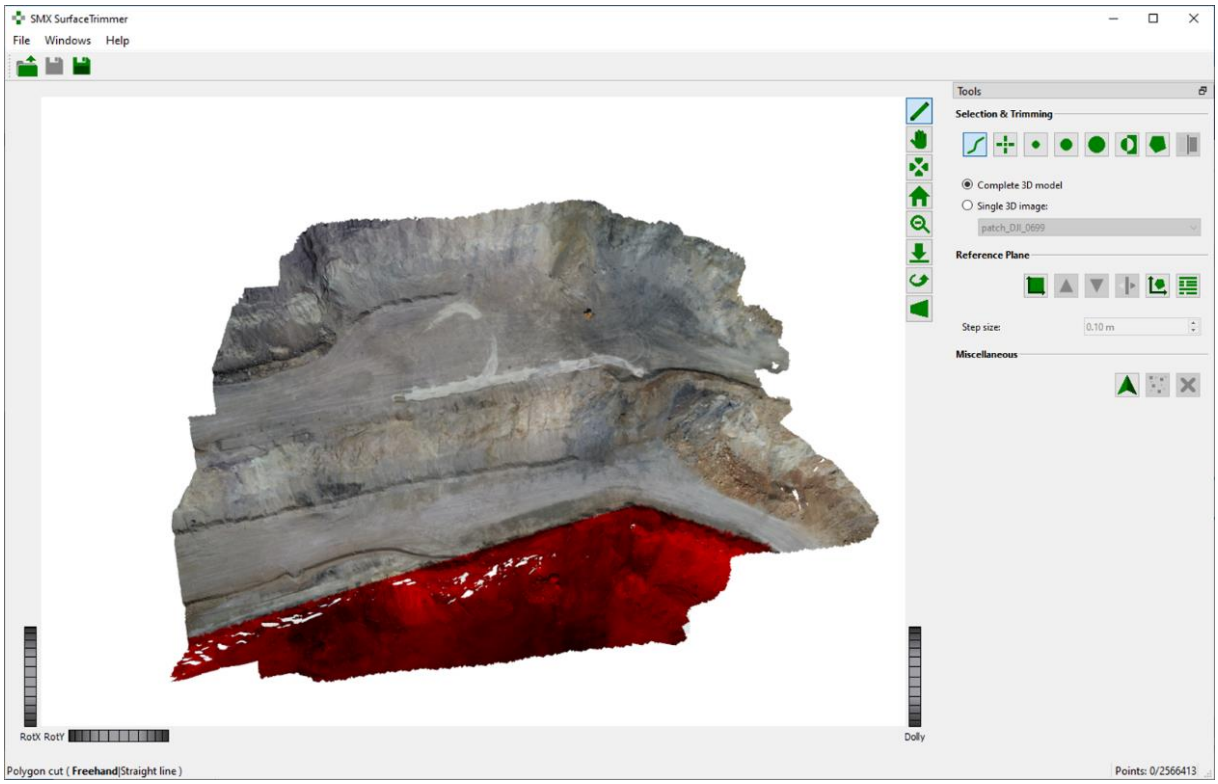


Figure 5: Highlighted region to delete (red)

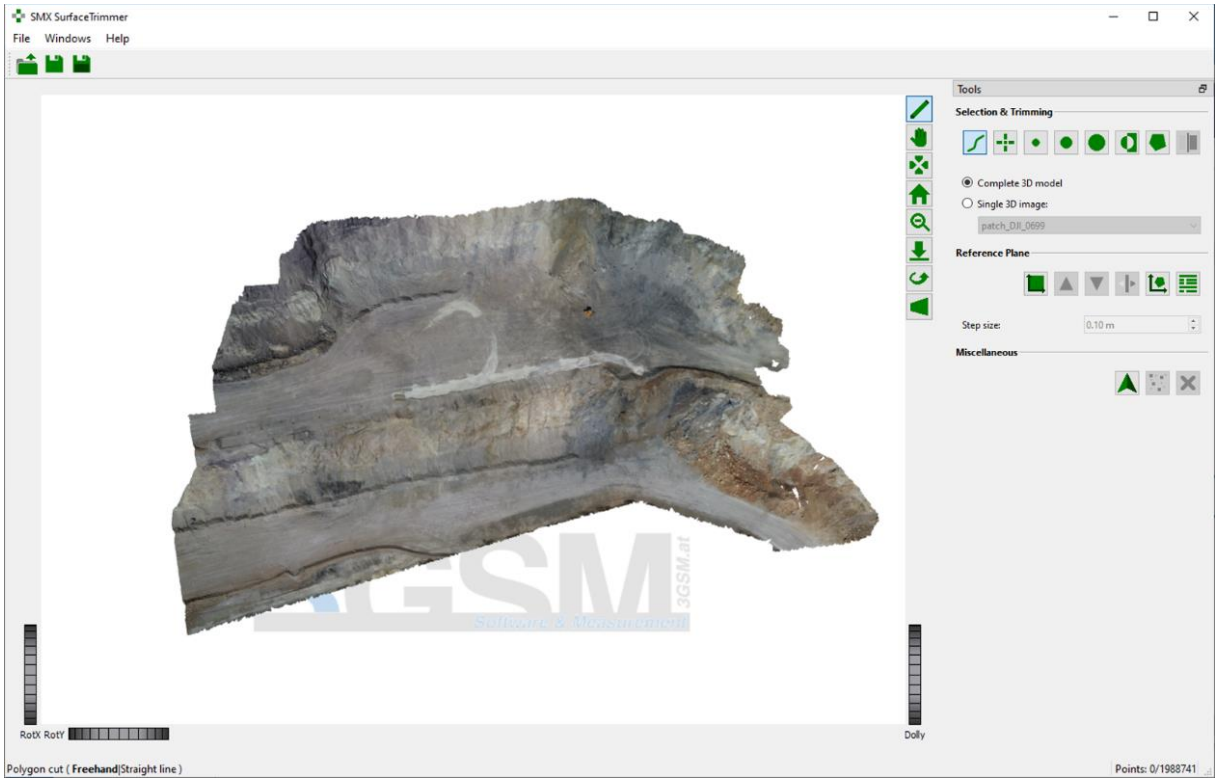


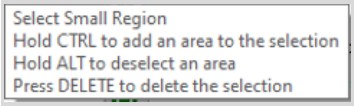
Figure 6: 3D model after deletion of the marked region

Delete single points and regions

1. Click on one of the icons to select a single point *"Select Single Point"* or specific region (i.e. *"Small Region"* , *"Medium Region"* or *"Large Region"*) in the *Tools* pane
2. Click on the section to delete marked with a yellow sphere or selected with the single point marker within the 3D viewer (Figure 7). After confirmation with a click on the left mouse button the point/region to delete is highlighted in red (Figure 8).
3. Delete region by pressing the *"Delete"* key or pressing the middle mouse button (Figure 9)
4. Save the 3D model by clicking *"File | Save"* or alternatively *"File | Save as"* in the menu bar or use the corresponding icons in the toolbar

Hint:
The icons refer to the size of the enclosing sphere. For instance, the left icon selects one individual point.

