

ARCHEOFOSS

XIV | 2020

Open software, hardware, processes, data
and formats in archaeological research



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3D Survey Collection, a software for the production of digital replicas.

The case study of the roman forum of Nora (Sardinia, CA)

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What is 3DSC 3D Survey Collection ?



is an **open source add-on** (GPL3) for Blender that simplifies the tasks involved in the **management and optimization of the archaeological and architectonic 3D record**

it can be used to **transform an extensive survey** of an archaeological excavation into a **real-time oriented asset** that can be used inside a Game Engine to create Open World experiences (Unreal, Unity, Godot). It allows to:

- dramatically enhance the visual quality of a photogrammetric survey through interactive tools (paint from cameras, color correction)
- integrate different surveys made in different light conditions (color correction, texture patcher)
- segment big models in tiles and create automatically level of details
- manage 3D scene complexity and model a virtual reconstruction hypothesis
- manage georeferenced GPS and Total station data points
- import and export 3D models with customized tools

<https://github.com/zalmoxes-laran/3D-survey-collection>

3DSC Shifting and coordinate import

The screenshot displays the 3DSC software interface with a text editor on the left and a 3D view on the right. The text editor shows two files: `GPS_points.txt` and `TotalStation_points.txt`. The `GPS_points.txt` file contains two lines of coordinates, with the first line highlighted in red. The `TotalStation_points.txt` file contains a list of points, with the first line highlighted in green. The 3D view shows a grid with points labeled `+110` and `+111_fk`. A red line connects the first line of `GPS_points.txt` to the `+110` point, labeled "Absolute". A green line connects the first line of `TotalStation_points.txt` to the `+111_fk` point, labeled "Local". The right sidebar shows the "Shifting" and "Importers" sections. The "Shifting" section has "Shift values" for X, Y, and Z shifts. The "Importers" section has "Coordinates" selected.

GPS_points.txt

```
1 110 2279666.7680015564 4654025.005001068 87.27300262451172
2 111_fk 2279750.423526764 4653905.558712006 87.27300262451172
```

TotalStation_points.txt

```
1 110_GPS -0.002099808305501938 40.606849670410156 -1.9729995727539062
2 400 0.0 0.0 0.0
3 B1 -49.237125396728516 23.375293731689453 -2.01300048828125
4 B10 -54.96841049194336 -9.031867980957031 -0.48600006103515625
5 B11 -50.6722412109375 -12.707093238830566 -0.22499847412109375
6 B12 -42.10647201538086 -7.255149841308594 -0.30699920654296875
7 B13 -46.250099182128906 -1.9320135116577148 -1.324005126953125
8 B14 -39.42899703979492 1.801187515258789 -0.712005615234375
9 B15 -43.809226989746094 11.96516227722168 -1.13800048828125
10 B16 -56.62955093383789 33.325359344482422 -2.2450027465820312
11 B17 -65.72730255126951 21.19045066833496 -2.4080047607421875
12 B18 -78.27763366699219 20.036296844482422 -2.7130050659179688
13 B19 -70.2285385131836 12.601269721984863 -1.9970016479492188
14 B2 -59.41426467895508 33.441043853759766 -1.9950027465820312
15 B20 -62.47089385986328 10.126479148864746 -1.9560012817382812
16 B21 -61.530818939208984 4.26414680480957 -2.7970046997070312
17 B22 -54.66852951049805 12.464128494262695 -2.8680038452148438
18 B23 -58.31511688232422 17.668119430541992 -1.9540023803710938
19 B24 -49.32249450683594 6.98804235458374 -3.9160003662109375
20 B25 -42.91889953613281 0.6861381530761719 -2.4200057983398438
21 B26 -44.7659797668457 7.220894813537598 -2.1840057373046875
22 B28 -48.88187026977539 -1.3581981658935547 -1.4980010986328125
23 B29 -64.03144073486328 -3.9028778076171875 -1.983001708984375
24 B30 -70.91983795166016 29.20382308959961 -2.1689987182617188
25 B30 -60.977752685546875 -2.911592483520508 -4.234001159667969
```

Shifting

Shift values:

- X shift: 2279703.00
- Y shift: 4653966.00
- Z shift: 0.00

Importers

- Coordinates
- Multiple objs
- Agisoft.xml cams

Exporters

- Quick Utils
- LOD generator
- LOD manager
- Color Correction
- Photogrammetry paint
- Texture mixer
- Panorama suite

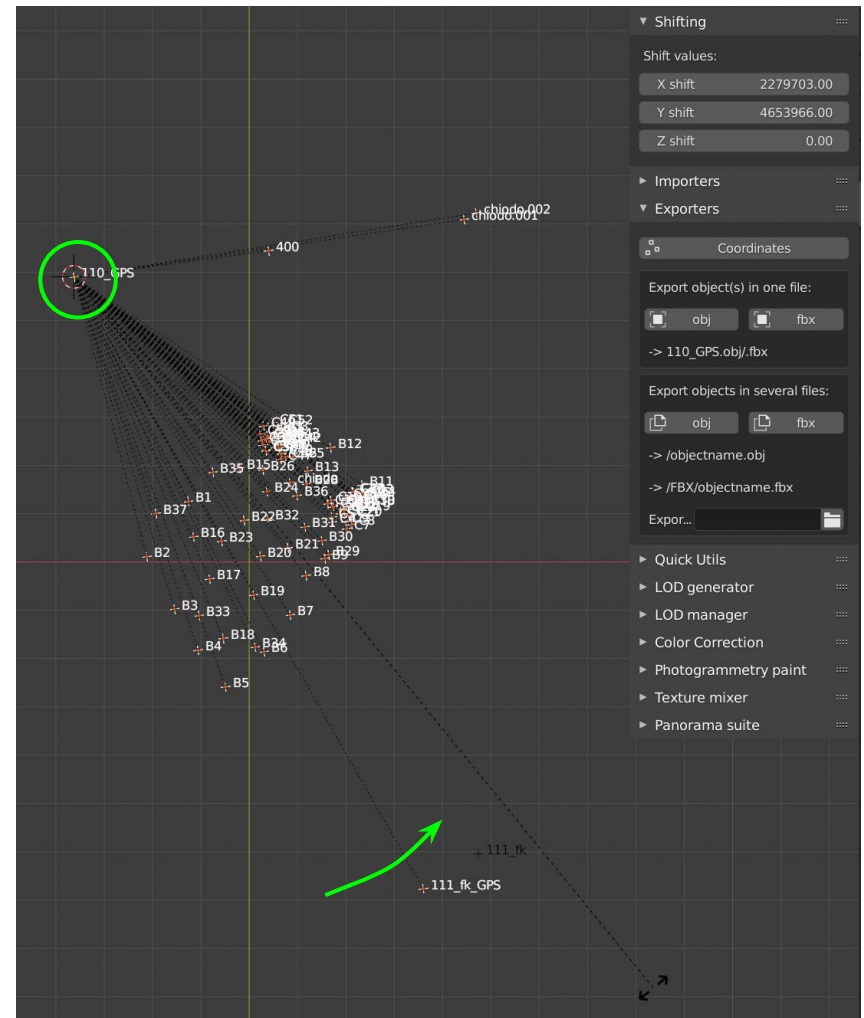
3DSC coordinates alignment

two points alignment

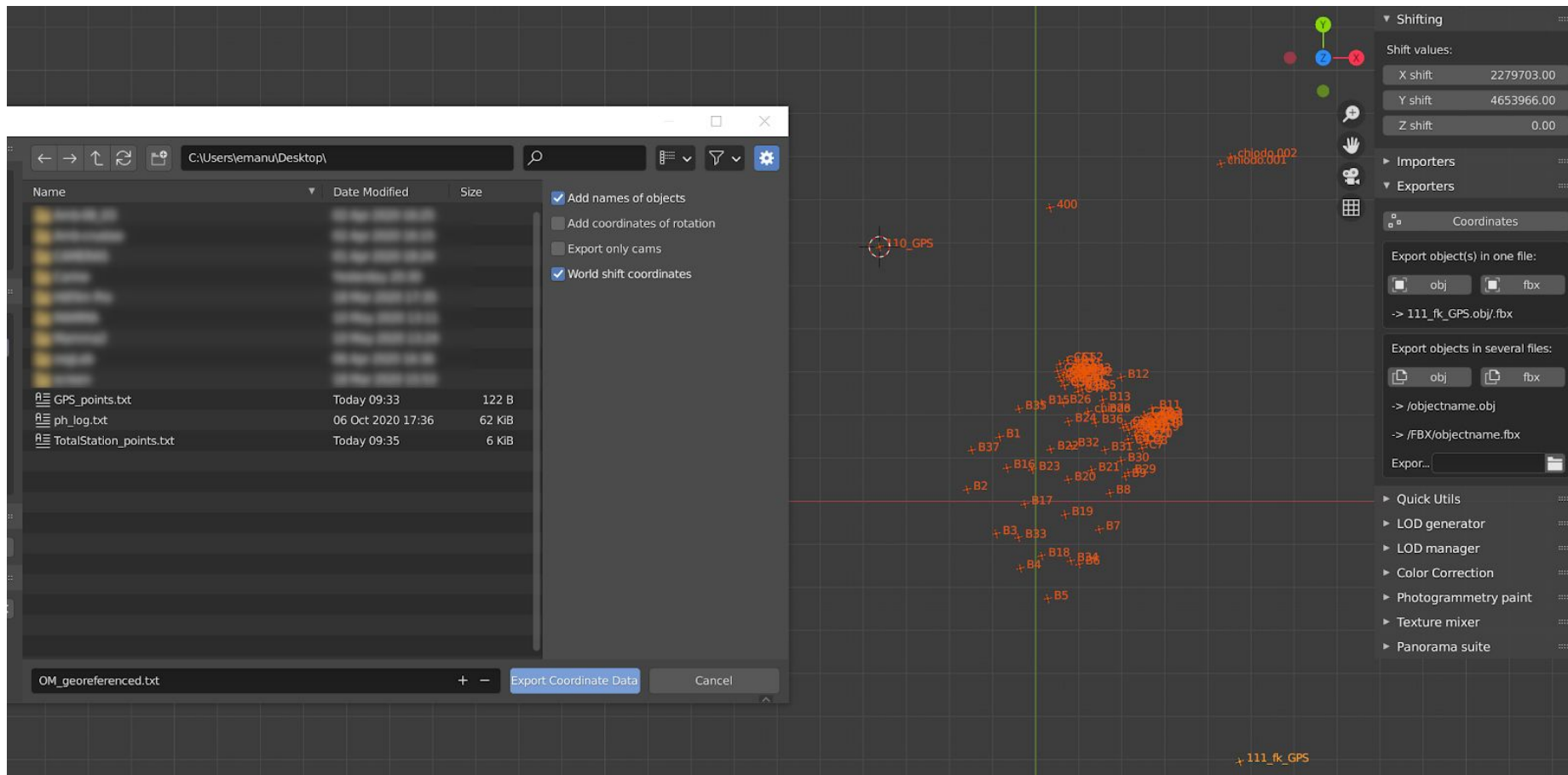
parenting total station dataset with
110_GPS point

