VIRTUAL MUSEUM OF THE TIBER VALLEY
3D landscape reconstruction in the Orientalising period. North of Rome.
A methodological approach proposal

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DIGITAL HERITAGE
INTERNATIONAL CONGRESS 2013
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The area North of Rome,
between Monte Soratte (North)
and Fidene (South),
Palombara Sabina (East)
and Sacrofano (West),
crossed by the Tiber
And between
the ancient consular roads
via Salaria and via Flaminia

Virtual Museum of the medium TIBER VALLEY: 2011-2014

CNR ITABC in collaboration with museums of the territory, Soprintendenza Archeologica of North Etruria, Ministry of CH, private companies.

Supported by Arcus s.p.a.

AIMS: Research, Cultural Dissemination, Promotion of the territory and its cultural heritage to encourage people to visit some important and beautiful places that are still marginal in relation with the main itineraries in the Capital.

Spectacular permanent VR application in Villa Poniatowsky museum in Rome:

a “portal” to promote the project and the territory. Natural Interaction, artistic and evocative style

Multimedia and VR applications for local museum and mobile applications

to be used during the visit of archaeological sites or naturalistic oasis

Multimedia Website, including:

narrative contents for general public

methodological studies, interpretative sources, metadata, papers etc.

Common dataset with some adjustments for the specific communicative formats and the different conditions of fruition.

INTERDISCIPLINARY APPROACH to build the identity of a territory

The landscape is represented in its several dimensions: geological, natural, historical, archaeological, anthropological, evocative and symbolic.

From MACRO-SCALE (the whole territory)
to **MICRO-SCALE**

Specific sites:

Lucus Feroniae: ancient roman city

Volusii's roman villa,

Natural Park of Tevere-Farfa,

Monte Soratte

Evolution through the time (BOTTOM UP- TOP DOWN):

Geological prehistorical evolution: 3ml – 12.000 years ago

Pre-roman/orientalising period

Roman period

Medieval age

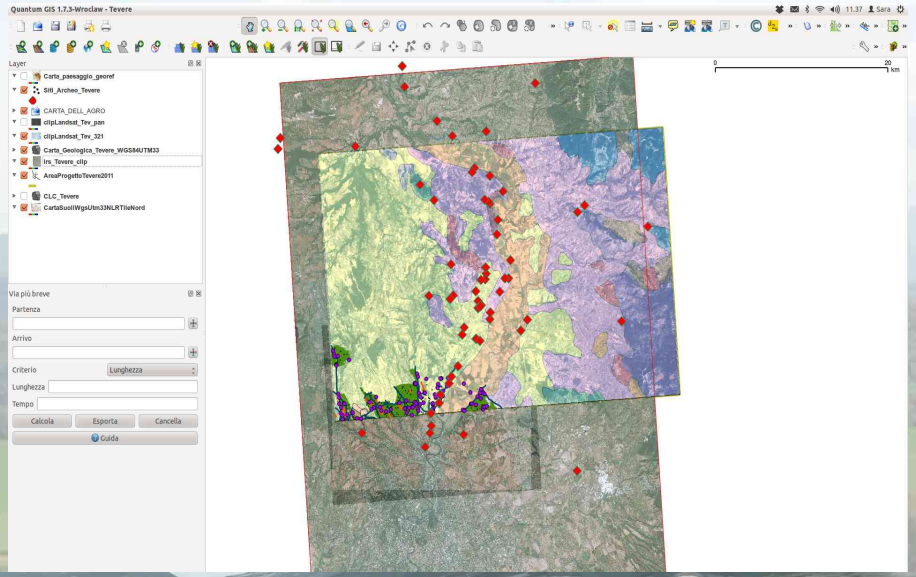
The reconstruction of the potential ancient landscape
METHODOLOGICAL APPROACH

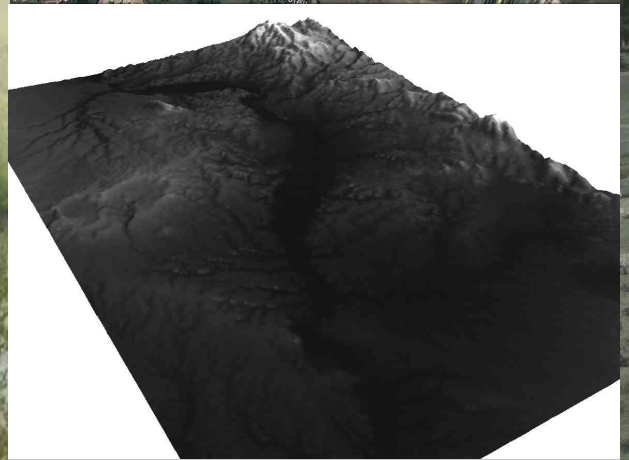
We focus on the orientalising period (end of the VIII century -VII century BC), **which was particularly important for the growth of the first urban centers.**

We propose a complete pipeline procedure, from:

Data collection and data acquistion on the field through integrated technologies

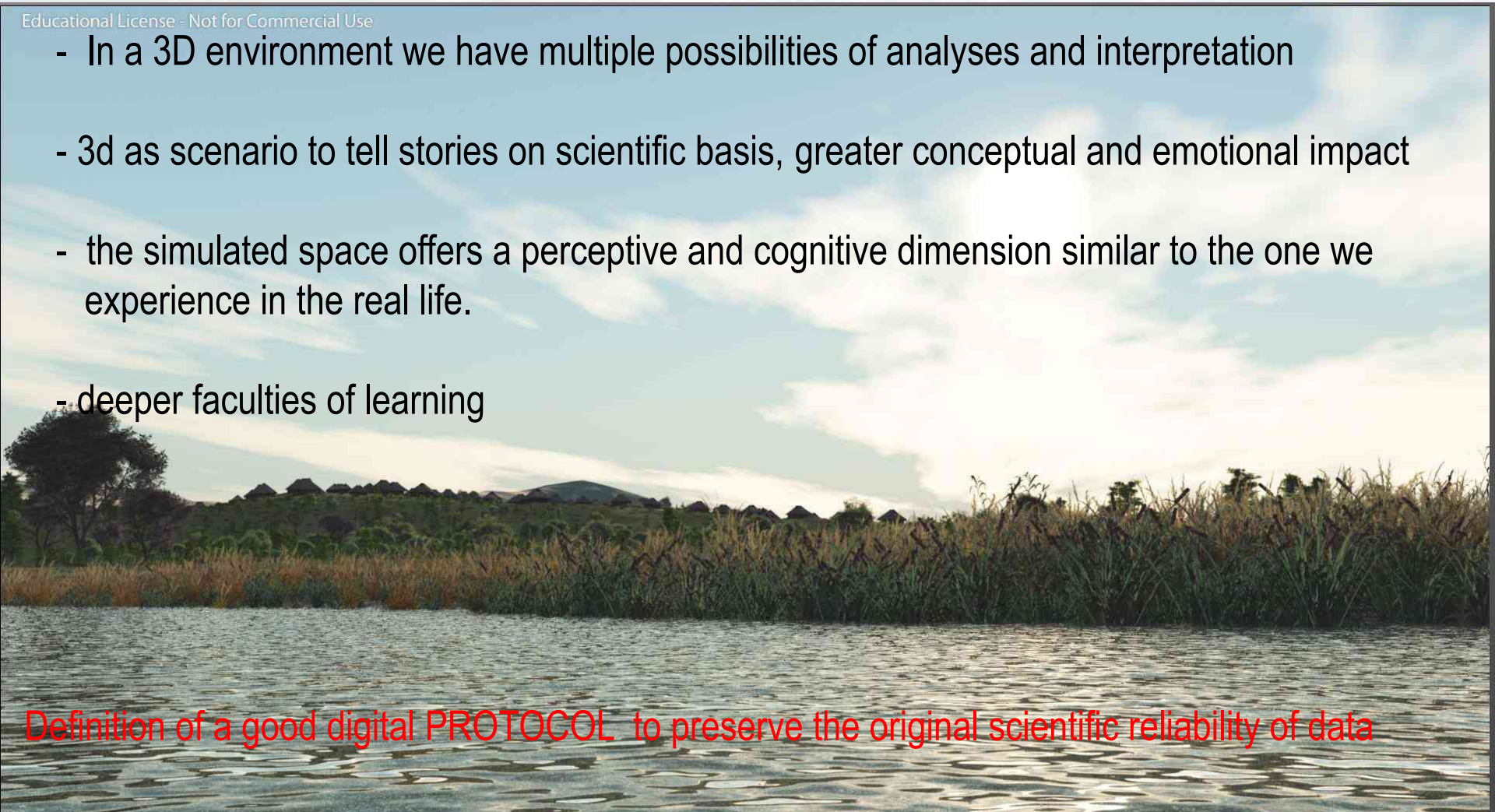
To GIS data elaboration up to final realistic 3D presentation for communication needs.