Hint:
Move the cursor on top of one of the icons *"Small Region"* , *"Medium Region"* or *"Large Region"* in the *Tool* and a notification (tool tip) appears:



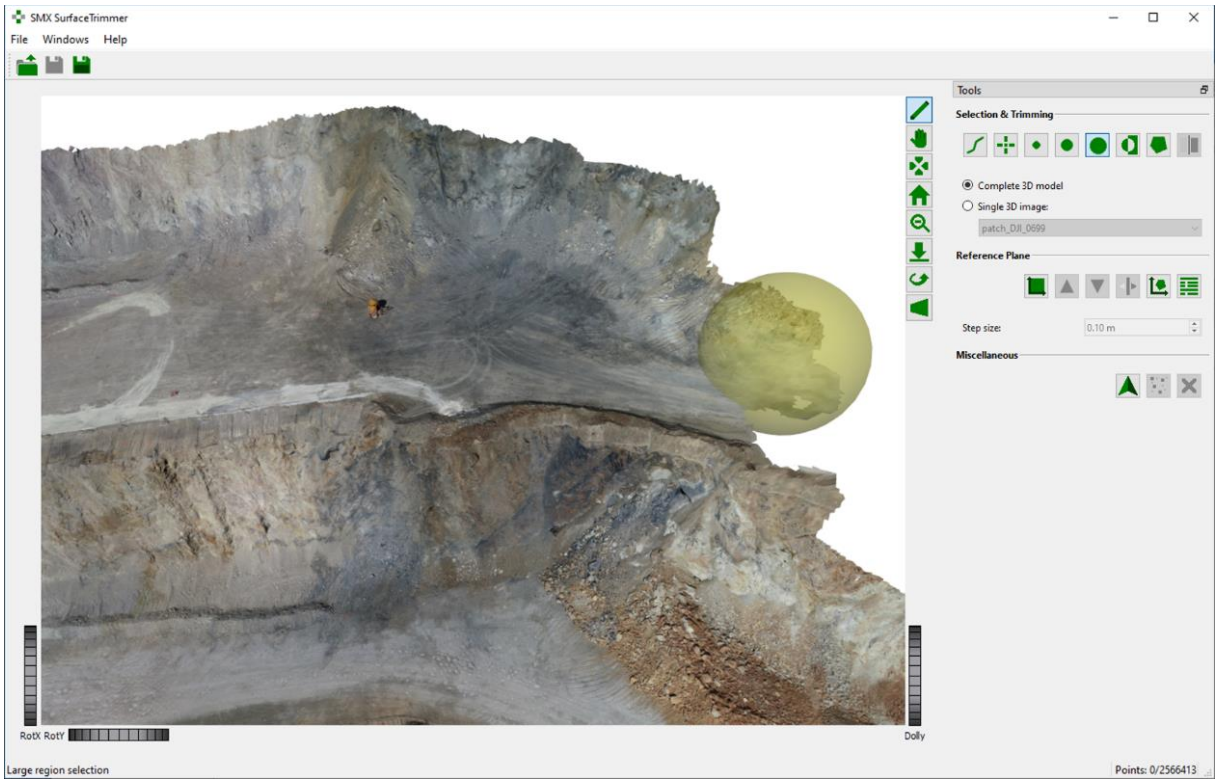


Figure 7: Selection of a region by a sphere

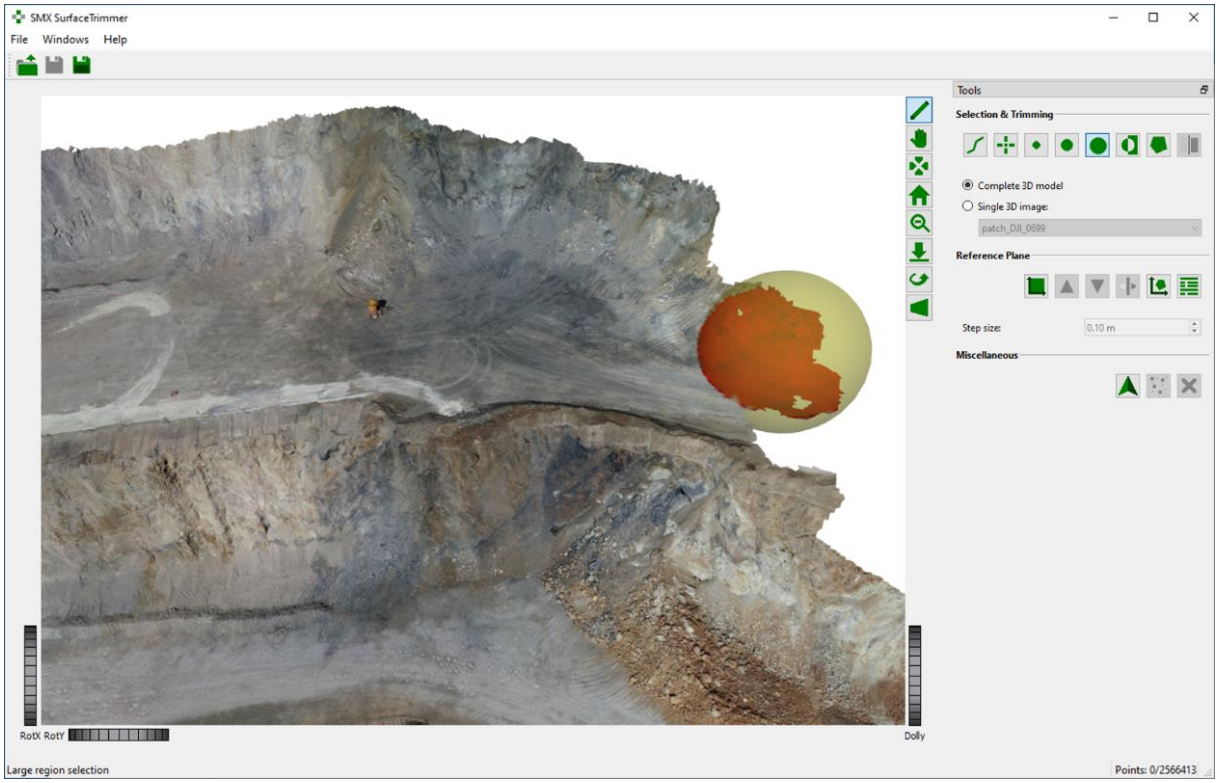


Figure 8: Region to delete (red) enclosed by the sphere

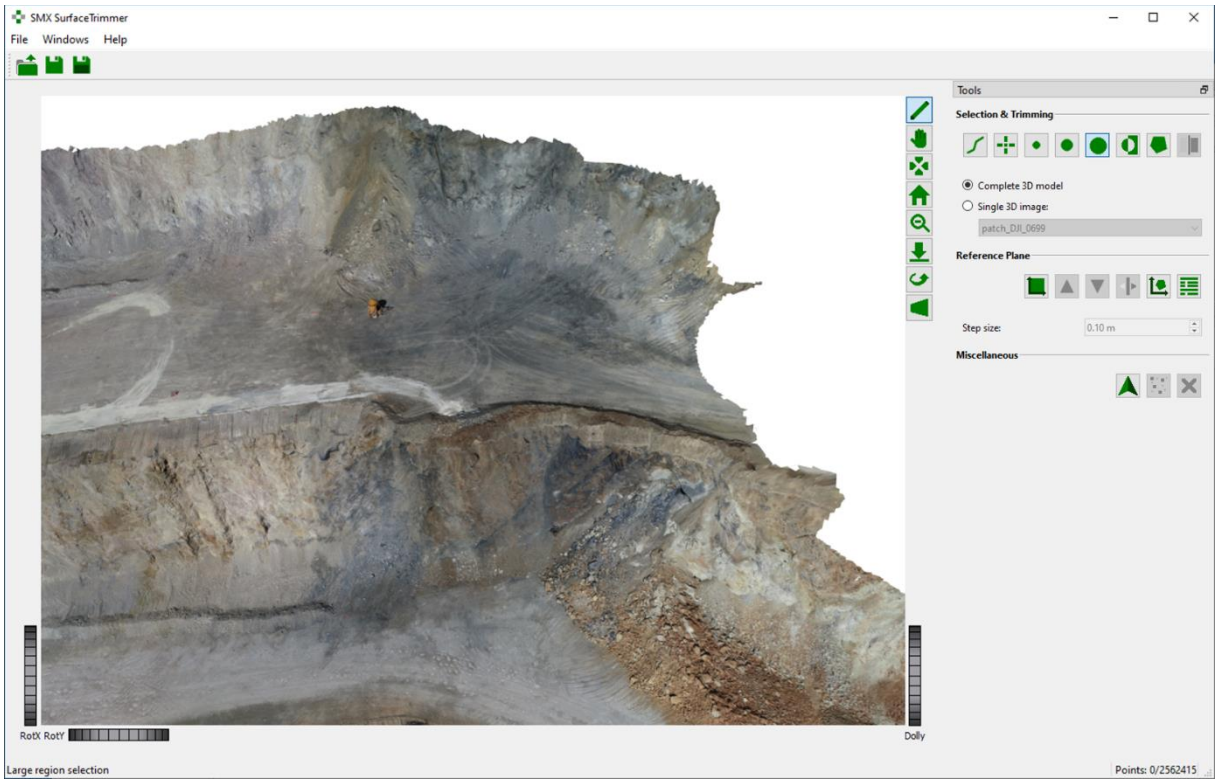


Figure 9: 3D model after deletion of the region

Comment on deletion of 3D points

3D models generated with *SMX ReconstructionAssistant* and/or *SMX ModelMerger* have the triangulated surface description calculated in real time from the 3D point cloud. This entails that any gaps inside a 3D subimage due to point removal from will be re-meshed to a continuous 3D surface (Figure 10). 3D models generated with *SMX MultiPhoto* have the triangulated surface description processed during 3D model generation. Any portion of the 3D surface removed from the 3D model will result complete removal of the edited parts (Figure 11). No re-mesh or filling of gaps takes place.