110_GPS -> 110 as rotation pivot

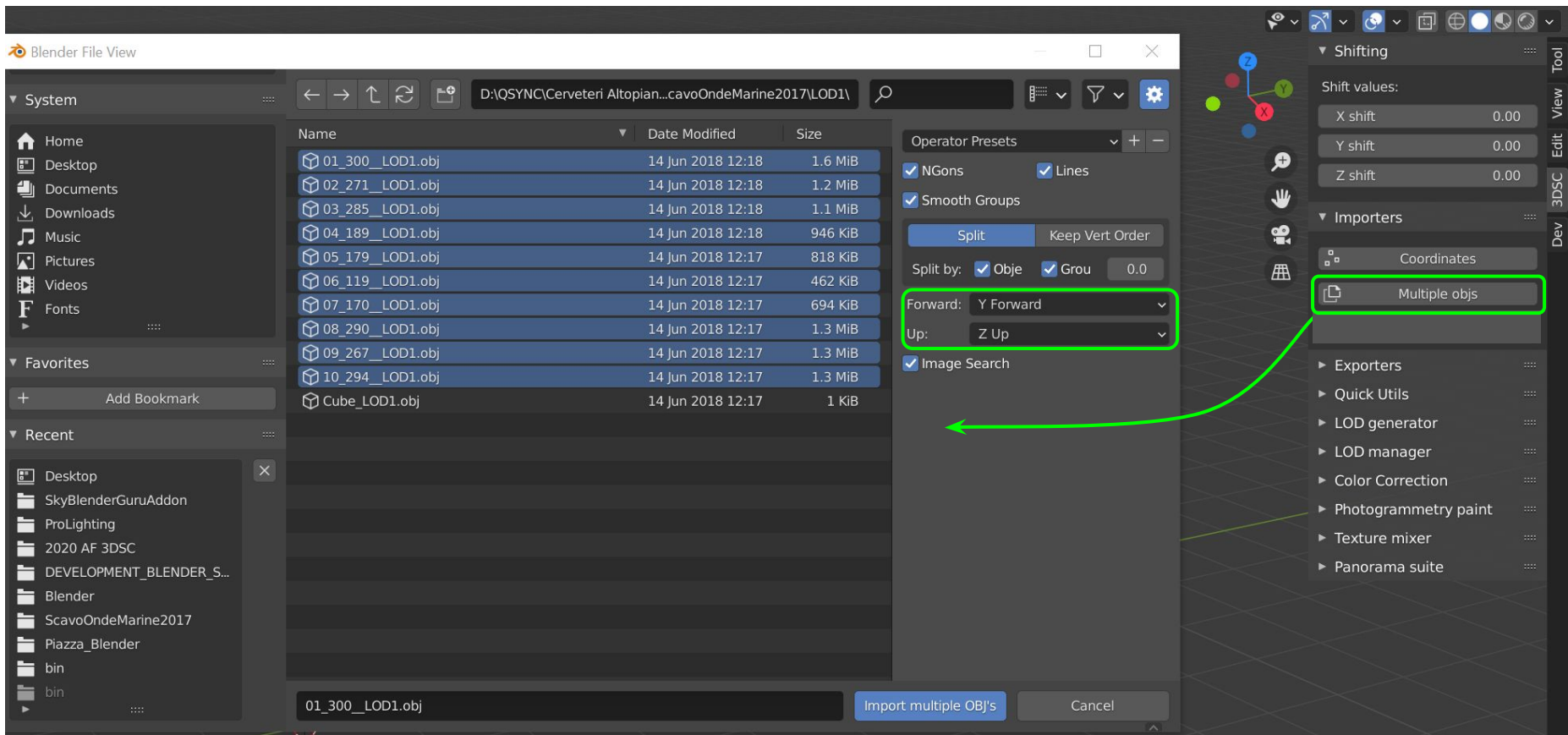
111_fk_GPS -> 111_fk as rotation target



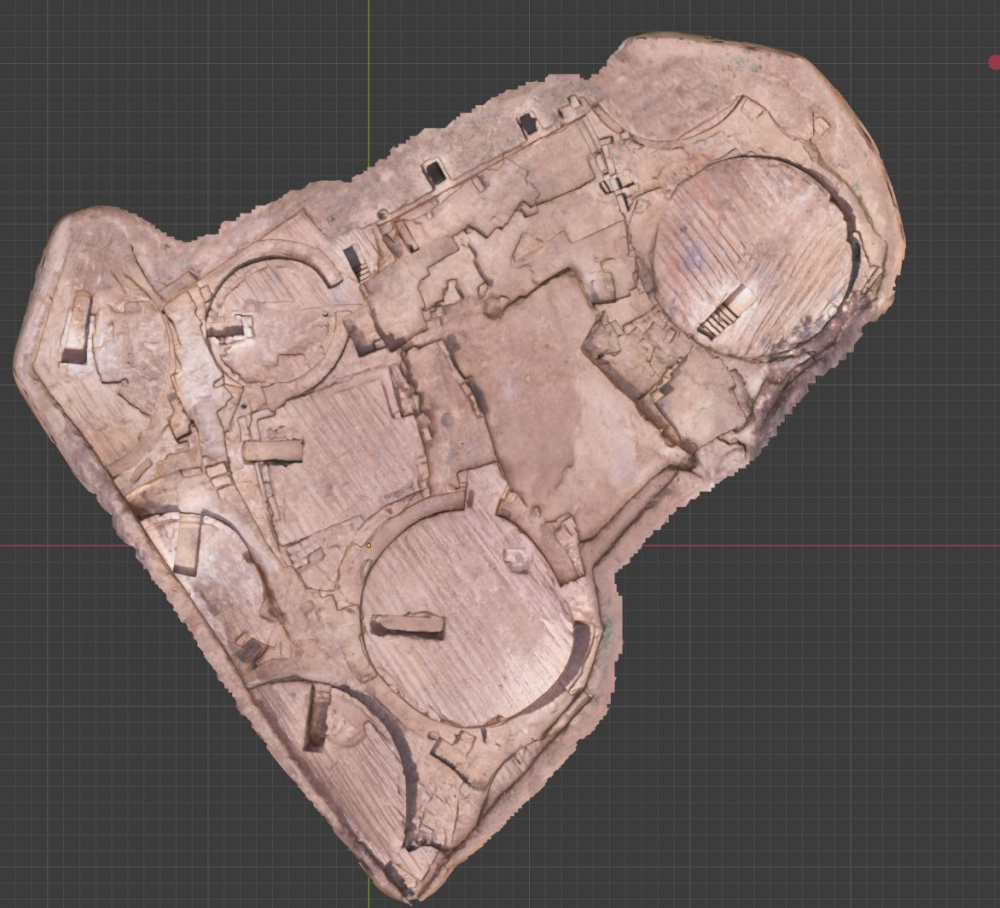
3DSC Shifting and coordinate export



3DSC Import multiple objs



3DSC Shifting integration with Blender GIS



The image displays a 3D model of an ancient archaeological site, possibly a temple or fortress, rendered in a reddish-brown color. The model is shown in a top-down perspective on a dark grid background. The interface includes various panels for viewing and editing the model.