WHY 3D?

3D representation is fundamental for ENHANCED LEARNING and COMMUNICATION NEED (= our project)



- In a 3D environment we have multiple possibilities of analyses and interpretation

- 3d as scenario to tell stories on scientific basis, greater conceptual and emotional impact

- the simulated space offers a perceptive and cognitive dimension similar to the one we experience in the real life.

- deeper faculties of learning

Definition of a good digital PROTOCOL to preserve the original scientific reliability of data

1. GIS

morphological, geological, fitoclomatic information

+ archaeological data

- -Satellite images: (Landsat 30mt, IRS 5mt)
- Geologica Map: (1:100.000)
- Soil use map: (Corinne Land Cover 1:100.000)
- Carta dell'Agro
- Cartography: IGM 1:25.000
- Carta Tecnica Regionale 1:10.000

Villages

Infrastructures

Roads

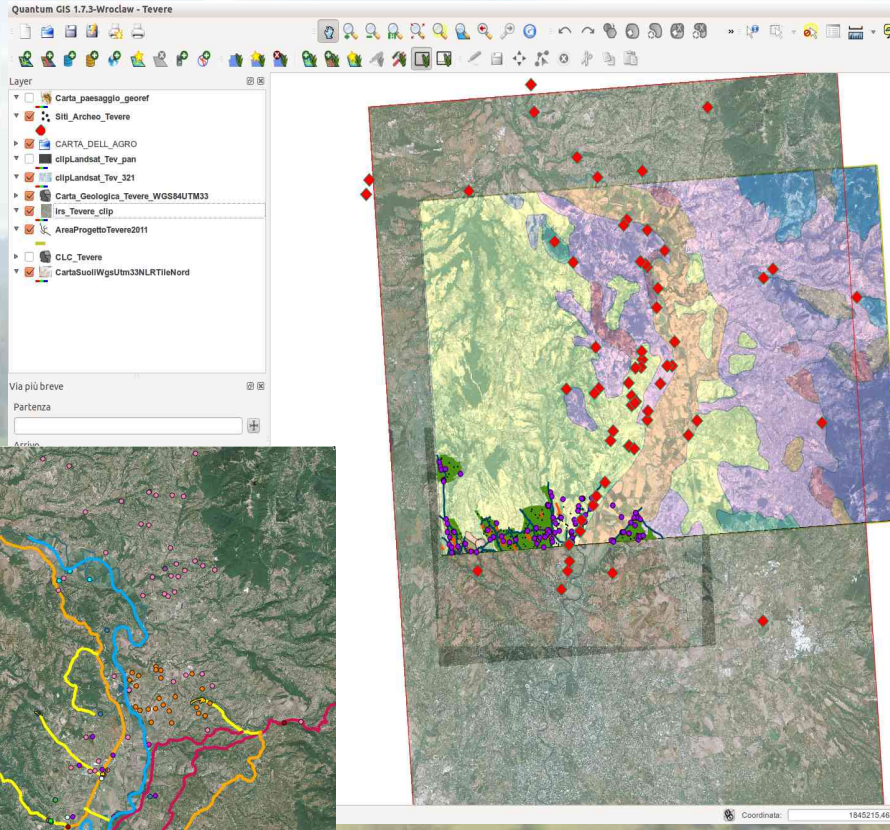
Bridges

Harbours

Necropolis

Boundaries, centuriae

Ancient river paths



2. DEM

Actual DEM 10m resolution
(thanks to Istituto Nazionale di Geofisica e Vulcanologia).
Texture: IRS satellite image 5m resolution
.

Highway buit in 1961

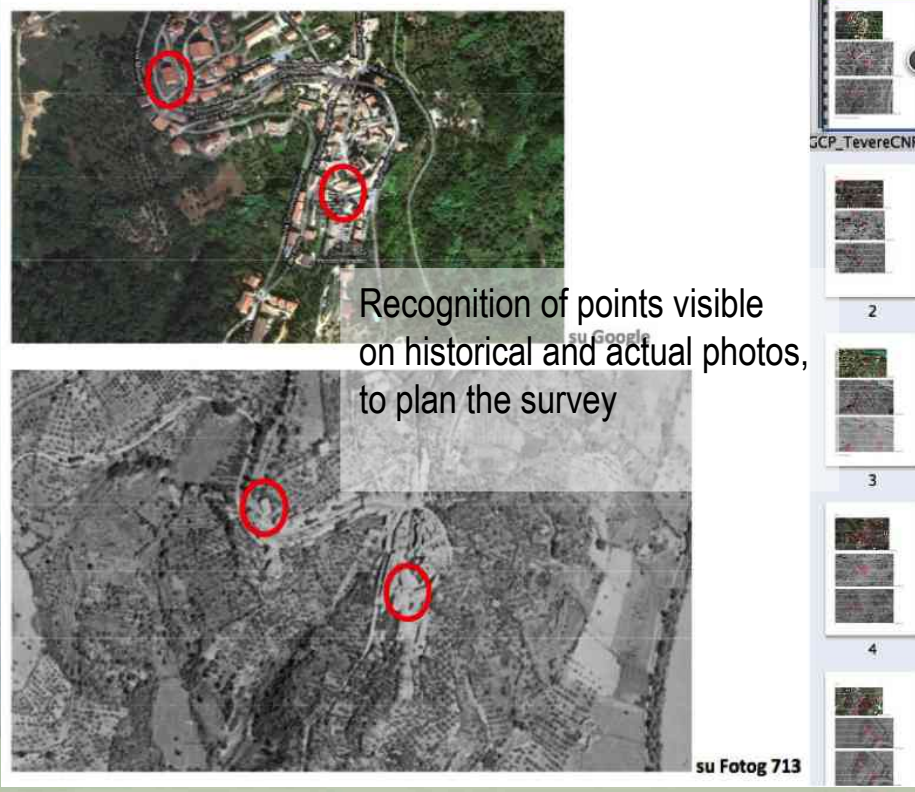
Nazzano Dam built in 1955

DEM reconstruction for the ancient phases

5 mt resolution

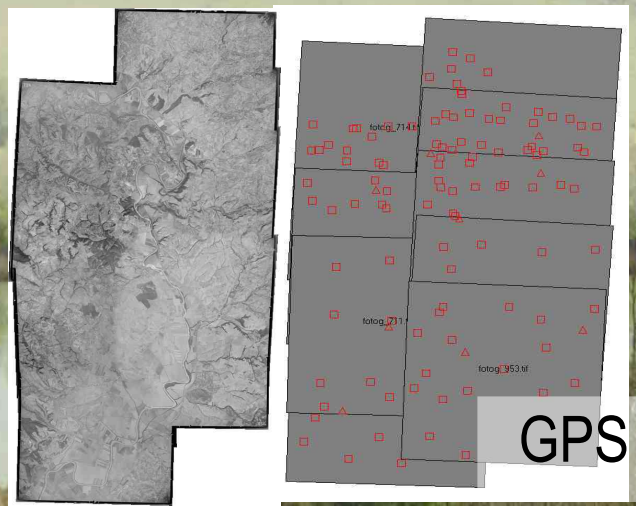
Photogrammetric elaboration from IGM aerophotos taken in 1954 (before the highway and dam were built), for the area where the valley morphology has strongly changed (FBK, Trento)