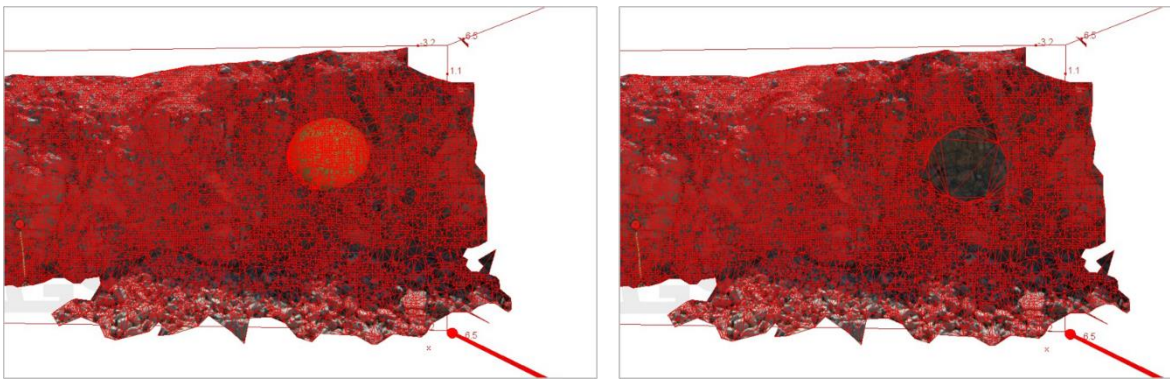


Figure 10: Wireframe of a 3D model before (left) and after (right) deletion of a section in the centre of the image

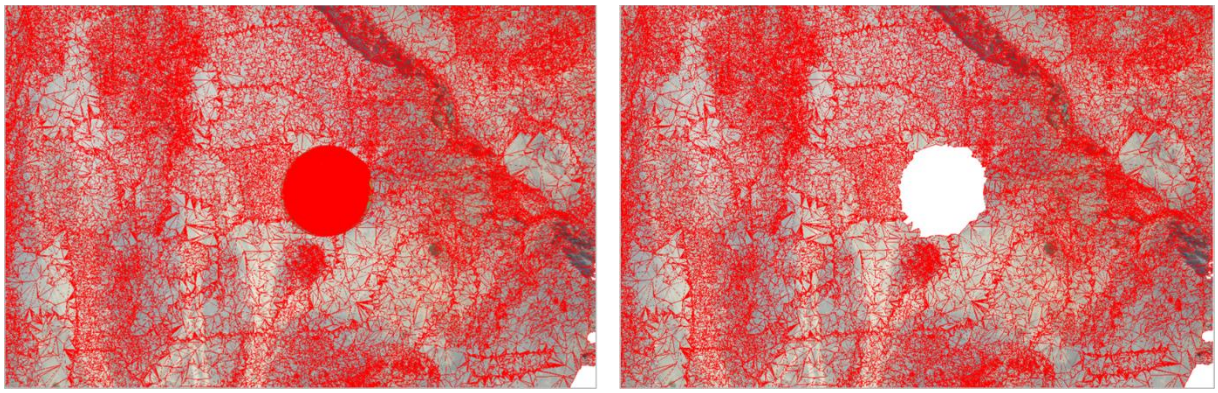


Figure 11: Wireframe of a 3D model generated with SMX MultiPhoto before (left) and after (right) deletion of a section in the centre of the image

Invert selection of points

The selection of points can be inverted by the *SMX SurfaceTrimmer* by following procedure:

1. Select a region as described in Chapter 4.3. The region to be deleted is highlighted in red (Figure 12)
2. Click on the "*Invert Selection*" icon in the *Tools* pane. The selection of points is inverted, i.e. previously unselected points are now highlighted and will be deleted by pressing the *"Delete"* key or the middle mouse button.