View Panel:

- Focal Length: 50.000
- Clip Start: 0.010
- End: 1000.000
- Local Camera: ☐
- Render Region: ☐
- View Lock: ☐
- Lock to Object: ☐
- Lock: ☐ To 3D Cursor
- Camera to View: ☐

3D Cursor Panel:

- Location:
 - X
 - Y
 - Z
- Rotation:
 - X: 0°
 - Y: -0°
 - Z: 0°
- XYZ Euler:

Geoscene Panel:

- Scene georeferencing: ☐
- ☒ CR Web Mercator ☐
- ☒ Ori Geo ☒ Proj ☐
- X: 1000.00 Y: 1500.00
- ☐ Geo-coordinates

Shifting Panel:

- Shift values:
 - X shift: 1000.00
 - Y shift: 1500.00
 - Z shift: 0.00
- ☒ from Bender GIS
- Importers
- Exporters
- Quick Utils
- LOD generator

Statistics Panel:

- Area
- TexStats
- MeanRes

Python Console:

```
def execute(self, context):  
    scene = context.scene  
    scene['BL_x_shift'] = scene['crs x']  
    scene['BL_y_shift'] = scene['crs y']  
  
    return {'FINISHED'}
```

3DSC Segmentation

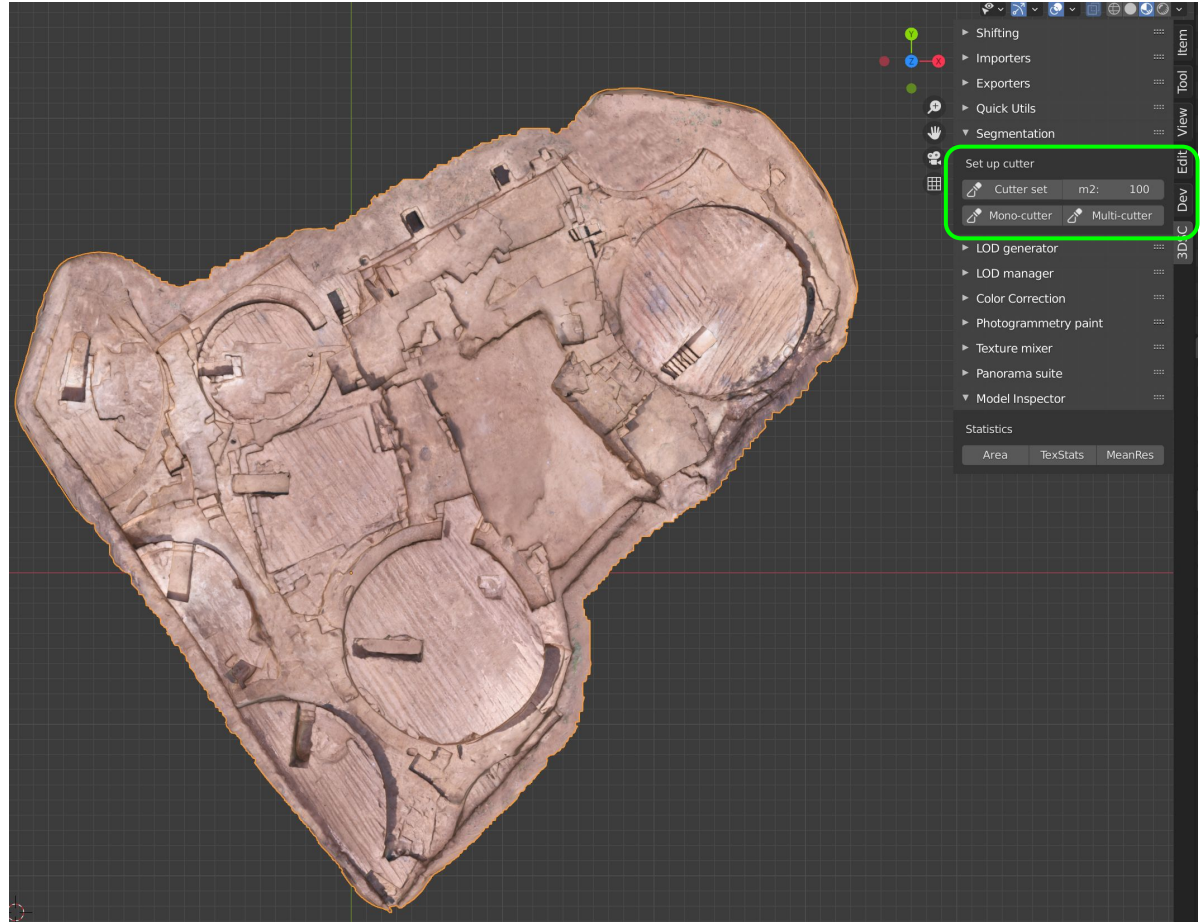
Creating tiles from a single mesh enables level of details (see LOD generator)

- for Game Engines
- for better interaction with big models (see LOD manager)

Set desired square meters (better < 100 sq.m)

Press Cutter set

Image source: Alfonsina Russo, Rita Cosentino, Enzo d'Annibale, Emanuel Demetrescu, e Daniele Ferdani. «La necropoli della Banditaccia di Cerveteri: da Raniero Mengarelli agli UAV». *Archeologia Aerea, Studi di Aerotopografia archeologica* XI, 2017 (2019): 171–76.



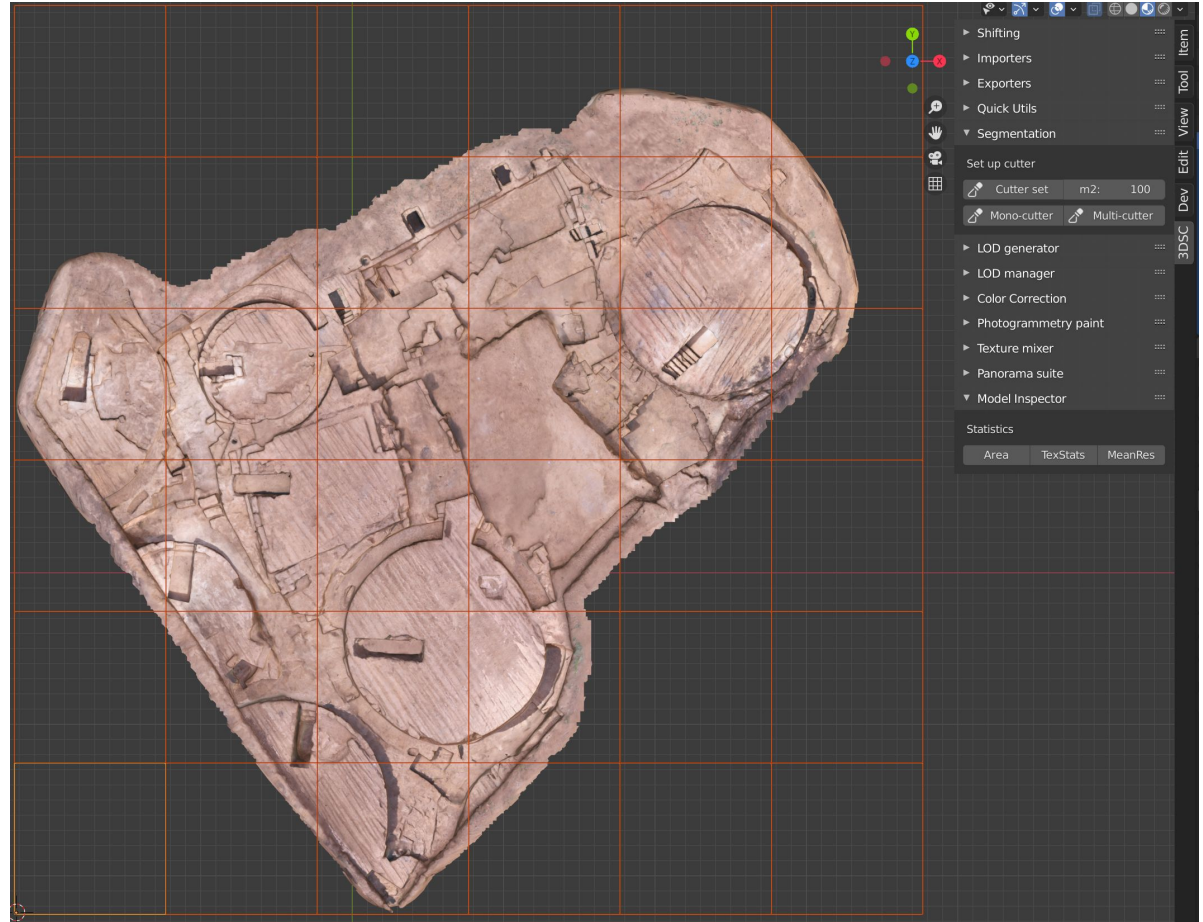
3DSC Segmentation

Create tiles from a single mesh
enables level of details (see
LOD generator)

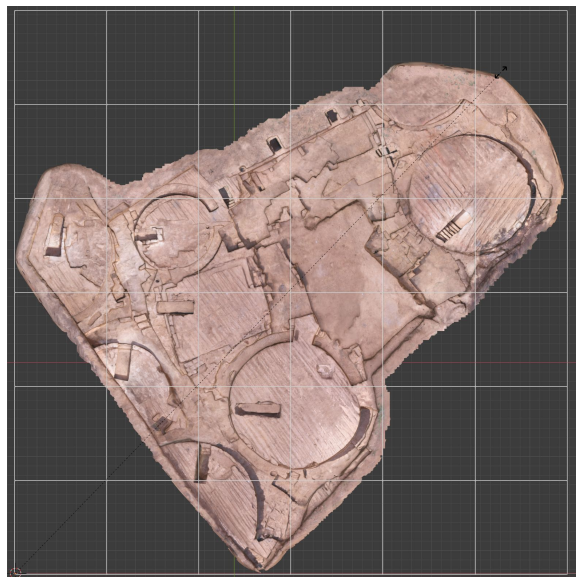
- for Game Engines
- for better interaction
with big models (see
LOD manager)

Set desired square meters
(better < 100 sq.m)