It can be considered a good base for the DEM of the ancient landscape

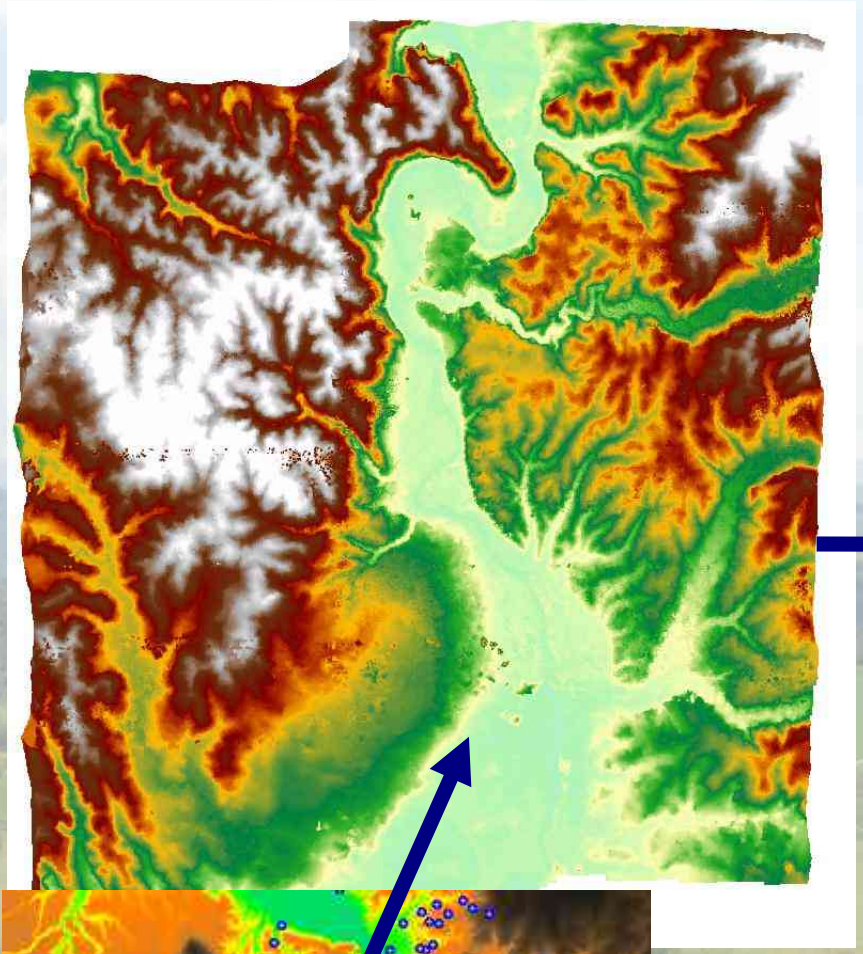


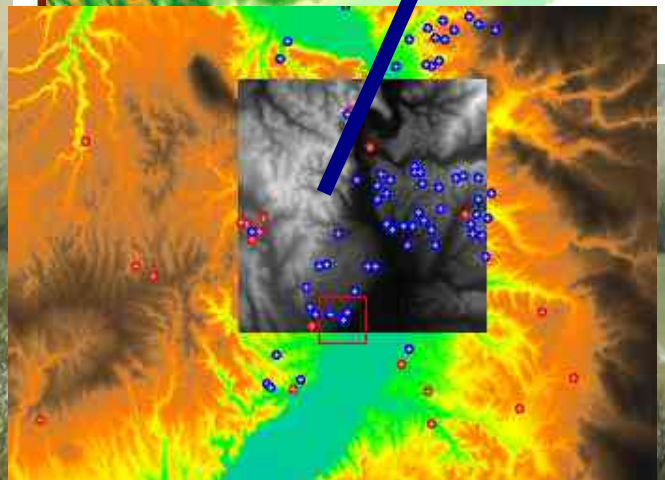
GPS SURVEY

30 control points to orient photos



Photogrammetry: DEM generation – (resolution 5 e 10 m) and ortophoto





Orto (1 m)

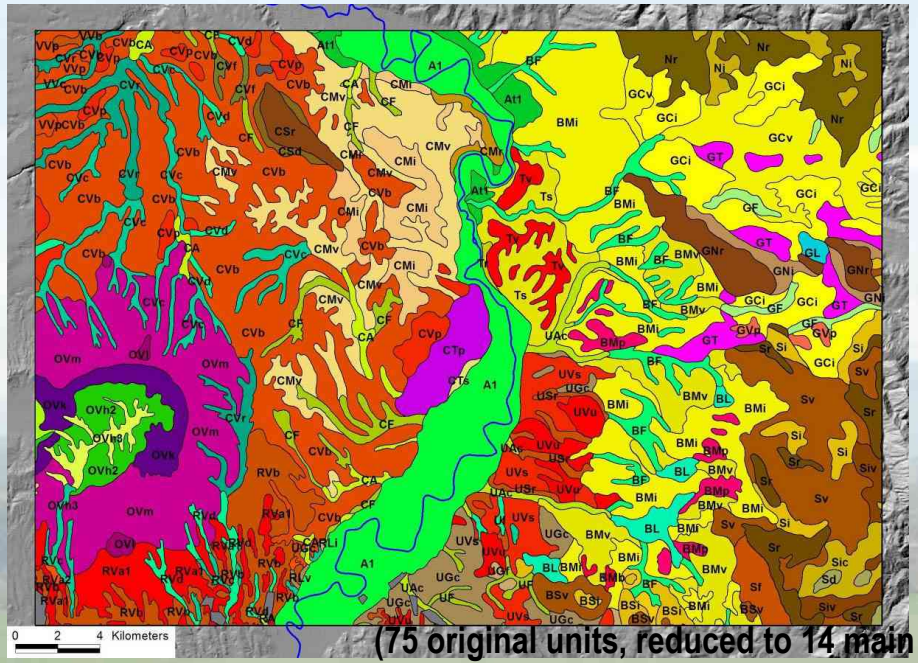
3.Study of the ecosystems in the orientalising period

Starting points

1) land unit map

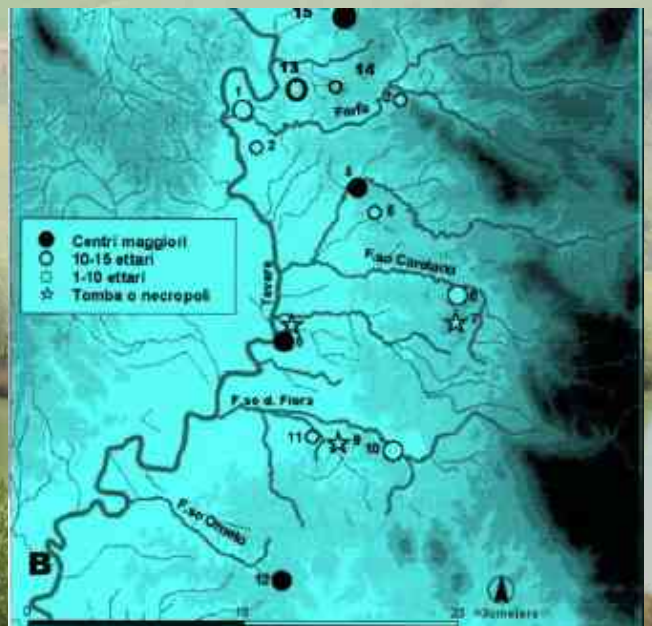
2) archaeological map

The LAND UNIT MAP
Shows the distribution of soils in their lithological, morphological and drainage context and their attitude to host specific ecosystems, both natural and cultivated by the man.



(75 original units, reduced to 14 main units).