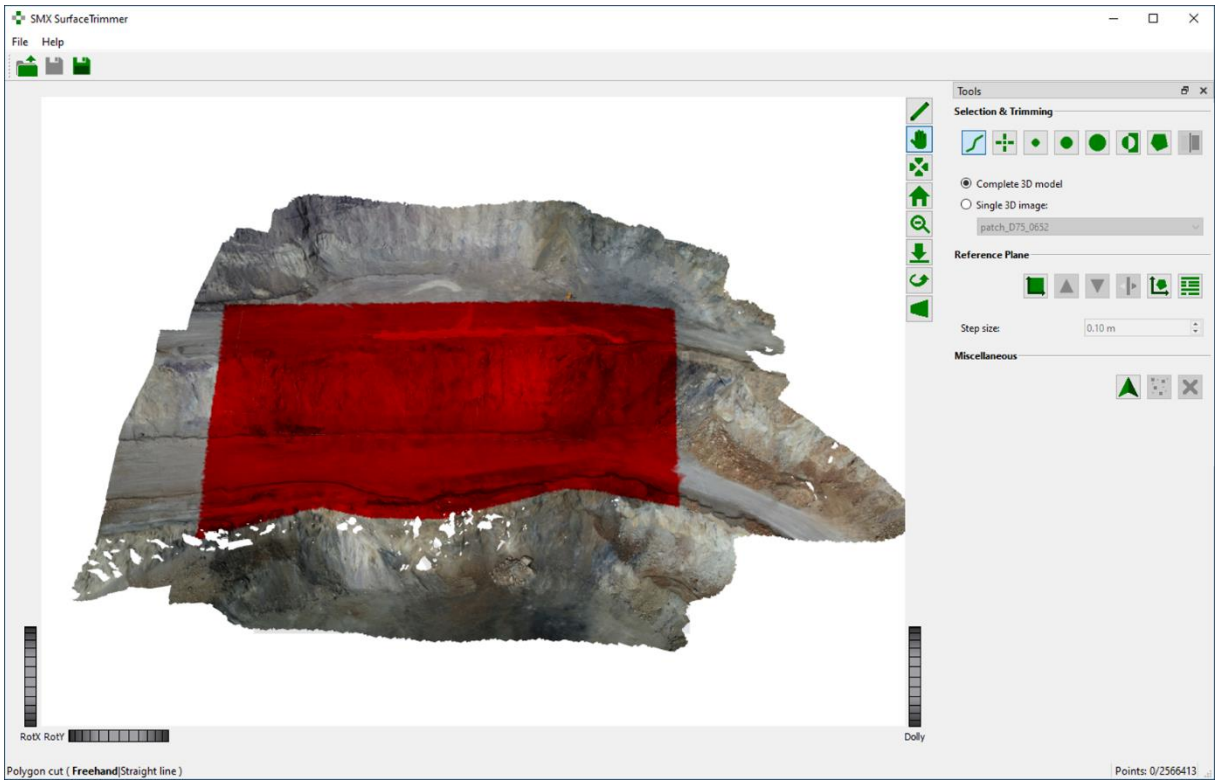


Figure 12: Selection of points

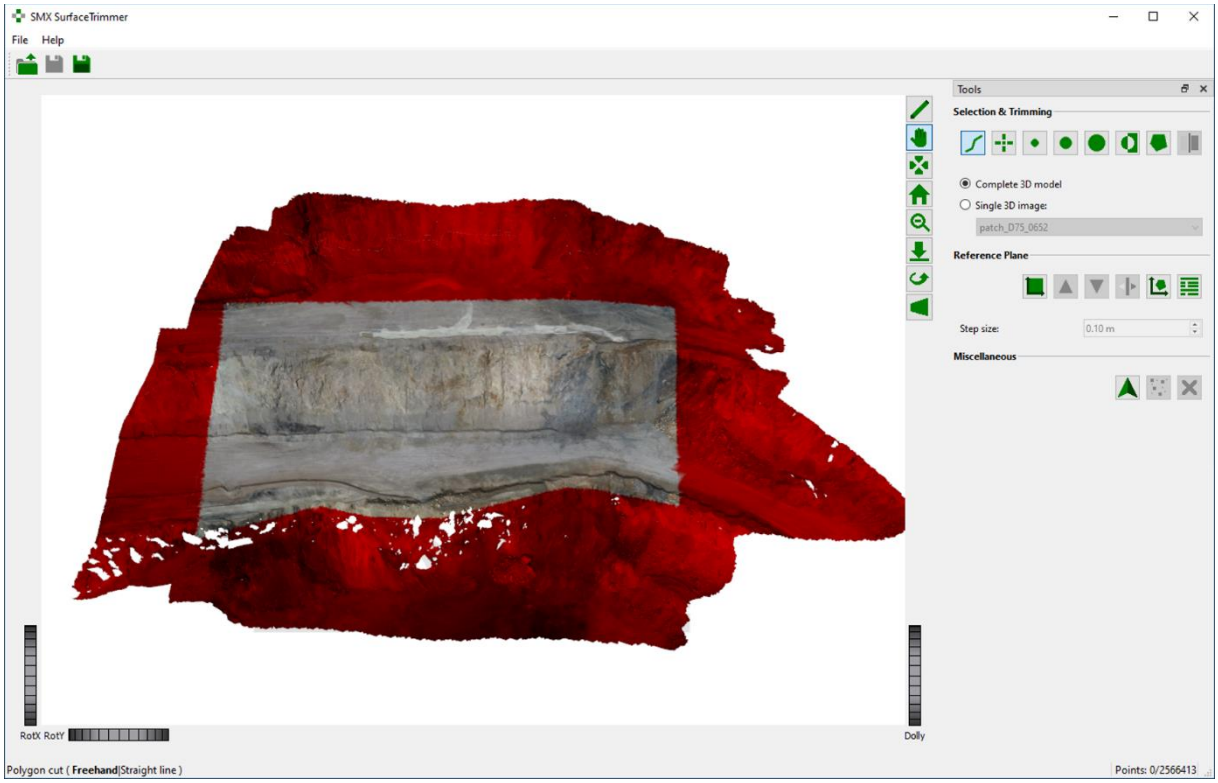


Figure 13: Inverted selection of points

4.4 Reference Plane

The *Reference Plane* is set automatically after 3D model generation as the plane having the mean orientation and position of the 3D model. It is visualized in the 3D viewer by clicking the "*Show Reference Plane*" button. The *Reference Plane* is used as the basis for measurements, e.g. depth colouring in the *JMX Analyst*. The position of the *Reference Plane* can be modified interactively by setting the *Reference Plane* from a user defined region defined directly on the 3D model or from measured co-ordinates (x, y, z or easting, northing, height) and slopes (azimuth and inclination).

Set Reference Plane from Region

1. Click on the "*Select Region*" icon in the toolbar and mark a polygonal region on the 3D model. The *Reference Plane* is defined by the set of points enclosed by this region.
2. The *Reference Plane* will be calculated and set by selecting *"Set Reference Plane from Region"* in the *Tools* pane (see Figure 14)

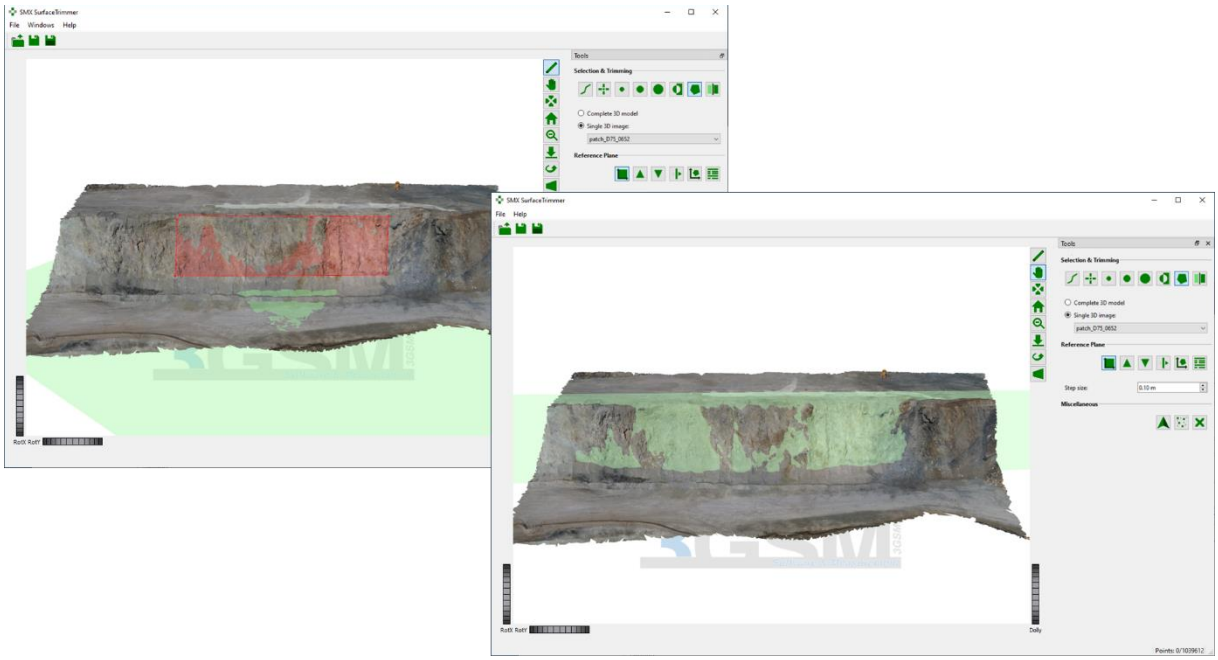


Figure 14: Definition of the Reference Plane: Selection of a polygonal region (left); matching Reference Plane for selected region (right).

Set Reference Plane from co-ordinates

1. Select *"Define Reference Plane"* in the *Tools* pane
2. Enter values for positioning the *Reference Plane* in the appearing dialog (see Figure 15):
    a. inclined plane
        - co-ordinate system (easting, northing, height)
        - slope (dip direction and dip angle)
    b. horizontal plane
        - elevation
        - co-ordinate system (local or global)

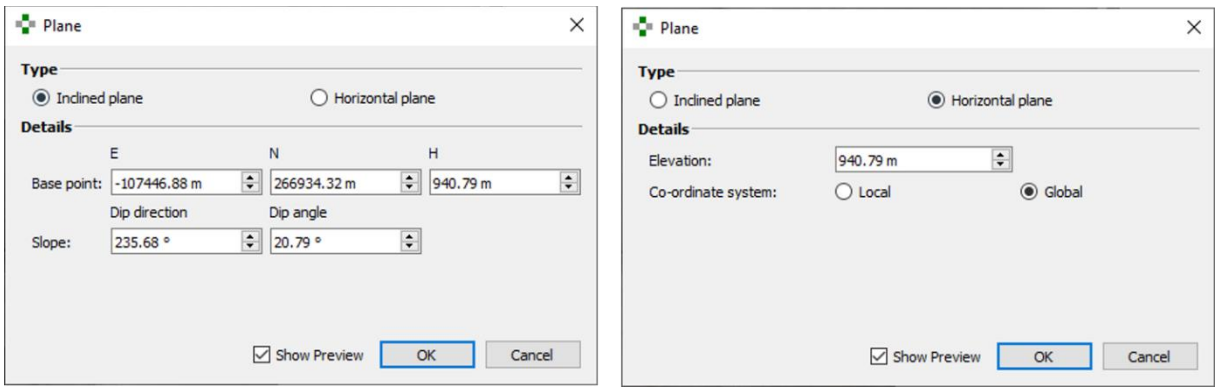


Figure 15: Positioning of the Reference Plane

Adjust Reference Plane

1. If necessary, adjust the orientation of the upward normal vector of the *Reference Plane* by a click on the "*Flip Normal*" icon in the *Tools* pane. The orientation of the normal vector is indicated by a green shading of the *Reference Plane*. Light green shading means that the observer faces the upward normal vector (Figure 16 and Figure 17 left) while dark green shading means the upward normal vector points away from the observer (Figure 16 and Figure 17 right).
2. If necessary, move the *Reference Plane* in or against the direction of its normal vector using the arrow buttons "*Move in Normal Direction*" or "*Move against Normal Direction*" *Tools* pane (Figure 18). The step size is adjusted by entering the value in *"Step Size"* field 0.10 m .