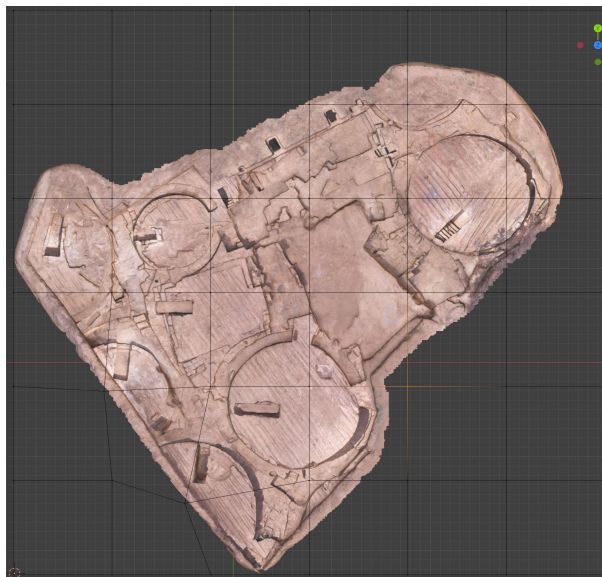
Press Cutter set



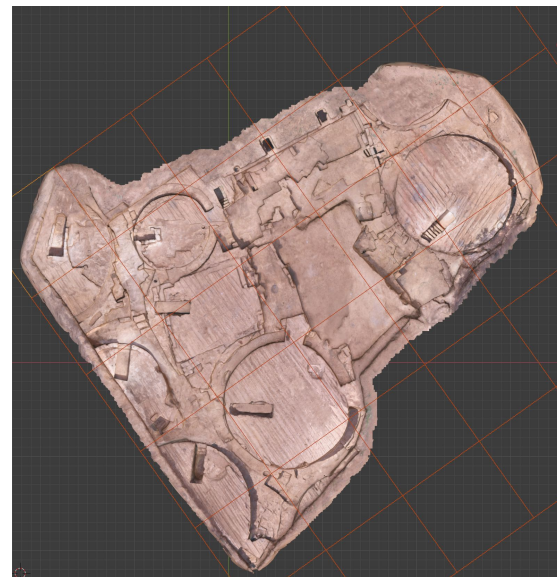
3DSC Segmentation - grid tuning



possibility to scale



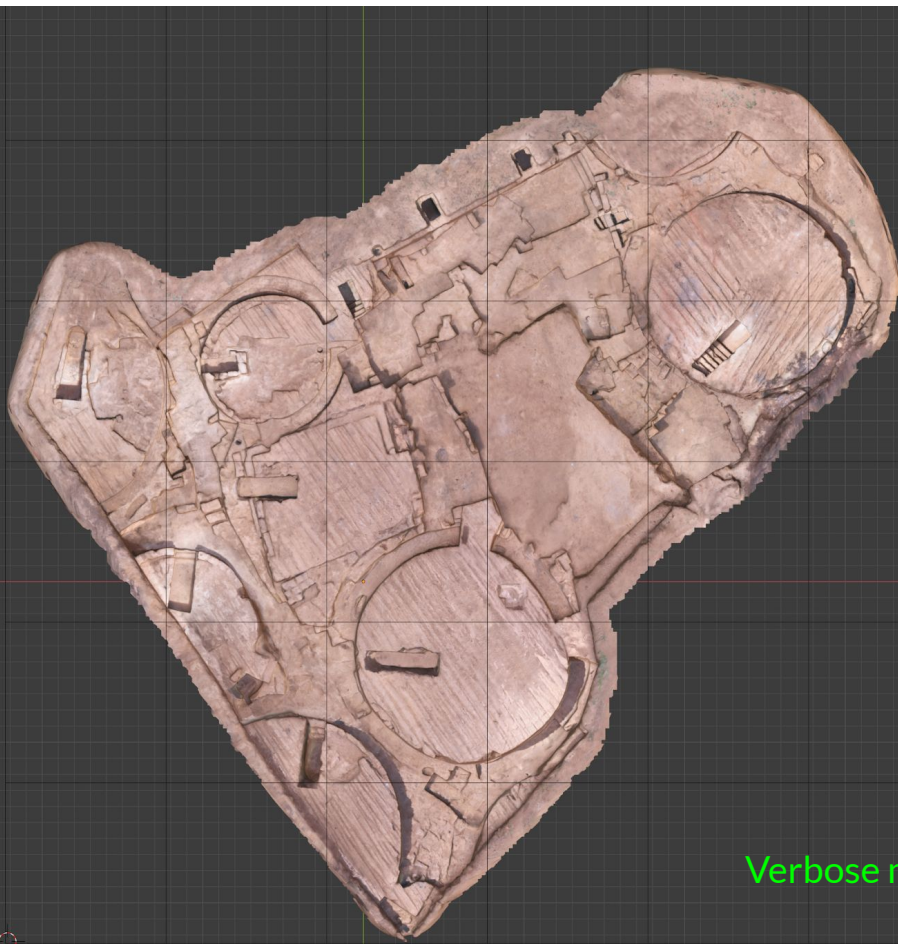
edit



or rotate the grid

3DSC Segmentation

```
>> "cutter.019" (20/36) object used to cut in 1.7235112190246582 seconds
>> CUTTING >>>
>>>> the object "cutter.020" (21/36) is cutting the object02_271_LOD0
>> "cutter.020" (21/36) object used to cut in 1.272672414779663 seconds
>> CUTTING >>>
>>>> the object "cutter.021" (22/36) is cutting the object02_271_LOD0
>> "cutter.021" (22/36) object used to cut in 0.8311254978179932 seconds
>> CUTTING >>>
>>>> the object "cutter.022" (23/36) is cutting the object02_271_LOD0
>> "cutter.022" (23/36) object used to cut in 1.1313856945809781 seconds
>> CUTTING >>>
>>>> the object "cutter.023" (24/36) is cutting the object02_271_LOD0
>> "cutter.023" (24/36) object used to cut in 0.5380668640136719 seconds
>> CUTTING >>>
>>>> the object "cutter.024" (25/36) is cutting the object02_271_LOD0
>> "cutter.024" (25/36) object used to cut in 0.5415019989013672 seconds
>> CUTTING >>>
>>>> the object "cutter.025" (26/36) is cutting the object02_271_LOD0
>> "cutter.025" (26/36) object used to cut in 0.5035674571990967 seconds
>> CUTTING >>>
>>>> the object "cutter.026" (27/36) is cutting the object02_271_LOD0
>> "cutter.026" (27/36) object used to cut in 0.5451538562774658 seconds
>> CUTTING >>>
>>>> the object "cutter.027" (28/36) is cutting the object02_271_LOD0
>> "cutter.027" (28/36) object used to cut in 0.3881876468658447 seconds
>> CUTTING >>>
>>>> the object "cutter.028" (29/36) is cutting the object02_271_LOD0
>> "cutter.028" (29/36) object used to cut in 0.1039042728393555 seconds
>> CUTTING >>>
>>>> the object "cutter.029" (30/36) is cutting the object02_271_LOD0
>> "cutter.029" (30/36) object used to cut in 0.06694531440734863 seconds
>> CUTTING >>>
>>>> the object "cutter.030" (31/36) is cutting the object02_271_LOD0
error: Nothing selected
>> "cutter.030" (31/36) object used to cut in 0.013985633850097656 second
>> CUTTING >>>
>>>> the object "cutter.031" (32/36) is cutting the object02_271_LOD0
error: Nothing selected
>> "cutter.031" (32/36) object used to cut in 0.011989116668701172 second
>> CUTTING >>>
>>>> the object "cutter.032" (33/36) is cutting the object02_271_LOD0
>> "cutter.032" (33/36) object used to cut in 0.024977445602416992 second
>> CUTTING >>>
>>>> the object "cutter.033" (34/36) is cutting the object02_271_LOD0
>> "cutter.033" (34/36) object used to cut in 0.037210941314697266 second
>> CUTTING >>>
>>>> the object "cutter.034" (35/36) is cutting the object02_271_LOD0
>> "cutter.034" (35/36) object used to cut in 0.029973983764648438 second
>> CUTTING >>>
>>>> the object "cutter.035" (36/36) is cutting the object02_271_LOD0
error: Nothing selected
>> "cutter.035" (36/36) object used to cut in 0.004995822906494141 second
>> CUTTING >>>
<<<<<< Process done >>>>>>
>>>>> 36 objects processed in 30.393804788589478 seconds
>>>>> TemplateIconView: property of type Enum not found: World.env_previews
C:\Users\emano\AppData\Roaming\Blender Foundation\Blender\2.90\scripts\add
```