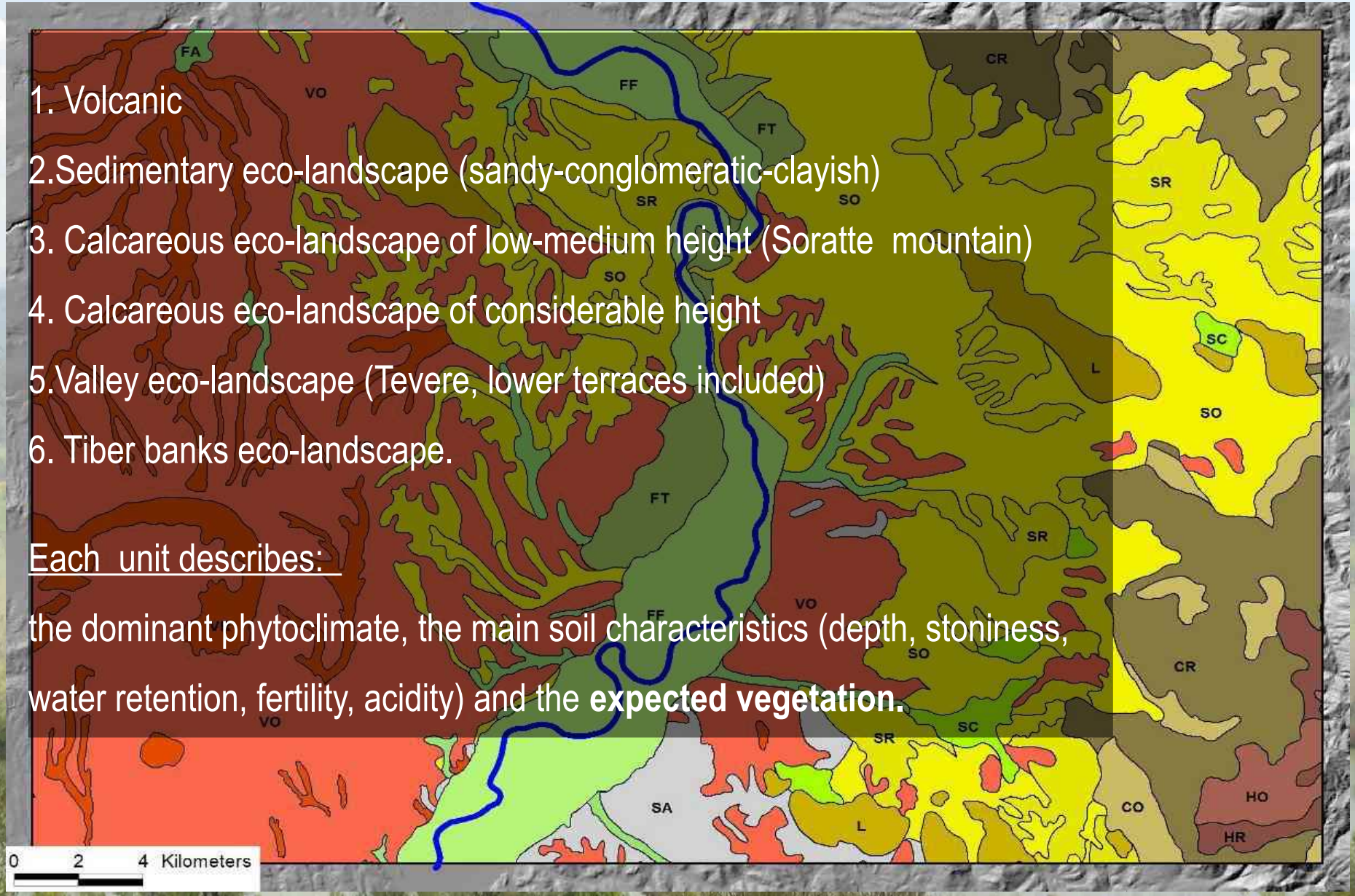
These data are compared with the archaeological map for the elaboration of a potential ancient landscape



1. Campo del Pozzo
2. Farfa Ponte Riano
3. San Vittore (Montopoli)
4. Cures Sabini
5. Zara Madonna (Fara)
6. Montelibretti
8. Eretum
10.Cretone
11.Colle Lupo
12. Nomentum
13.Colli della Città (Poggio Mirteto)
14. San Pietro (Poggio Mirteto)
15. Colle Ballone (Montopoli)

Falerii
Nazzano
Capena

From the Land unit map and the Fitoclimatic map we obtained the **Eco-Landscape map = 6 main macro-ecosystems**



1. Volcanic
2. Sedimentary eco-landscape (sandy-conglomeratic-clayish)
3. Calcareous eco-landscape of low-medium height (Soratte mountain)
4. Calcareous eco-landscape of considerable height
5. Valley eco-landscape (Tevere, lower terraces included)
6. Tiber banks eco-landscape.

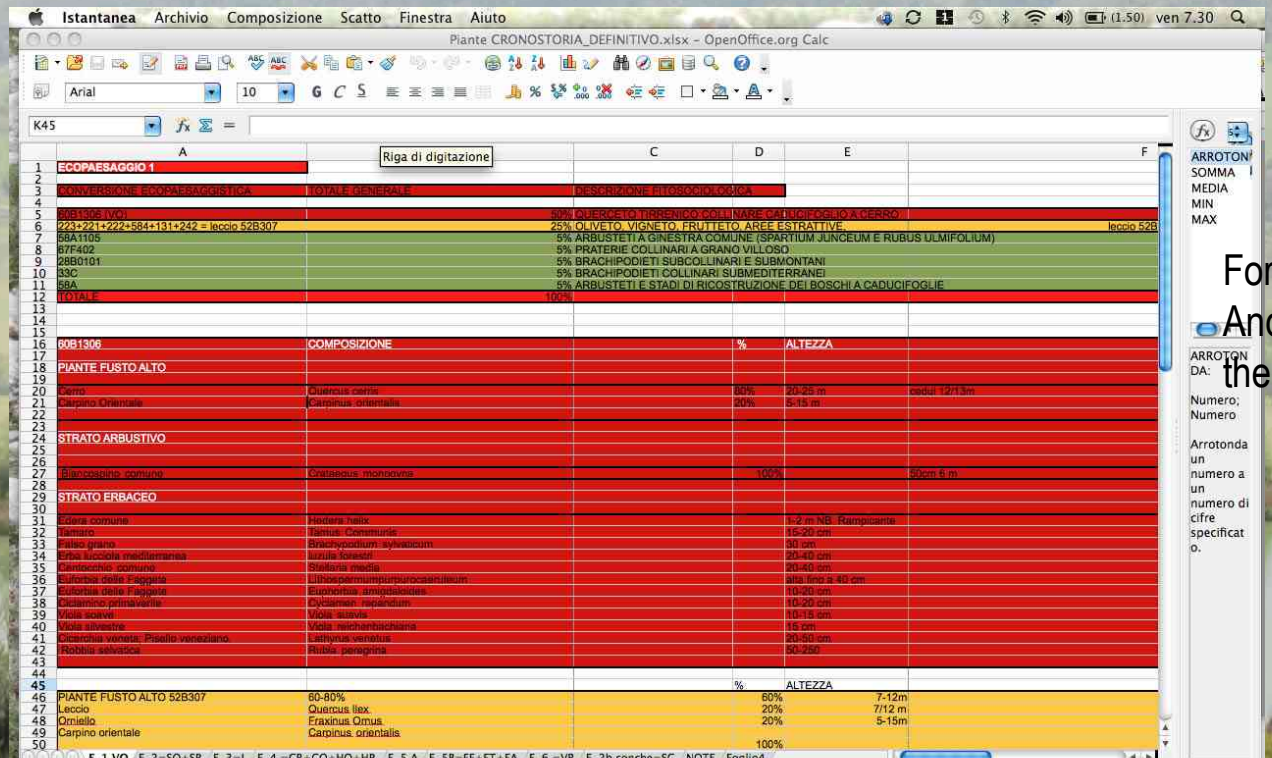
Each unit describes:

the dominant phytoclimate, the main soil characteristics (depth, stoniness, water retention, fertility, acidity) and the **expected vegetation.**

Natural vegetation has been associated
to every macro-ecosystem
(independently from human presence).