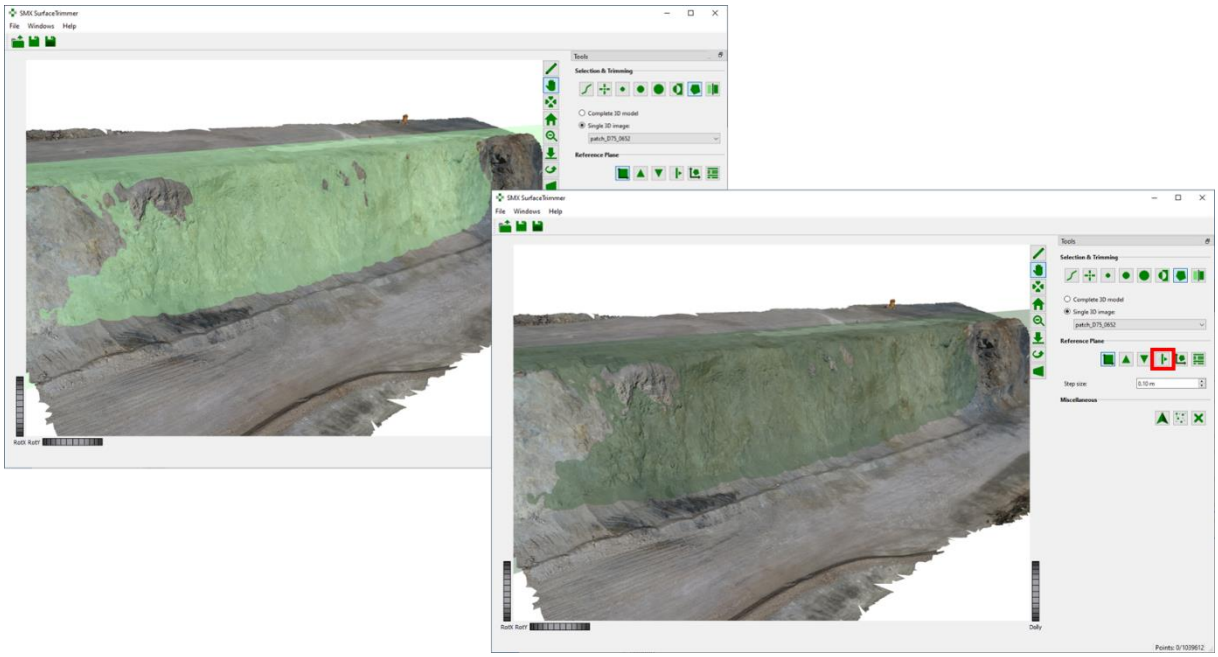


Figure 16: Left: Reference Plane (light green shaded) with the upward normal vector faces the observer. Right: Reference Plane (dark green shaded) with the upward normal vector points away from the observer.

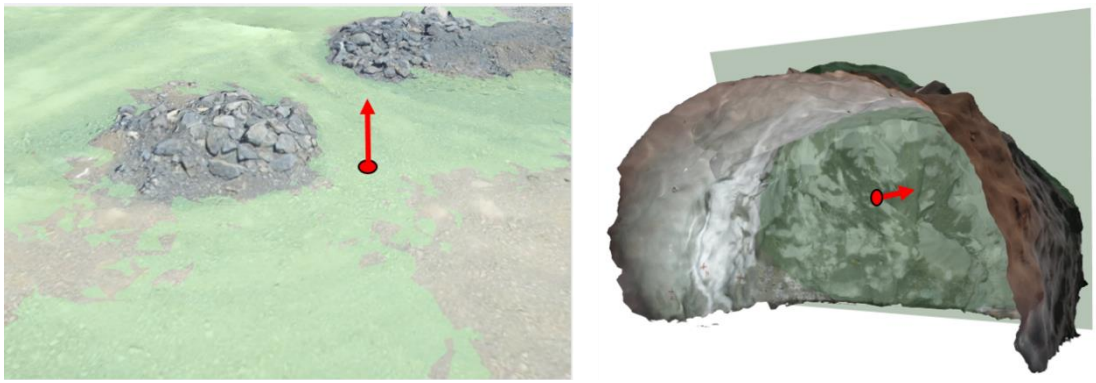


Figure 17: Left: Upward normal vector pointing the physical upward direction in a surface quarry. Right: Upward normal vector pointing in the direction of excavation in a tunnel.

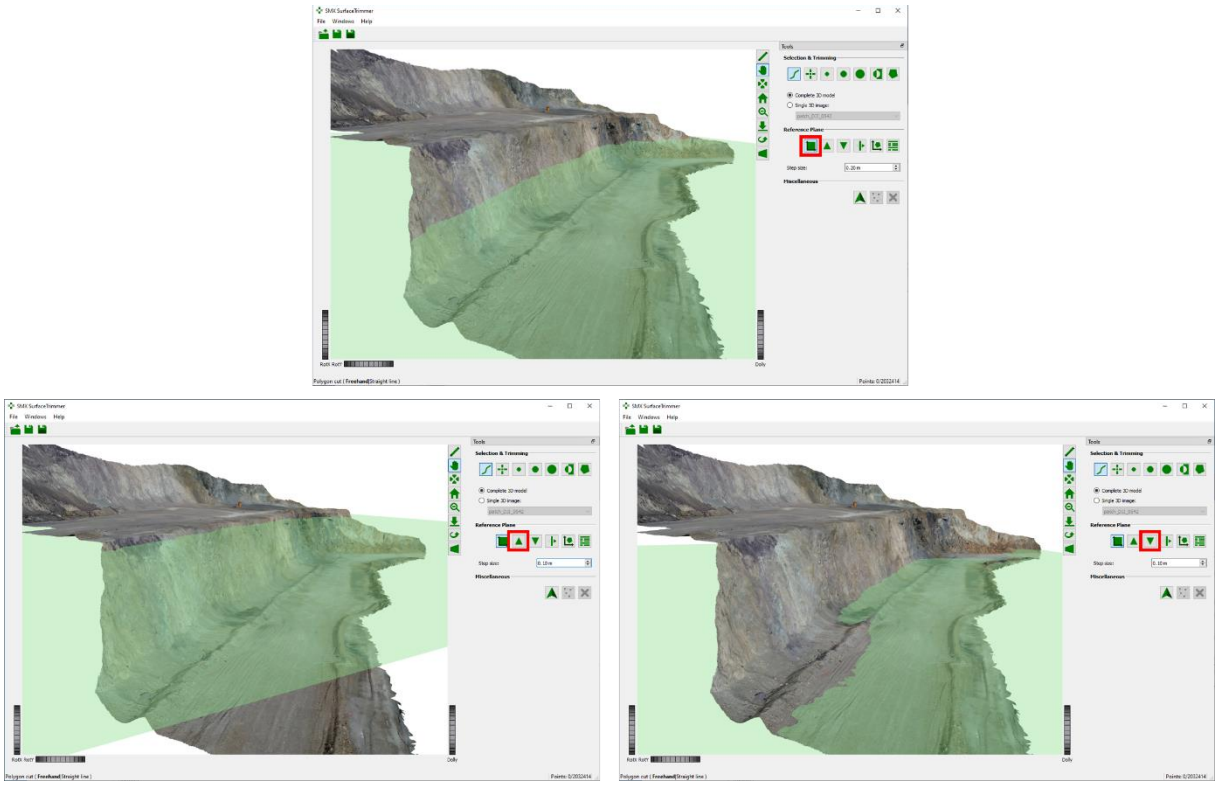


Figure 18: Top: green shaded Reference Plane. Bottom left: Reference Plane moved in normal direction (blue arrow). Bottom right: Reference Plane moved against normal direction (blue arrow).