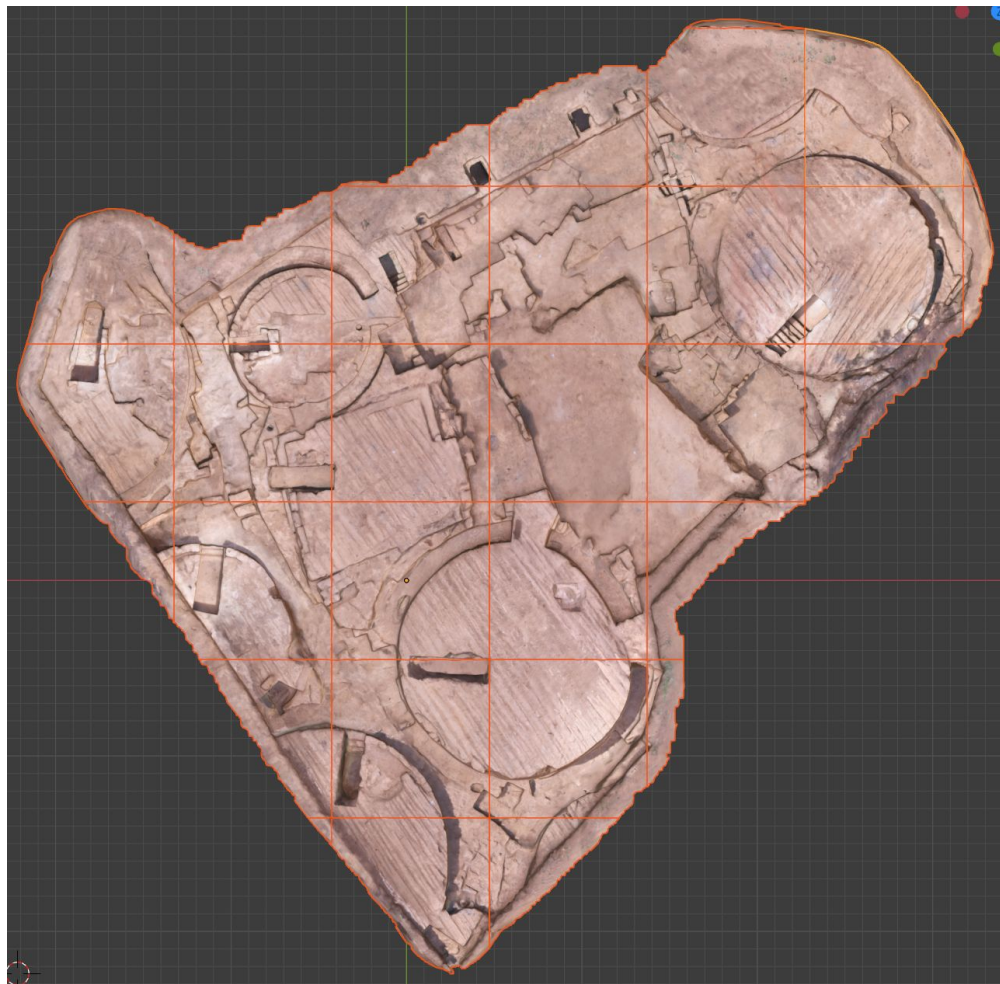


Verbose mode in terminal

- Shifting
- Importers
- Exporters
- Quick Utils
- Segmentation
 - Set up cutter
 - Cutter set m2: 100
 - Mono-cutter Multi-cutter
 - LOD generator
 - LOD manager
 - Color Correction
 - Photogrammetry paint
 - Texture mixer
 - Panorama suite
 - Model Inspector
- Statistics
 - Area
 - TexStats
 - MeanRes

3DSC Segmentation

31 tiles obtained



3DSC Texturing

in this version of 3DSC this task is performed within a photogrammetric software

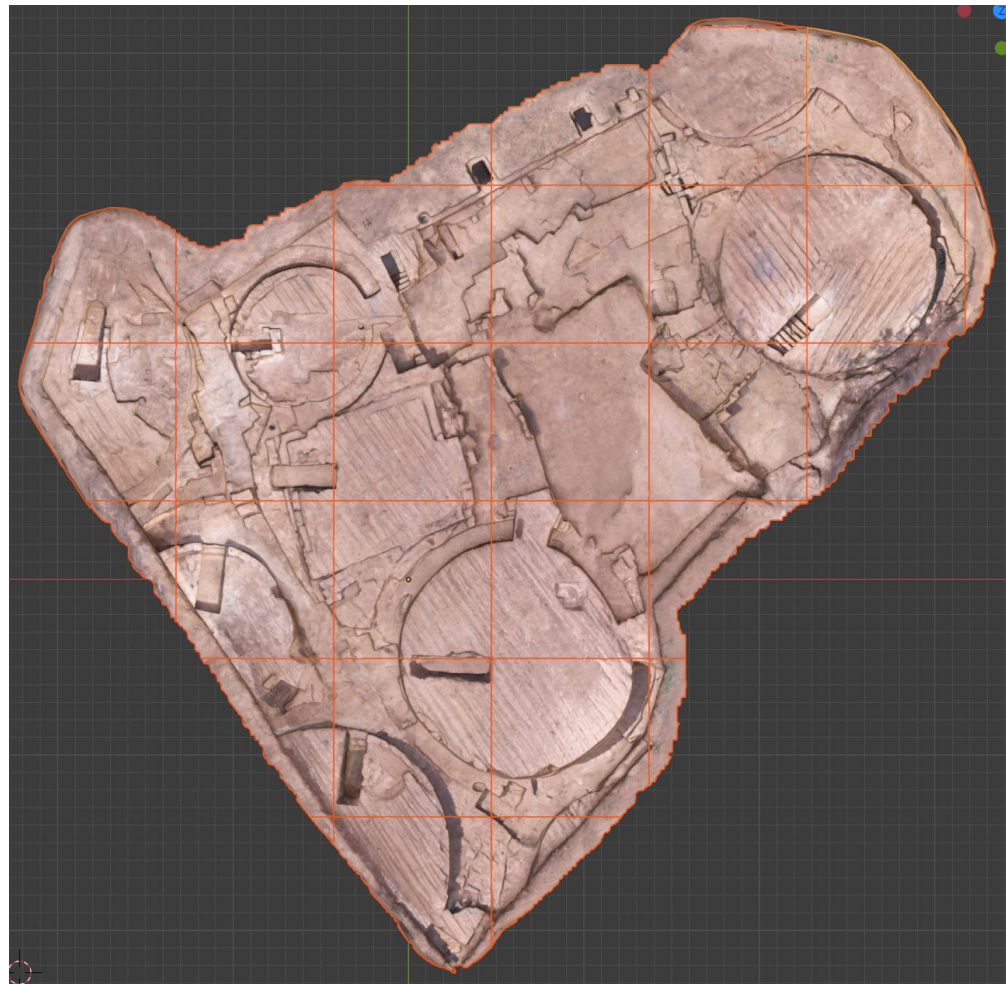
1. export from blender
2. import meshes inside a photogrammetric software
3. creation of textures per tile
4. export back in blender

tile sq m	textures
0-16	1
16-33	2
33-49	3
49-66	4
66-83	5
83-100	6

~1,4 mm²/px

Emanuel Demetrescu, Rossella Rea, Simona Morretta, Daniele Ferdani, Bruno Fanini, and Enzo d'Annibale, *Digital replicas and 3D virtual reconstructions for large excavations in urban archaeology: methods and techniques drawn from the "Metro C" case study in Rome*, Springer, CS

Table 2. Number of 4096 textures related to tile area (sq m)