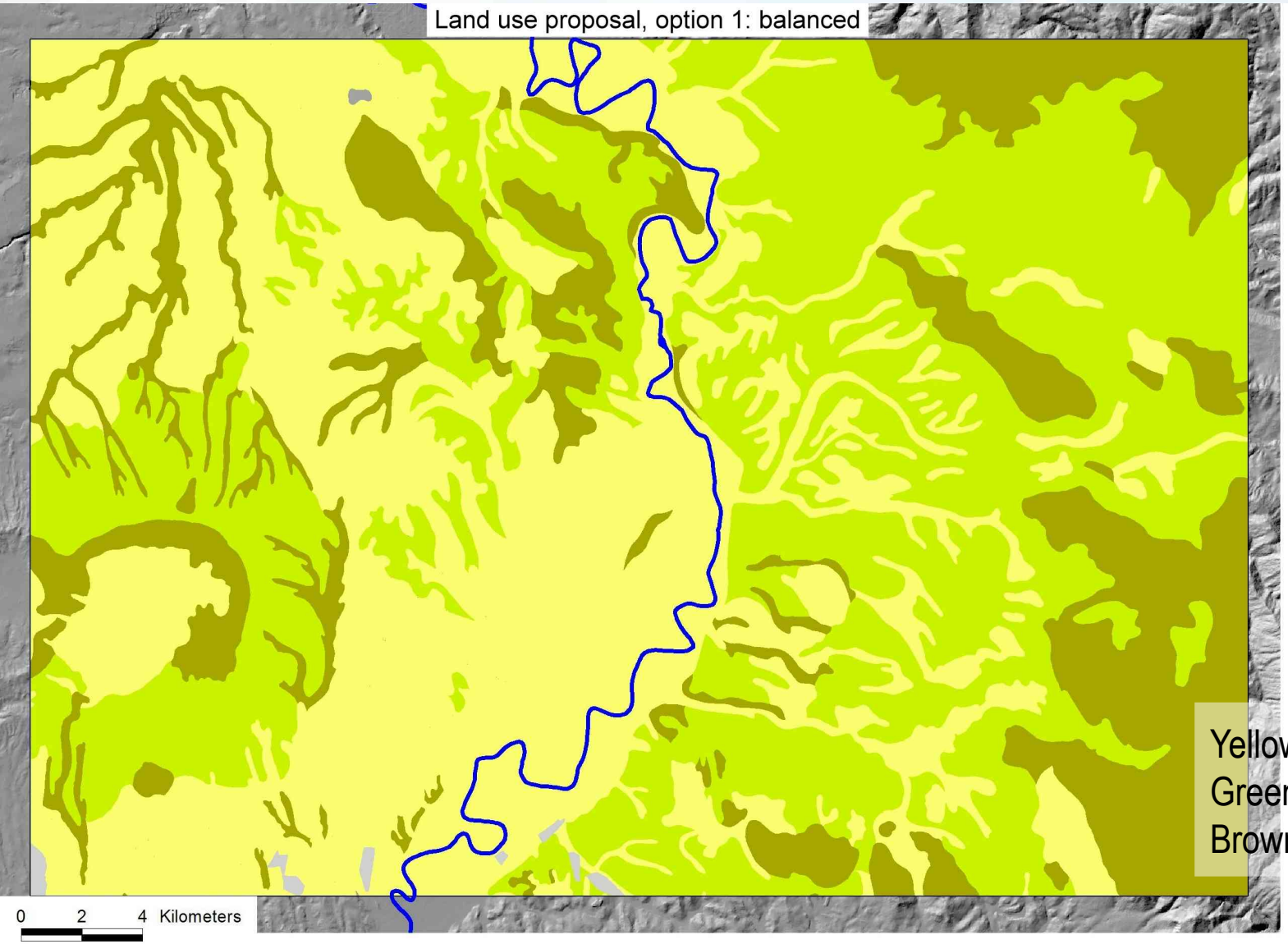
We can assume that the potential natural vegetation has not changed in a substantial way.

(cartography elaboratedby Regione Lazio and Provincia di Roma).



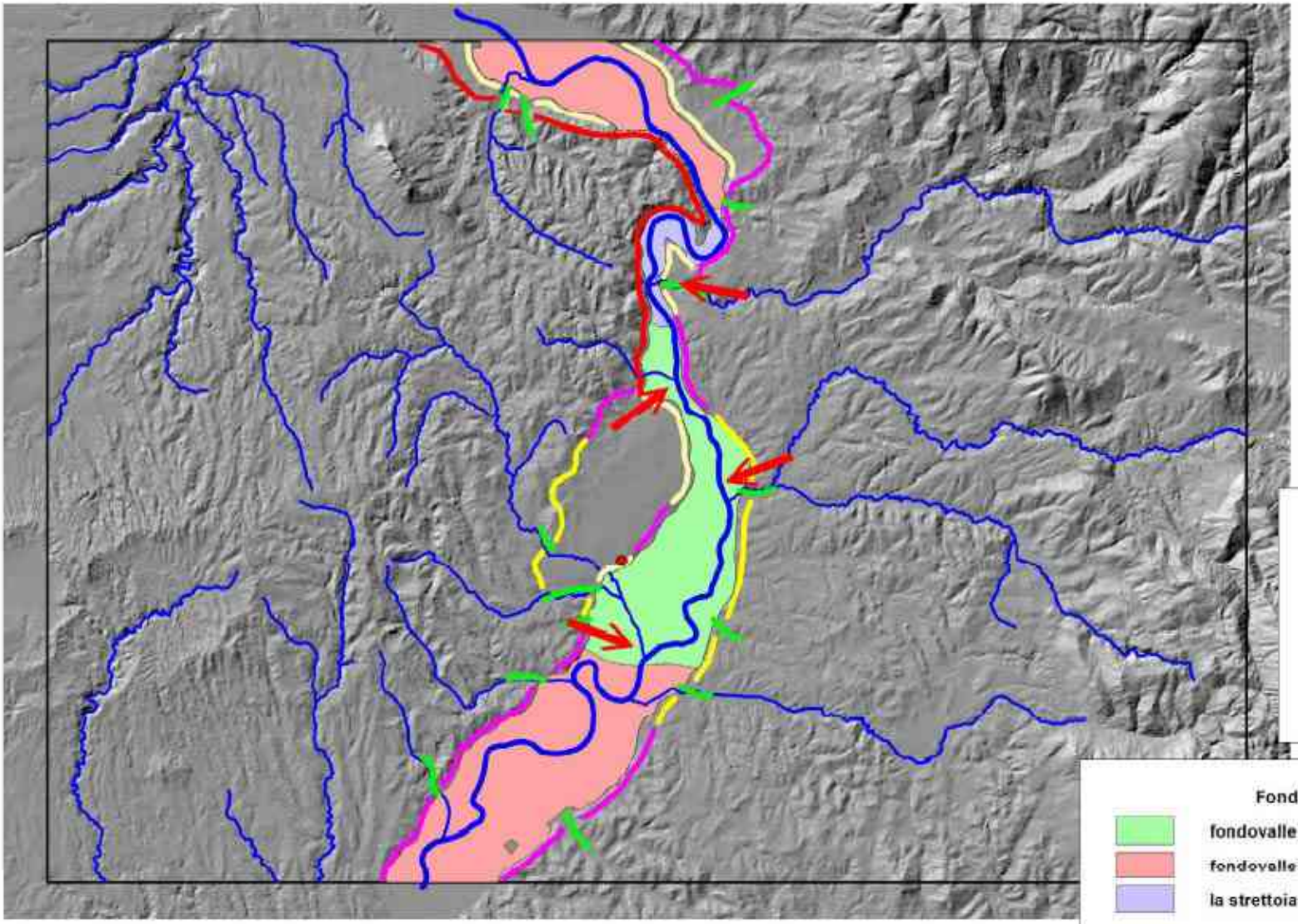
For every ecosystem
And excel file describes
the plants combination

Evaluation of the suitability of the territory for cereals (eventually with rows of vines) and grassland, and for olive groves and orchards (balanced hypothesis)



Yellow: cereals, 42.3%
Green: olives 37.5%
Brown: woods 20.2%

Study of the slopes, orography, accessibility of the river. Geological hypothesis of the ancient courses of the Tiber river and the plausibility of the ancient harbours or crossing points/structures on the river



Criteri: buona raggiungibilitˆ dall'hinterland, fondovalle presumibilmente non soggetto a ristagno o la presenza di una estensione di terrazzo fluviale basso, Tevere presumibilmente non soggetto a migrazione laterale. Ci vuole il confronto con i dati archeologici…

Antonia Arnoldus-Huyzendveld Digiter S.r.l

The proposal for the final map of the orientalising period

The tradition of Ecological GIS approach to agricultural potential

Higgs E.S., Vita-Finzi C. 1970, *Prehistoric Economy in the Mount Carmelo Area of Palestine: Site Catchment Analysis*. Proceedings of the Prehistoric Society, XXXVI

Gaffney V., Stancic Z. 1991, Gis approaches to regional analysis: a case study of the island of Hvar, Ljubjana 1991.

Camporesi C., Palombini A., Pescarin S. 2007, *GIS e 3D Web-Gis* in M.Forte (ed.) La Villa di Livia, un percorso di ricerca di archeologia virtuale. L'Erma di Bretschneider, Roma, pp. 111-120.