4.5 Cut at Reference Plane

The 3D model can be trimmed along the *Reference Plane* by following procedure:

1. Visualize the *Reference Plane* in the 3D viewer by clicking the "*Show Reference Plane*" button
2. Adjust the position of the *Reference Plane* as described in Chapter 4.4
3. Adjust the orientation of the upward normal vector of the *Reference Plane* by a click on the "*Flip Normal*" icon in the *Tools* pane (Figure 19). The part of the 3D model against normal direction will remain after trimming.
4. Click on the "*Cut at Reference Plane*" icon and the area to be deleted is visualized in red (Figure 20)
5. Delete the desired region by pressing the "Delete" key or middle mouse button (Figure 21)
6. Save the 3D model by clicking *"File | Save"* or alternatively *"File | Save as"* in the menu bar or use the corresponding icons in the toolbar

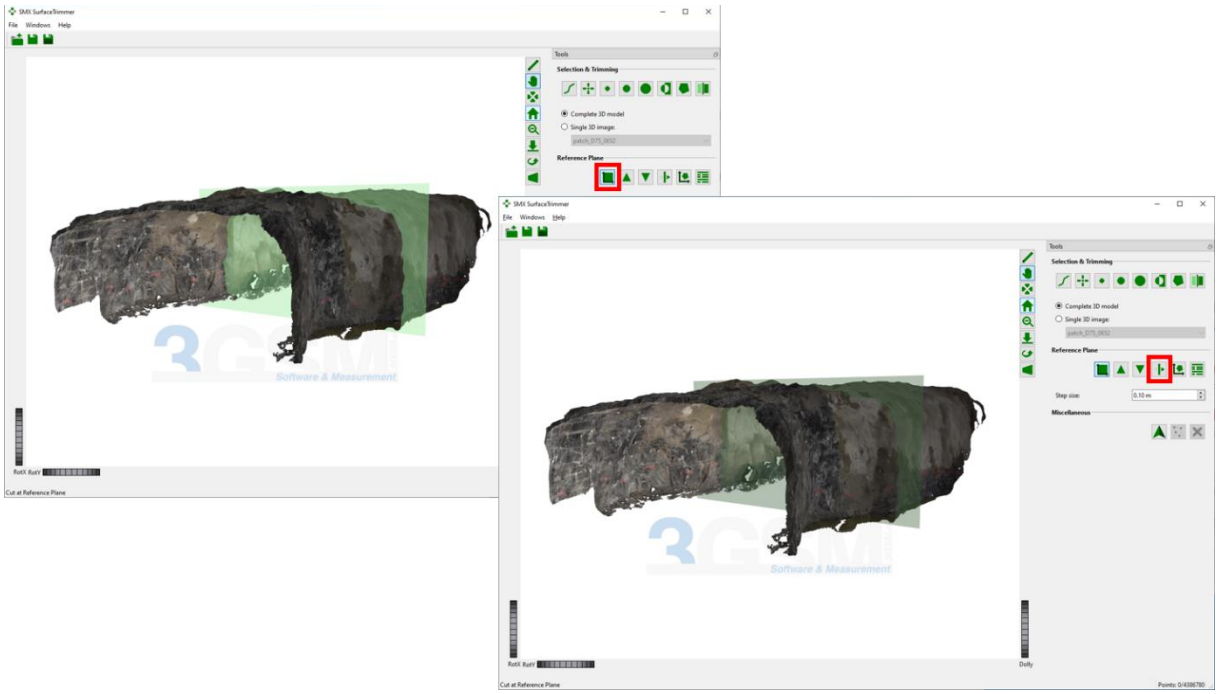


Figure 19: Flip of the normal direction. The orientation of the normal vector is indicated by a green shading of the Reference Plane. Light green shading means that the observer faces the upward normal vector while dark green shading means the upward normal vector points away from the observer.