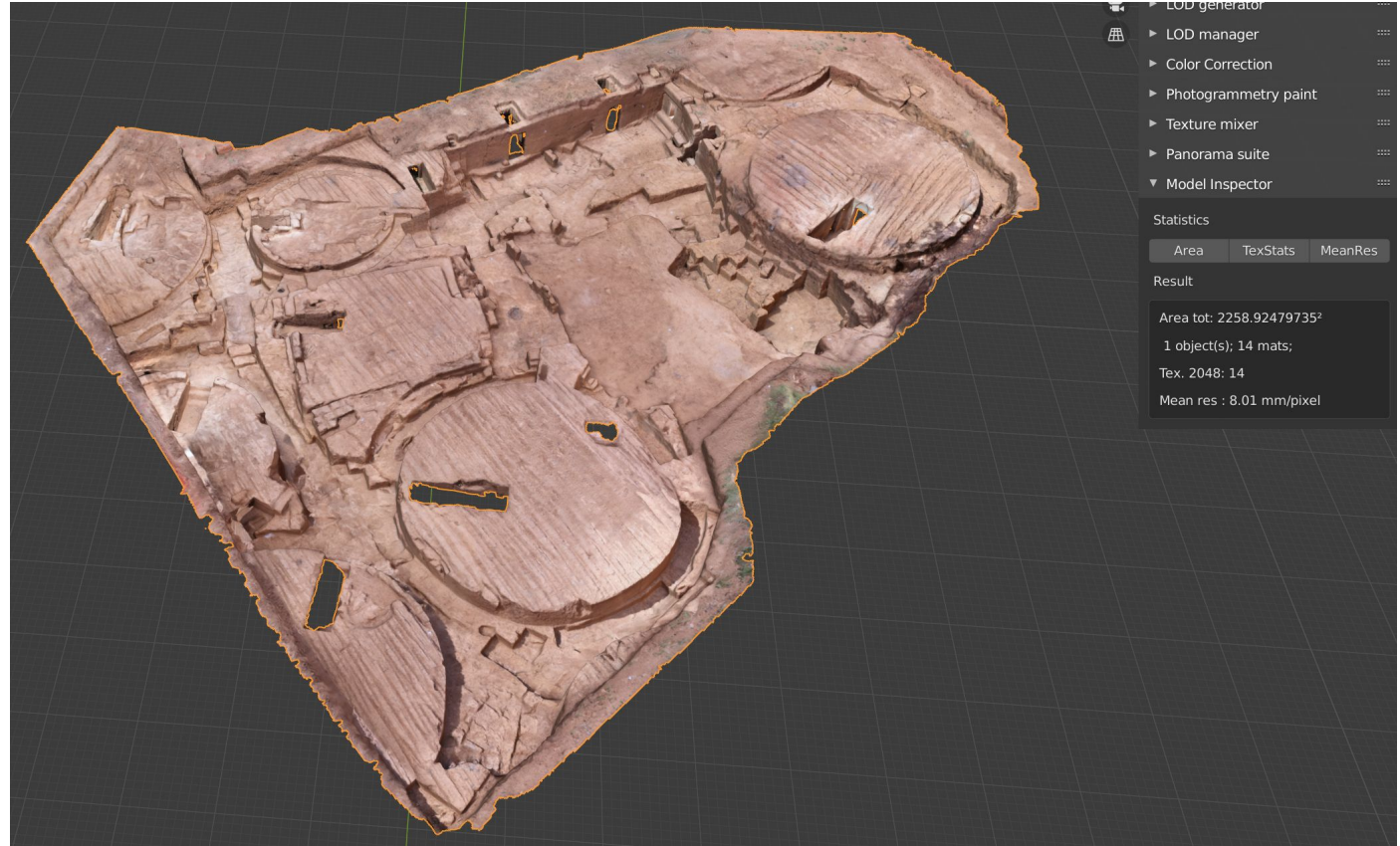
3DSCModel Inspector

Information
regarding surface of
the model

number of materials

resolution of
textures

mean resolution of
the model, in this
case 8 mm/pixel



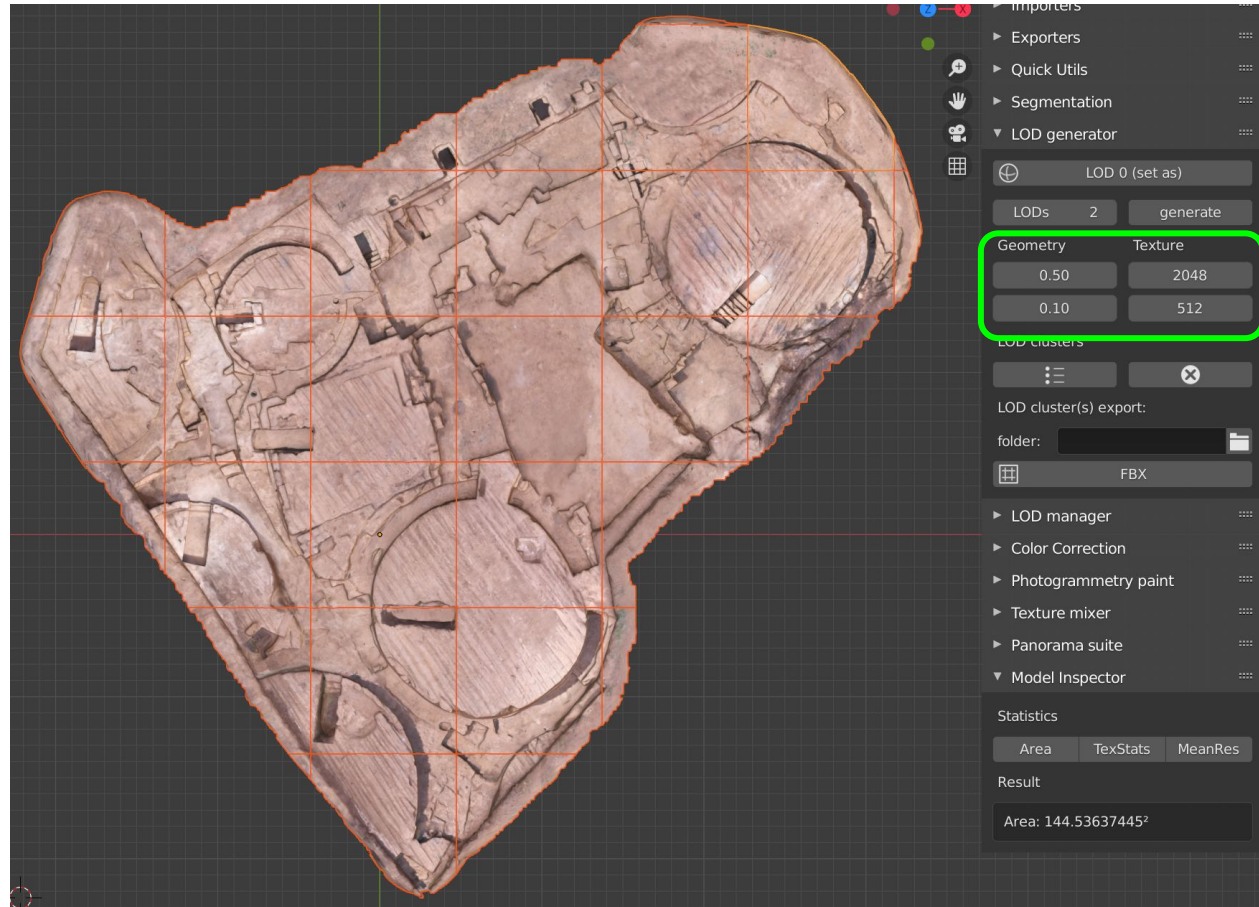
3DSC Level Of Details - LOD

Set up LOD generator

set objects as LOD0

set LOD number (2)

Generate following geometry
and texture settings



3DSC Level Of Details - LOD

LOD processed : 1

object processed

tasks:

decimation

material creation with new tex

passing color

save on disk an obj for external use

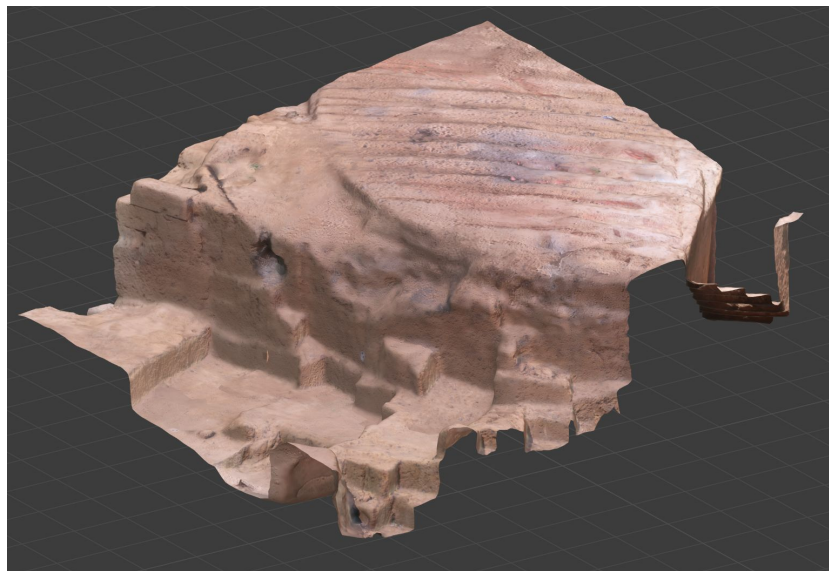
statistics: 2 seconds to process

287 sec total time for 31 objects

and 2 LOD for each object

```
>>> LOD1 >>>
>>>>> processing the object ""OB_OM.004_LOD0"" (5/31)
Creating new LOD1 object..
Found Atlas UV mapping layer. I will use it.
Decimating the original mesh to obtain the LOD1 mesh...
Creating new texture atlas for LOD1....
Creating custom material for LOD1...
Passing color data from LOD0 to LOD1...
Info: Baking map saved to internal image, save it externally or pack it
Saving on obj/mtl file for LOD1...
( 0.0000 sec | 0.0000 sec) OBJ Export path: 'F:\\ESEMPIO\\LOD1\\OB_OM_004_LOD1.obj'
( 0.3137 sec | 0.3127 sec) Finished writing geometry of 'OB_OM.004_LOD0'.
( 0.5015 sec | 0.1868 sec) Finished writing geometry of 'OB_OM.004_LOD1'.
( 0.5075 sec | 0.5075 sec) Finished exporting geometry, now exporting materials
( 0.5265 sec | 0.5265 sec) OBJ Export Finished
Progress: 100.00%
>> "OB OM.004 LOD1" (5/31) object baked in 2.2328362464904785 seconds
```