Hunt E.D. 2008, Upgrading site-catchment analyses with the use of GIS: investigating the settlement patterns of horticulturalists. World Archaeology 24:2, 283-309.

Pescarin S. 2009, *Reconstructing ancient landscape*, Budapest, Archeolingua.

The proposal for the final map of the orientalising period

Determining cultivated areas for different priods through a polynomial approach

$$aX+bY+cZ....$$

X,Y,Z: thematic elements connected to agriculture attitaude.

a,b,c: parameters given to each of them, according to social and technological features.

A common polynomial approach was used to define cultivated areas in different periods

$$aX+bY+cZ....$$

Agricultural attitude final map (Final Iron Age):

Fe_ColtivPot=(A+0.5*B+0.5*C+3*D+F) [Filtered on E]

where:

A= closeness to settlements (settlements buffers: 2,4,6,10km)

B= closeness to roads (path buffers: 1,2km)

C= closeness to water (rivers and streams buffers: 300,1000m)

D= ecolandscape units map (5 cats)

E= slope <40% and year solar power >900 Kwh/m2

F= cost analysis

A common polynomial approach was used to define cultivated areas in different periods

$$aX+bY+cZ....$$

Agricultural attitude final map **(Final Iron Age)**:

Fe_ColtivPot=(A+0.5*B+0.5*C+3*D+F) [Filtered on E]

Agricultural attitude final map **(Roman Age)**:

Fe_ColtivPot=(0,5*A+B+0.5*C+3*D+F) [Filtered on E]

where:

A= closeness to settlements (settlements buffers: 2,4,6,10km)

B= closeness to roads (path buffers: 1,2km)

C= closeness to water (rivers and streams buffers: 300,1000m)

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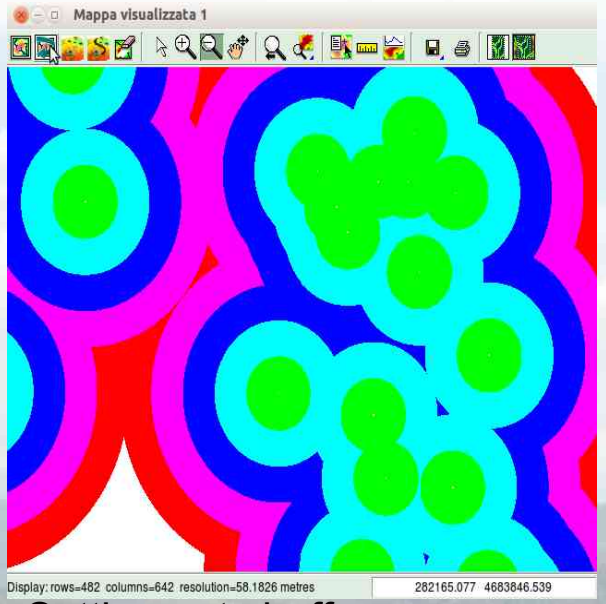
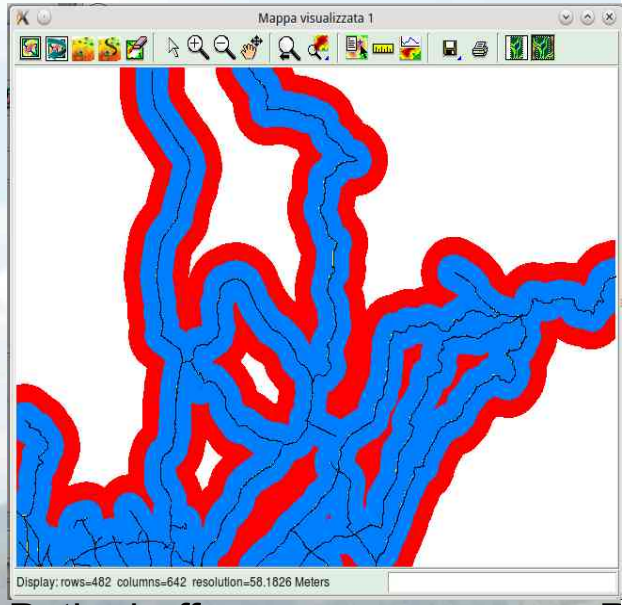
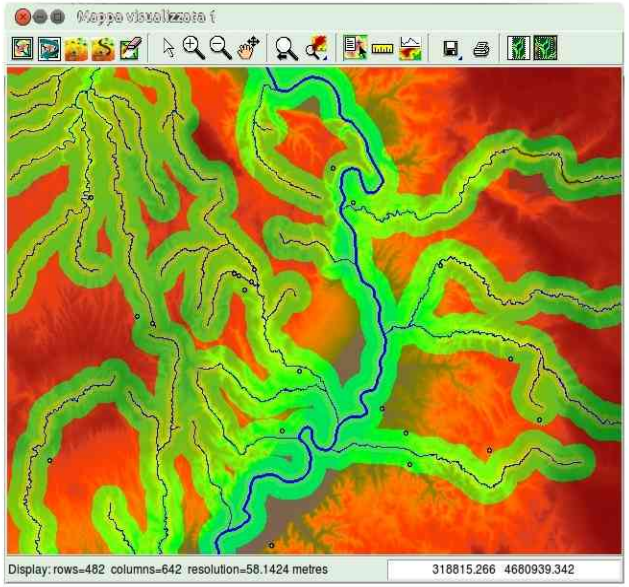


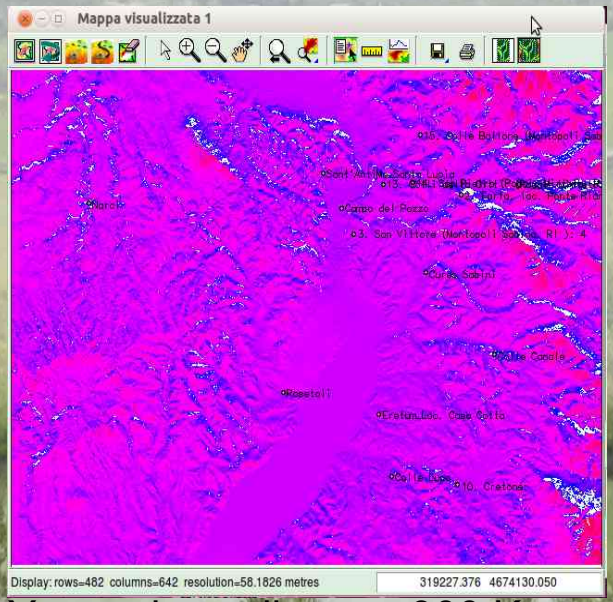
Settlements buffers



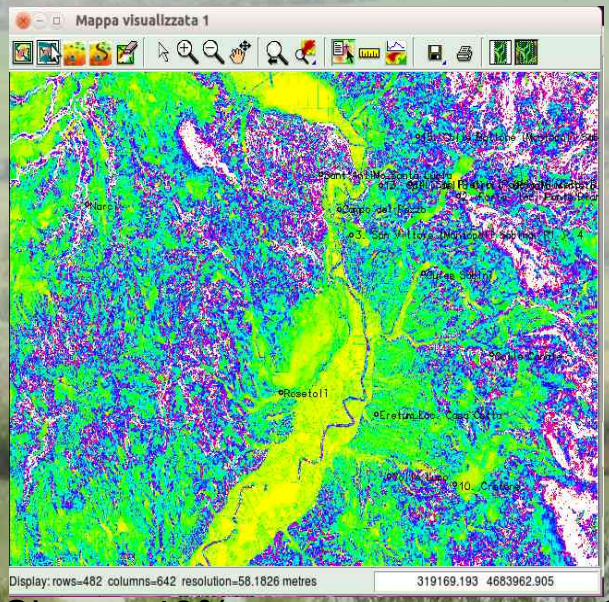
Paths buffers



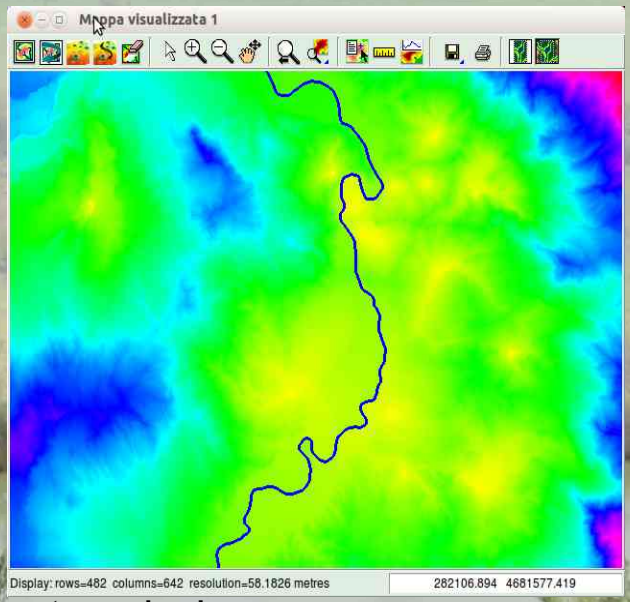
River & streams butters



Year solar radiance >900 Kw



Slope <40%



Cost analysis

Agricultural attitude final map (Final Iron Age):