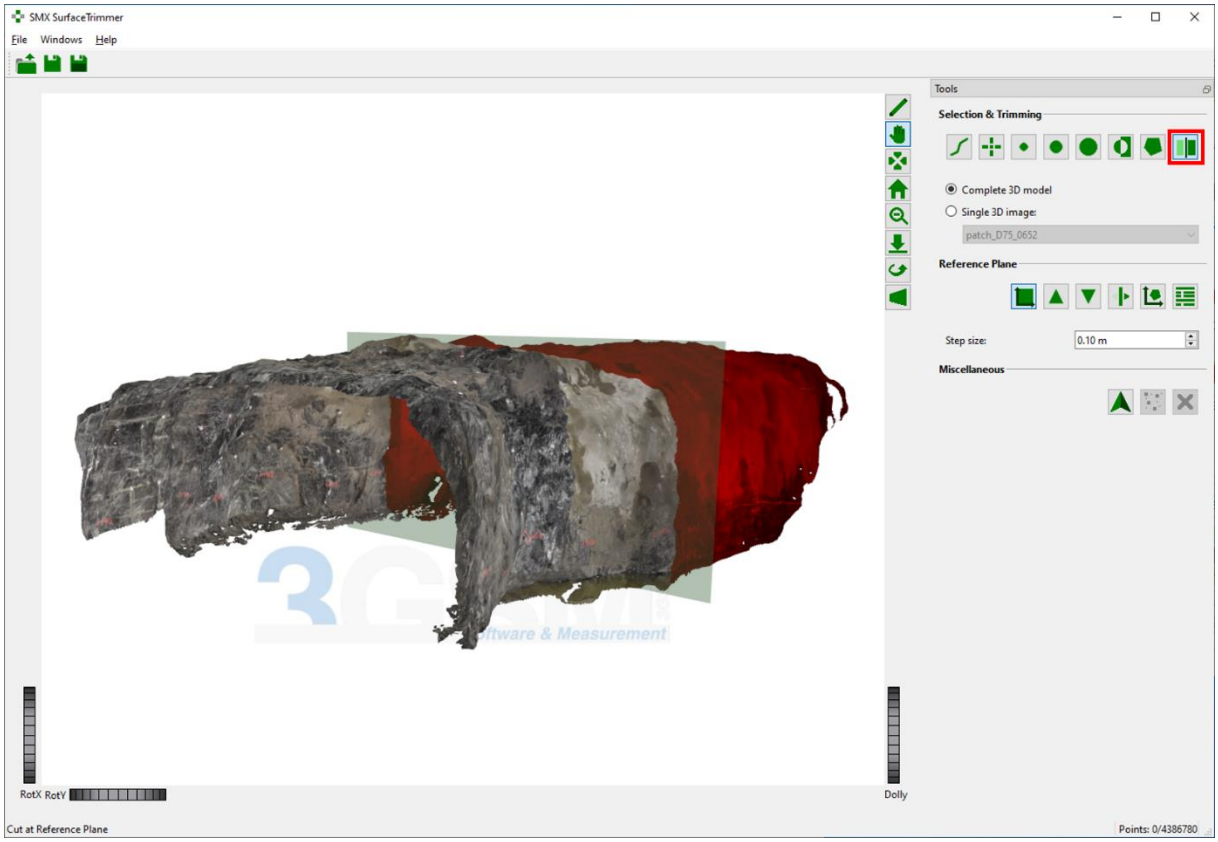


Figure 20: Area to be deleted visualised in red

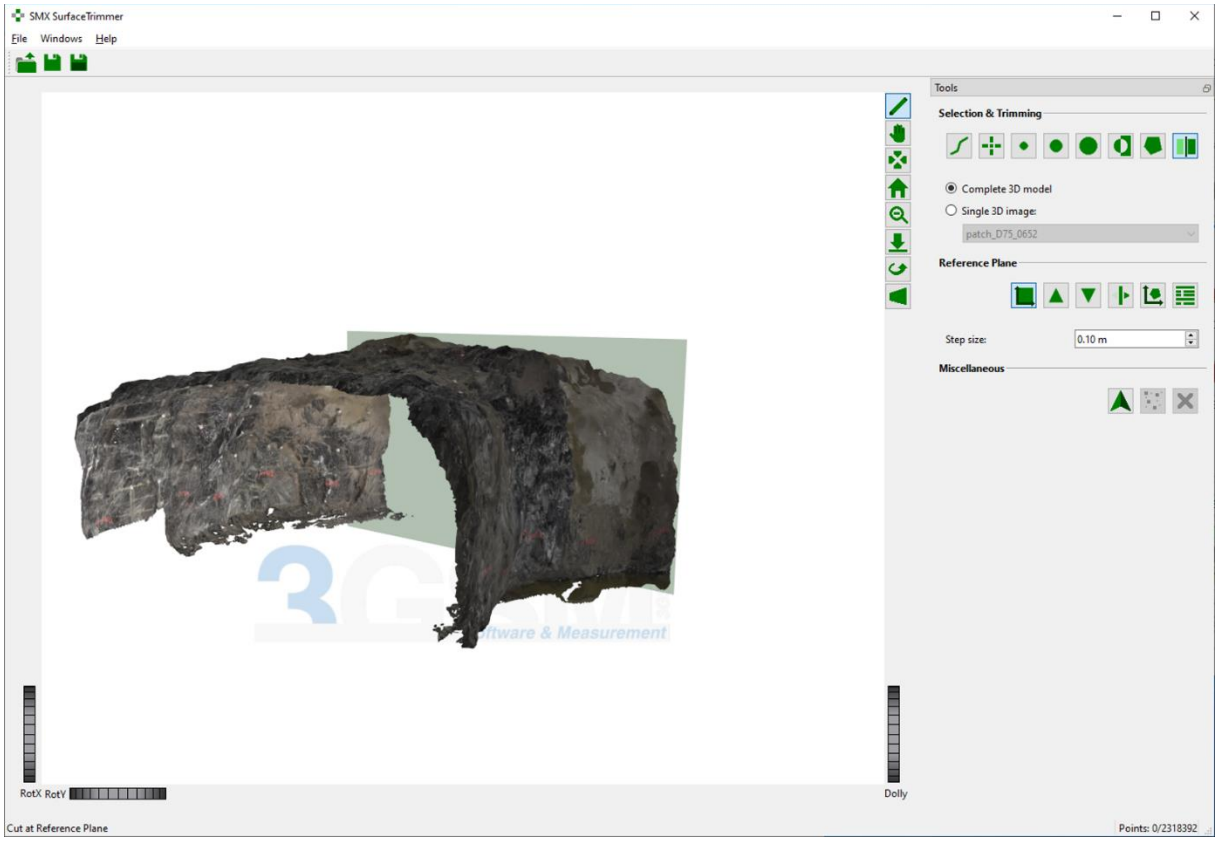


Figure 21: 3D model after trimming at the Reference Plane

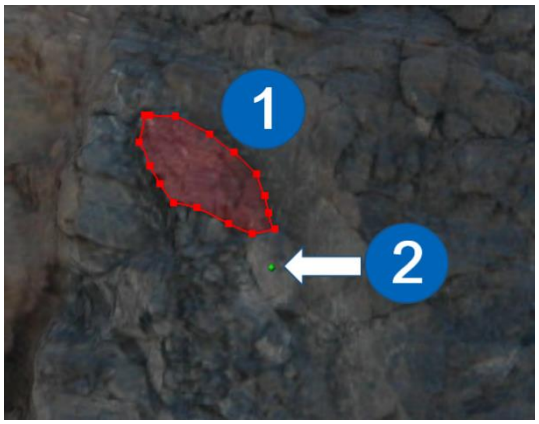
4.6 Orientation of a 3D model in the SMX SurfaceTrimmer

A scaled 3D model can be oriented in the *SMX SurfaceTrimmer*. It is possible to introduce co-ordinates to a visible point and the azimuth to an area.

Procedure:

1. Scale a generic 3D model using the *SMX Normalizer* (see *SMX Normalizer* manual)
2. Open the scaled 3D model (".jm3" file) in the *SMX SurfaceTrimmer* ( )
3. Select a prominent region of points of which you know the orientation in terms of dip and dip direction
    a. Use *"Edit | Select Region"* in the menu bar or use the according icon in *Tools* pane
    b. Mark the region by clicking a polygon with the left mouse button (using the right mouse button activates the "*Undo*" function)
    c. Close the region with the *"Enter"* key or the middle mouse button
4. Select a point (*Control Point*) of which you know the co-ordinates in terms of easting-northing-elevation
    a. Choose *"Select Single Point"* in the *Tools* pane
    b. Click at the point of which you know the co-ordinates. It is highlighted with a green sphere
5. Select *"Set North Direction"* in the *Tools* pane

6. Enter the measured azimuth and co-ordinates and press the *"OK"* button. The 3D model is transformed according to the new specifications. See also Figure 22 and Figure 23.
7. Save the 3D model by clicking *"File | Save"* or alternatively *"File | Save as"* in the menu bar or use the corresponding icons in the toolbar



1 Selected region
2 *Control Point*

Figure 22: Selected region in the 3D model. Selected Control Point with known co-ordinates

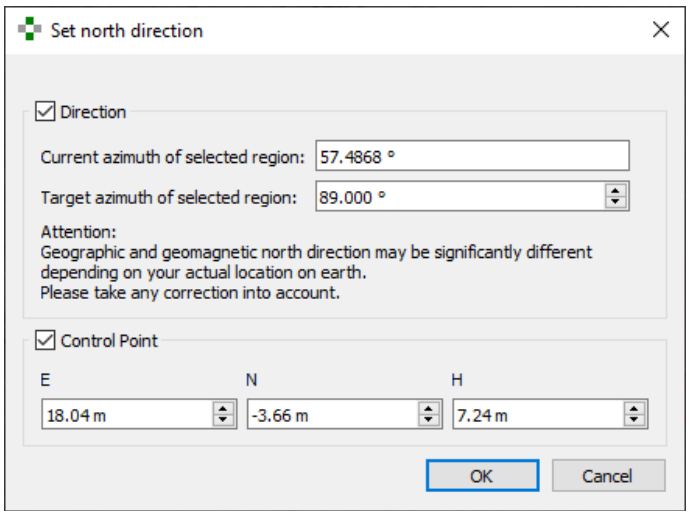


Figure 23: Input of target azimuth and co-ordinates of the Control Point (easting-northing-elevation)

Hint:
The definition of a region is mandatory while the definition of a single point (*Control Point*) is optional. If only a region is selected, the input of co-ordinates is disabled. The model will only be rotated.

Definition of the target azimuth

The target azimuth is related to the dip direction (not the strike) of the compass reading in the selected region. It is defined as the dip direction in viewing direction. According to the selected region the target azimuth implies two typical cases (Figure 24).

- If the selected area dips towards the observer (camera position), the target azimuth is the dip direction minus 180° (blue arrow). For instance, the compass reading gives 333°, hence the target azimuth is 153°.
- If the selected area is an overhang relative to the observer, the target azimuth is the dip direction (red arrow). For instance, the compass reading gives 200°, hence the target azimuth is also 200°.