3DSC Level Of Details - LOD



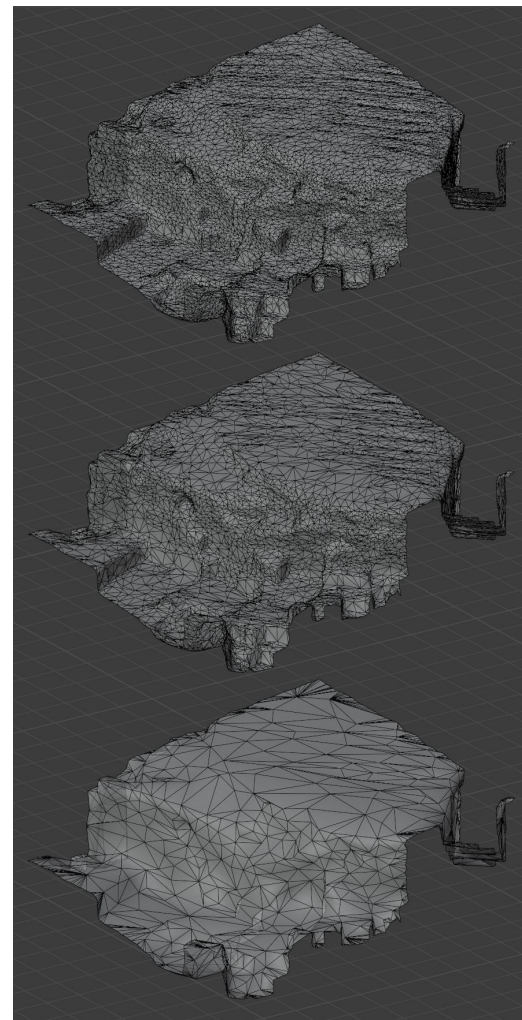
LOD0

LOD1

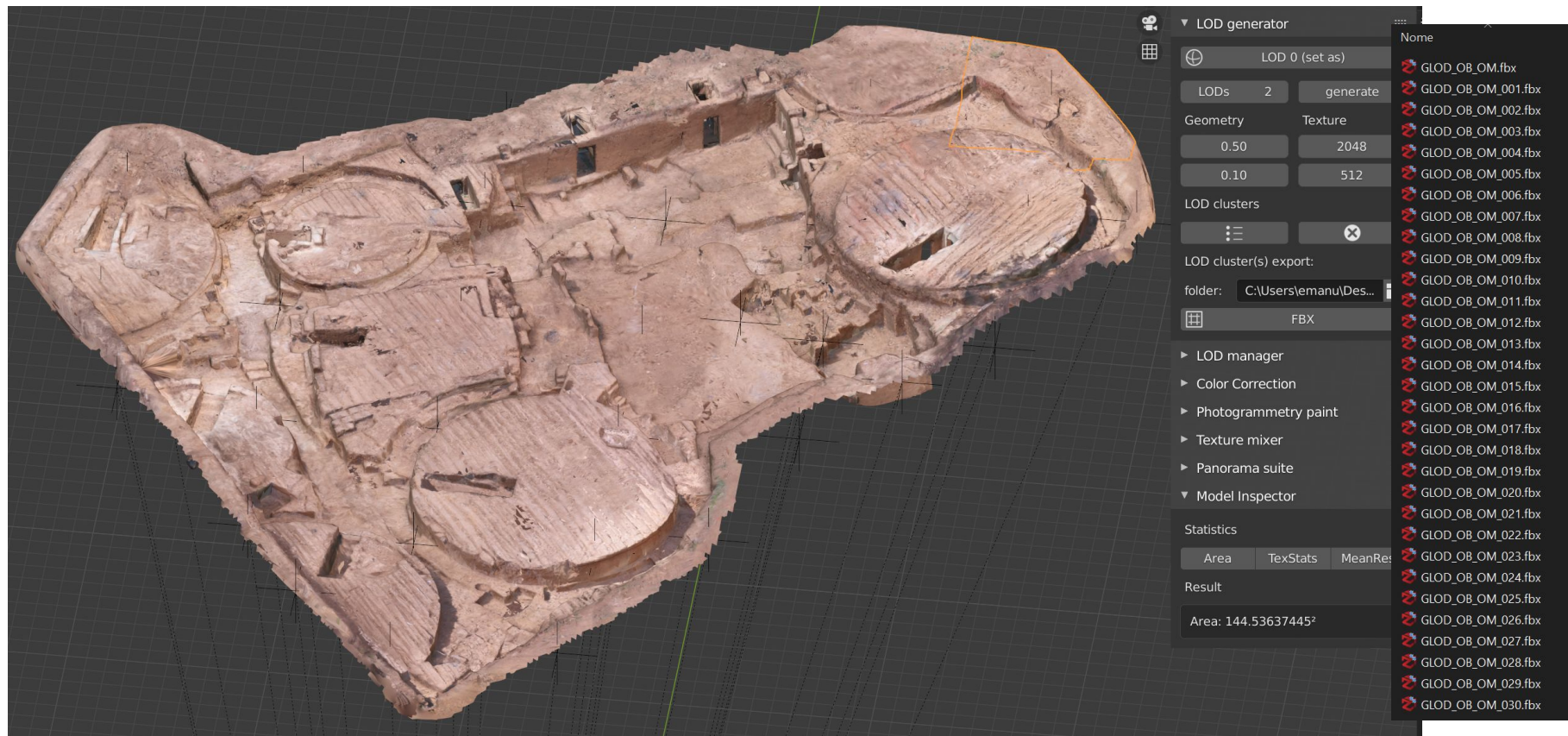
polygons:50% LOD0
tex: 2048

LOD2

polygons:10% LOD0
tex: 512



3DSC Level Of Details - LOD -> Cluster -> Export



The roman forum of Nora



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Archaeological remains:

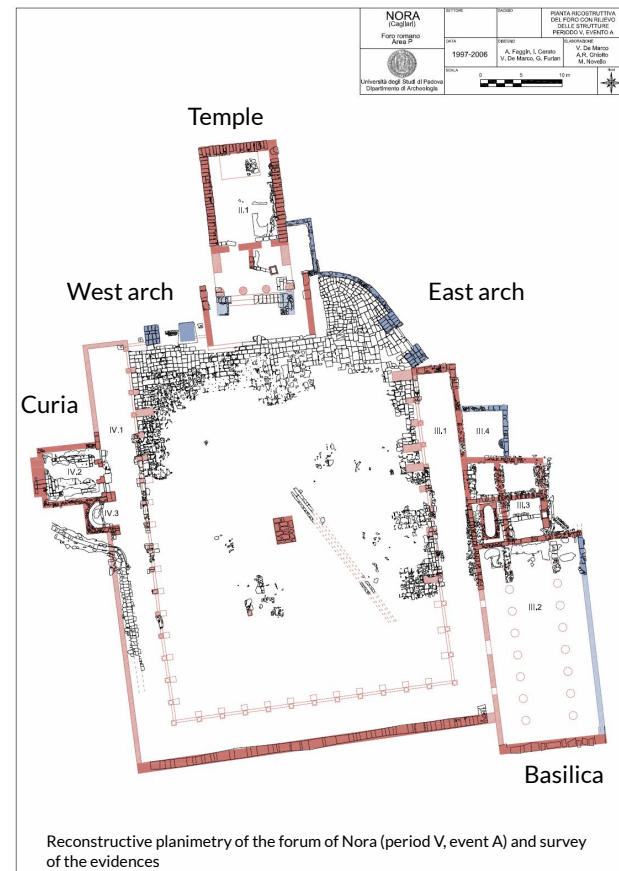
- structures;
- floors/pavements;
- evidences of basements facing the colonnades;
- no evidences of the south side of the forum. Exception: foundations of the back walls of the south portico and basilica

Enhancement project:

- 2008;
- improve the comprehension of different chronological periods;
- gravel of distinct colors.

Phd goal:

Improve the understanding of the whole monumental complex through a “reality based” 3D reconstruction.





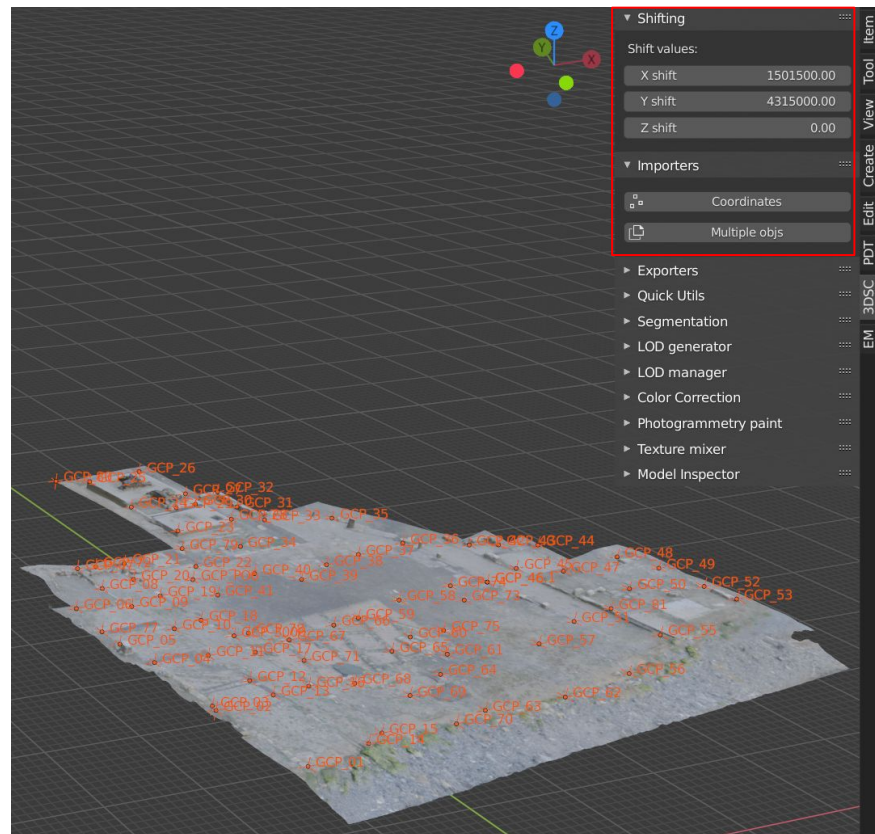
Data import: Import tool

Imported objects:

- control points (shift value operator)
- single .obj file
- several .obj files
- cameras (.dae format)

Goal:

Collect and manage all the photogrammetric data (control points, photogrammetric model, cameras) within Blender where the editing process will be executed.



Segmentation: Multi-cutter tool

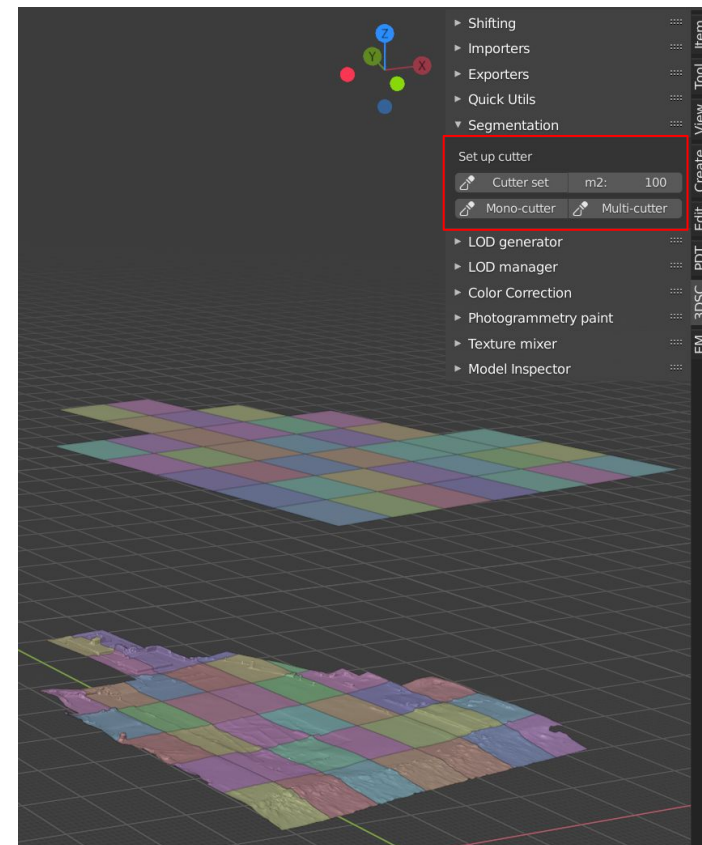


Grid definition:

- square shape
- 10x10 m
- 38 tiles
- alignment with the main axis of the forum

Goal:

Prepare tiles for both the texturing step (outside Blender) and the optimization process (in Blender).