Fe_ColtivPot=(A+0.5*B+0.5*C+3*D+F) [Filtered on E]

where:

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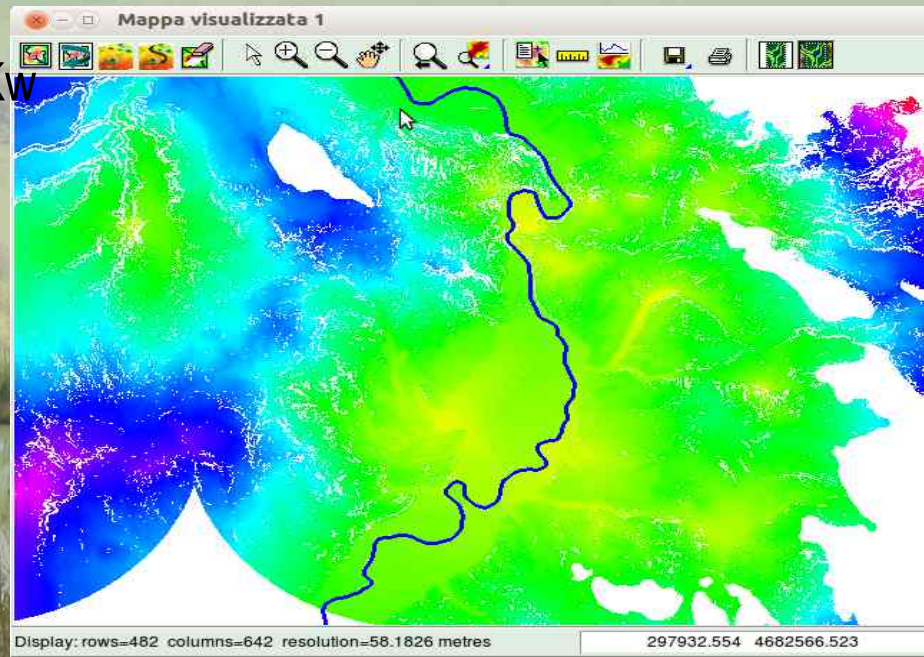
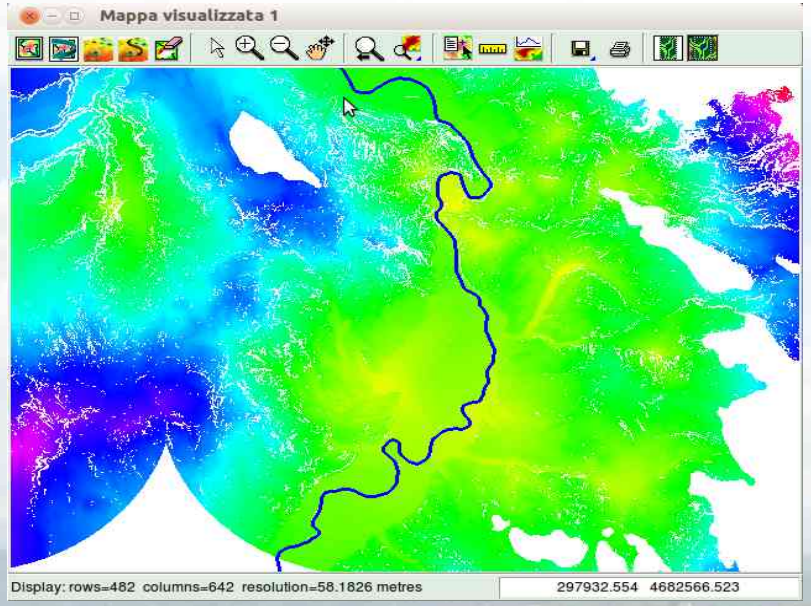
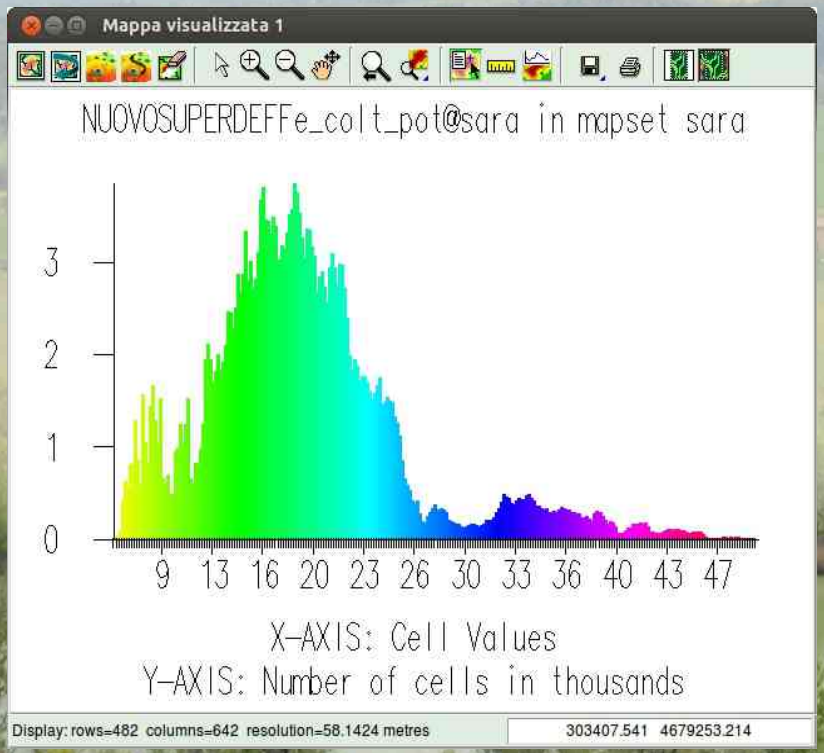
F= cost analysis







Problem:

Once we have classified the landscape in terms of suitability for agriculture, **how much terrain do we assign to cultivated areas?**

Assumption:

In a traditional and spatially delimited social context (non imperial) **land cultivation is aimed to local people feeding.**

Consequence:

The definition of cultivated areas is strictly connected to demographic analysis

Step a: Defining population entity

<u>According to literature:</u>

Population estimation: **120 persons x hectare**

- Di Gennaro F., Guidi A. 2010, *Lo stato delle anime come mezzo per la ricostruzione della popolazione dei villaggi protostorici*, Arqueología Espacial 28, 1-9.

<u>Sites extension:</u>

3 large sites (25 ha)

5 medium sites (8 ha)

6 small sites (2 ha)

- Di Gennaro F., Guidi A. 2009, *Ragioni e regioni di un Cambiamento culturale: modi e tempi della formazione dei Centri protourbani nella valle del Tevere e nel Lazio meridionale.* Scienze dell'Antichità, Storia Archeologia Antropologia 15 (2009)., 429-445

- GUIDI A. ET AL., 1996., *Cures Sabini: Lo scavo, le strutture, la cultura materiale, le attivita' economiche". In Identita' e Civilta' dei Sabini. Atti del XVIII Convegno di studi etruschi ed italici (Rieti – Magliano Sabina, 30 maggio - 3 giugno 1993).* Firenze, pp. 143–204.

127 hectares

ca. 15000 people

Step b: Defining nutrition needs

Hypothesis:
2500 calories per day
50% coming from crops
50% coming from other diet elements (meat, fish, etc.)

Cereals power:
about 300 cal x 100 gr.