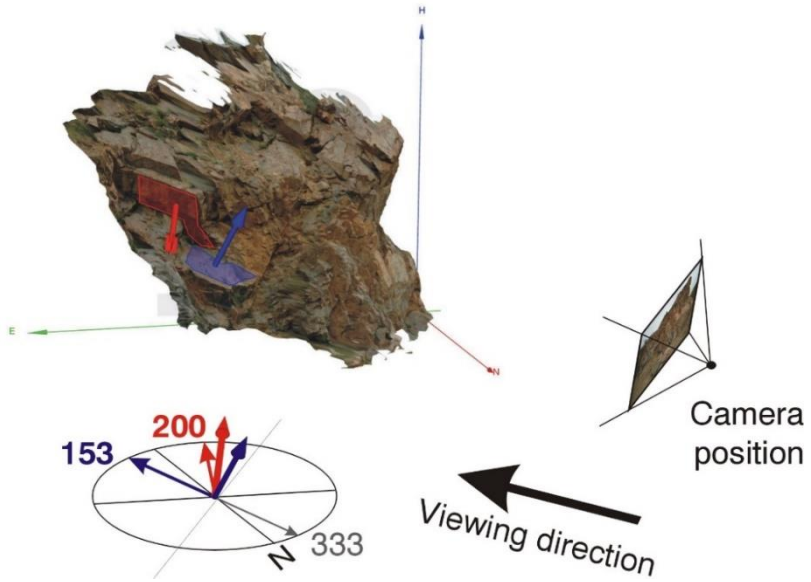


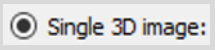
Figure 24: Definition of the target azimuth of selected region relative to the camera position. The blue arrow represents an area dipping towards the observer. The target azimuth is the dip direction minus 180°. The red arrow is an overhang. The target azimuth is the dip direction.

4.7 Reduce the number of points

It might be necessary to reduce the number of points when the resulting measurements are to be used with third party software, such as CAD. The current number of points is shown in lower right corner of the main window (see Figure 1).

Procedure:

1. Click on *the" Reduce Points"* icon in the *Tools* pane
2. Specify the maximum number of 3D surface measurements in the arising dialog window
3. Click the *"OK"* button
4. Save the 3D model by clicking *"File | Save"* or alternatively *"File | Save as"* in the menu bar or use the corresponding icons in the toolbar

Hint:
The number of points can only be reduced for a single 3D subimage. Therefore, the "*Single 3D image*" mode 

has to be activated and the desired image has to be chosen.

Attention:
Reducing the number of points is only available for 3D models generated with the *SMX ReconstructionAssistant* and/or the *SMX ModelMerger*. Reducing the number of points is not available for 3D models generated with *SMX MultiPhoto*.

4.8 Remove whole 3D image

A single 3D image (subimage) is completely removed from the collection (merged 3D images) by selecting *"Remove whole 3D Image"* ✖ in the *Tools* pane (Figure 25). Note that it can only be performed if the "*Singe 3D Image*" mode is selected. The active 3D subimage is then removed from the 3D model.

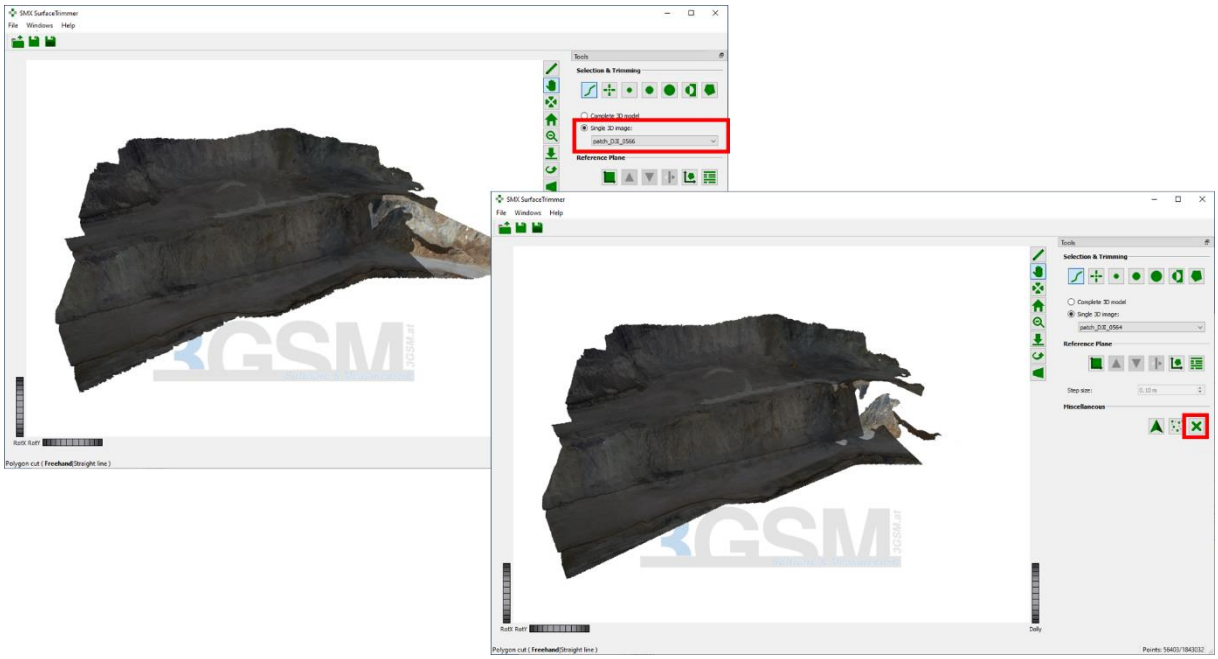


Figure 25: Remove of a subimage

5 Statistics on the 3D model

Characteristic and statistical data on the 3D models are displayed in a window by choosing *"File | Show Statistics"* in the menu bar.

Statistics of collection

The displayed data include (Figure 26):

- Number of subimages
- Number of points
- Total surface area
- Geometric image resolution: Size which covers one pixel in nature, aka ground pixel size.
- Resolution of the surface grid: Average distance between the 3D points.
- Size of the model

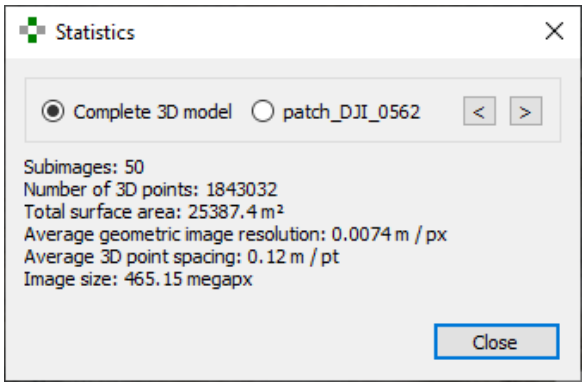


Figure 26: Statistics of the complete 3D model

Statistics of single 3D images

The displayed data include (Figure 27):

- Name of the 3D image:
- Number of points
- Minimal area patch size for orientation: This is the area which is averaged when doing single orientation measurements using *JMX Analyst*.
- Surface area of the single 3D image
- Used image area: Areas of the images used for the 3D image generation.
- Distance of camera to model
- Height of model
- Geometric image resolution: Size which covers one pixel in nature, aka ground pixel size.
- Resolution of the surface grid: Average distance between the points.

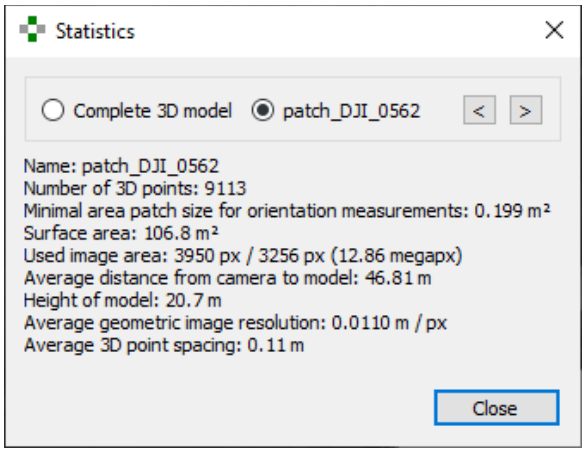


Figure 27: Statistics of a single 3D image (subimage)