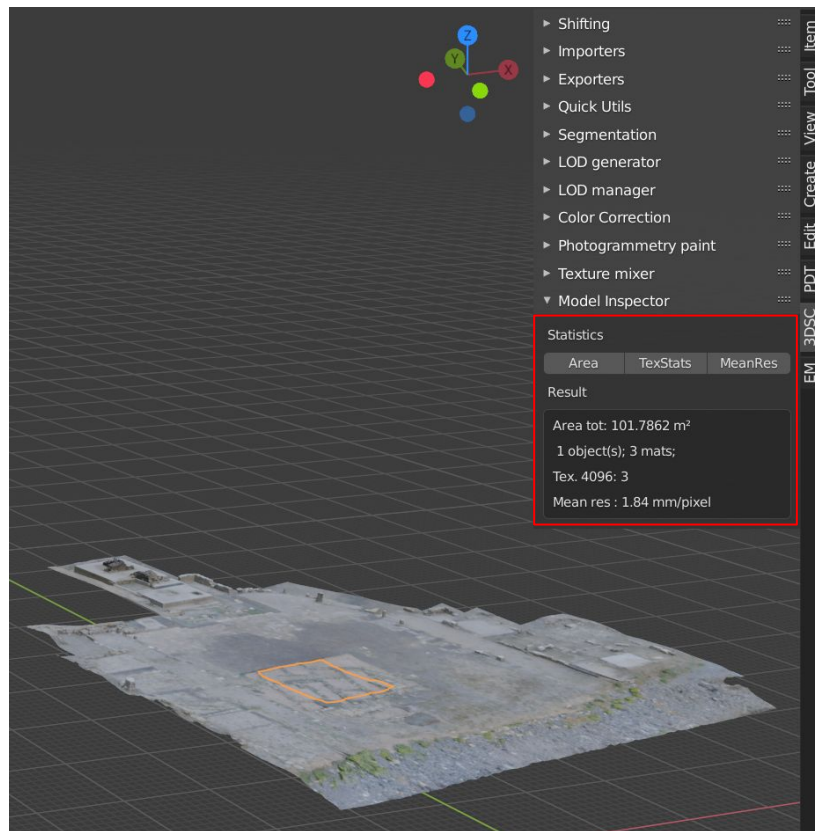
Data analysis: Model inspector

Statistics values related to:

- area (sq. m)
- number of selected objects
- texture resolution
- number of texture for each of the selected object
- pixel resolution of the texture

Goal:

Have useful object information to use for setting the texturing process. This tool will be also useful in other steps of the workflow.



Data sharing: Export tool



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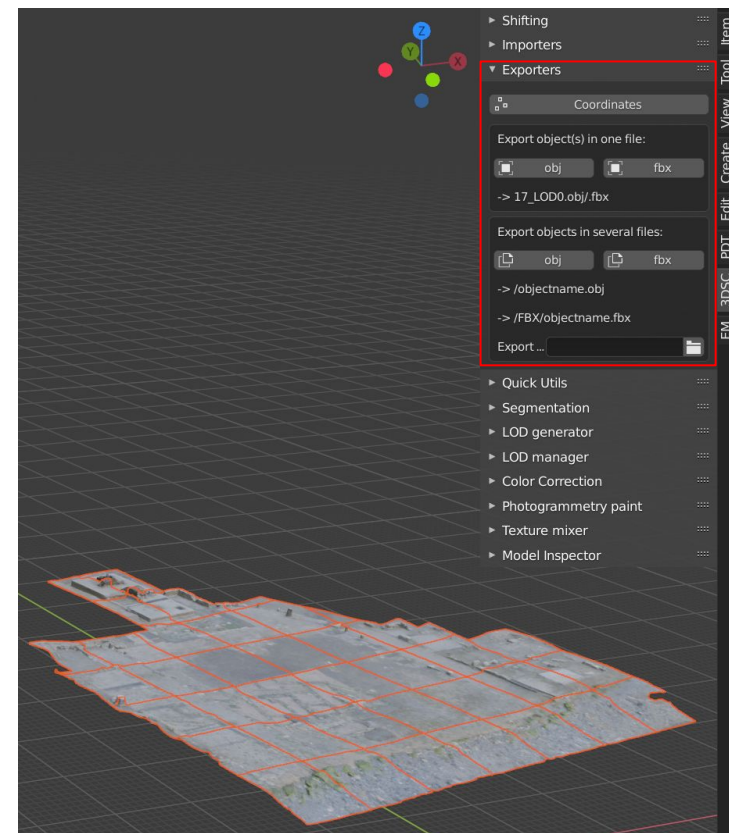
dbc

Tool options:

- single/multiple objects
- .obj or .fbx format
- specific directory

Goal:

Export data for the texturing process and the sharing activity towards other softwares.



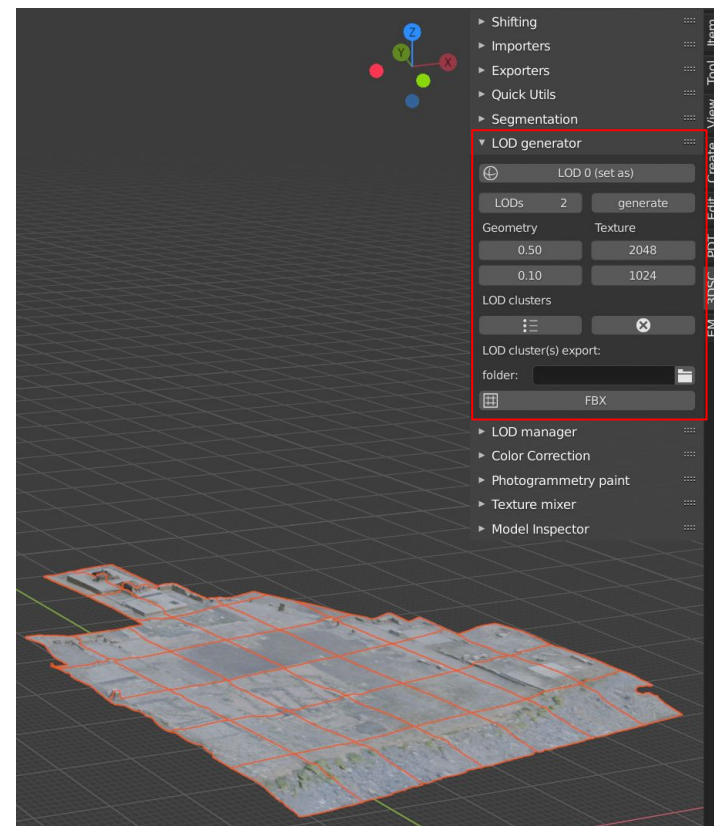
Optimization: LOD generator

Tool options:

- setting LOD0 (“high poly” meshes)
- setting LOD1 (geometry: -50%; Texture: -50%)
- setting LOD2 (geometry: -90% compare to LOD0; Texture: -50% compare to LOD1)
- automatic creation of LOD1 and LOD2 folders inside and outside Blender

Goal:

Optimize data for multiresolution visualization both in Blender and in other softwares.



Data visualization : LOD manager



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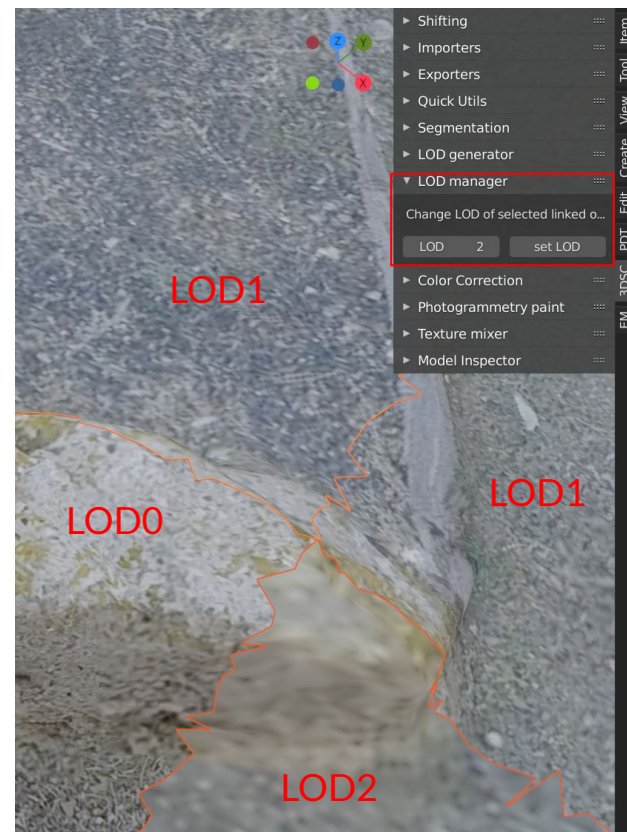
dbc

Tool options:

- single/multiple selection
- set the LOD to be visualize

Goal:

Optimize data visualization (in Blender) and software performance.



Conclusions:



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3D Survey Collection is a software which allows to:

- **import** and **export** 3D objects;
- **edit** 3D data, acquired with a photogrammetric approach or laser scanner methodology, from a geometrical and qualitative (texture) point of view;
- **manage** the visualization and the interaction of high resolution data with multiple LOD;
- **set** 3D objects for sharing them towards different platforms (other 3D softwares, game engines, web apps etc.).