Seeds/flour ratio:
1/1

Total need: 400 gr per person per day
x 365

150 kg x year

Step c: Defining crop yield

Which was the cereals anual yield in ancient times?
1300 kg. x hectare in the best situation
(Varro: De Re rustica)

Probable average value: 1000-1100 kg x hectar
(-1/3 for terrain regeneration each 3 year, and seeds to be preserved for next seeding)

ca 600-700 kg x hectare (= feeding 4 people)

Needed area: 0,25 hectares per person

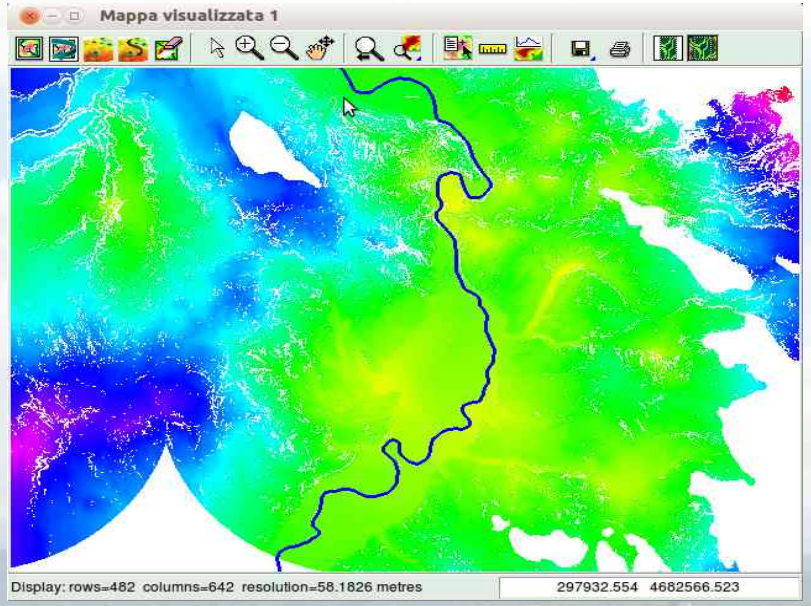
Step d: Summing up

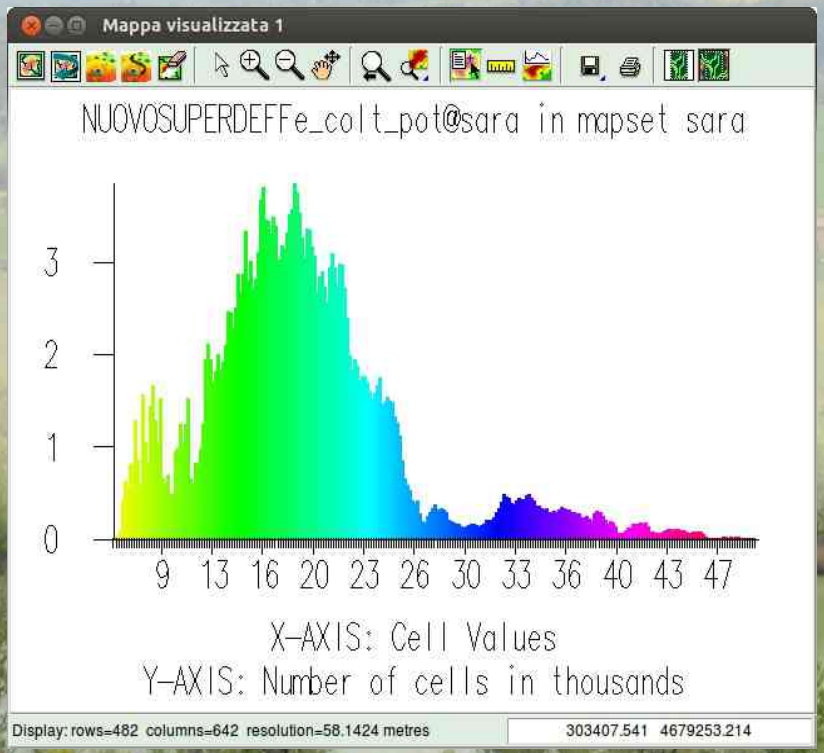
Our analysis:
0,250 hectares x person (=1200 cal.x day, 150 Kg.x year)

The historical sources:
The *Bina Iugera* tradition: Romulus distributed 2 iugera (0,5 hectares) to each family (4 people?), corresponding to an estimation of
0,125 hectares x person (= 700 cal.x day, 87 Kg.x year)

We decided to assume 0,2 hectares per person, still compatible both with the Bina iugera tradition and with the hypothesized nutrition needs and yield potentials.

Total cultivated land:
3000 hectares





Back to the problem:

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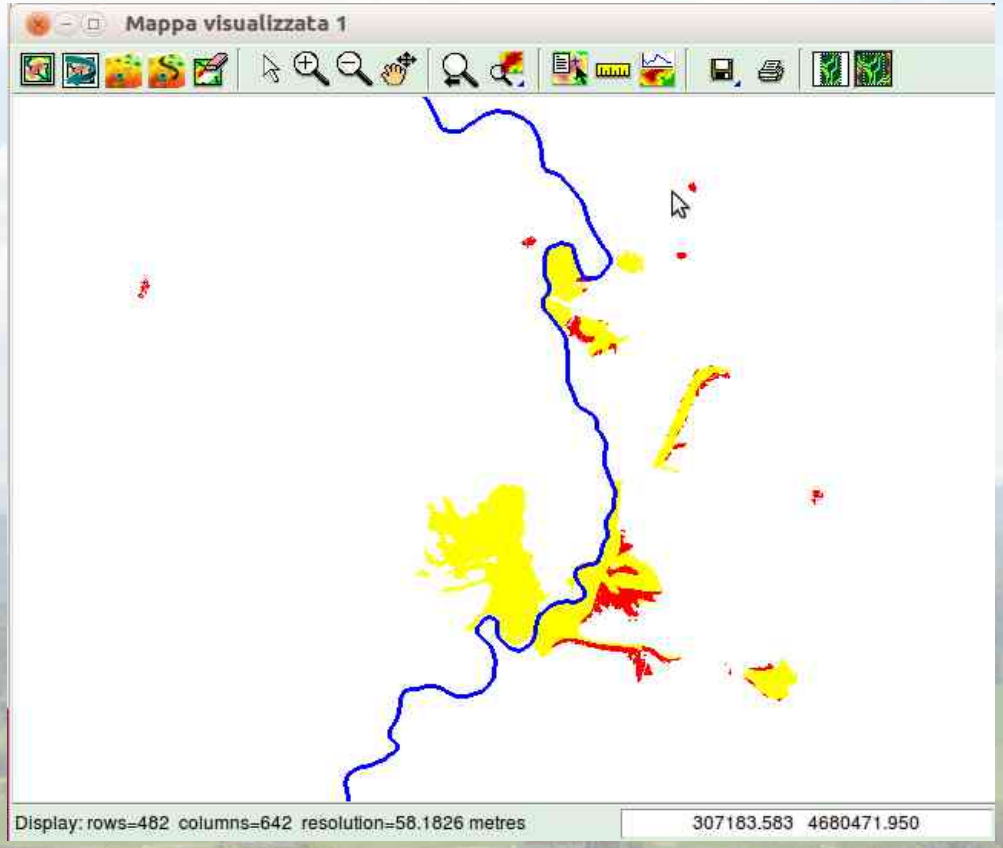
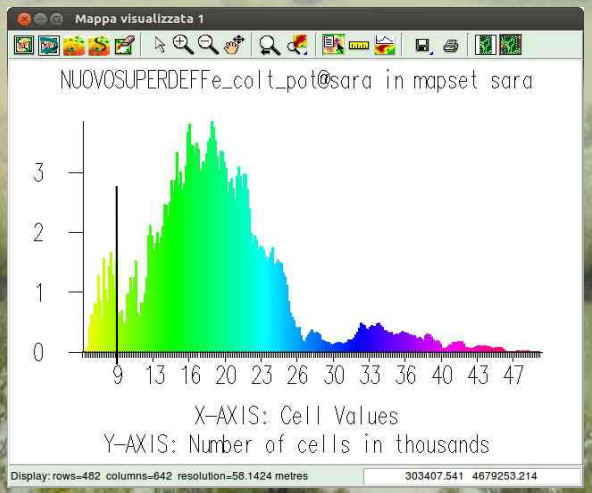


How much terrain do we assign to cultivated areas?

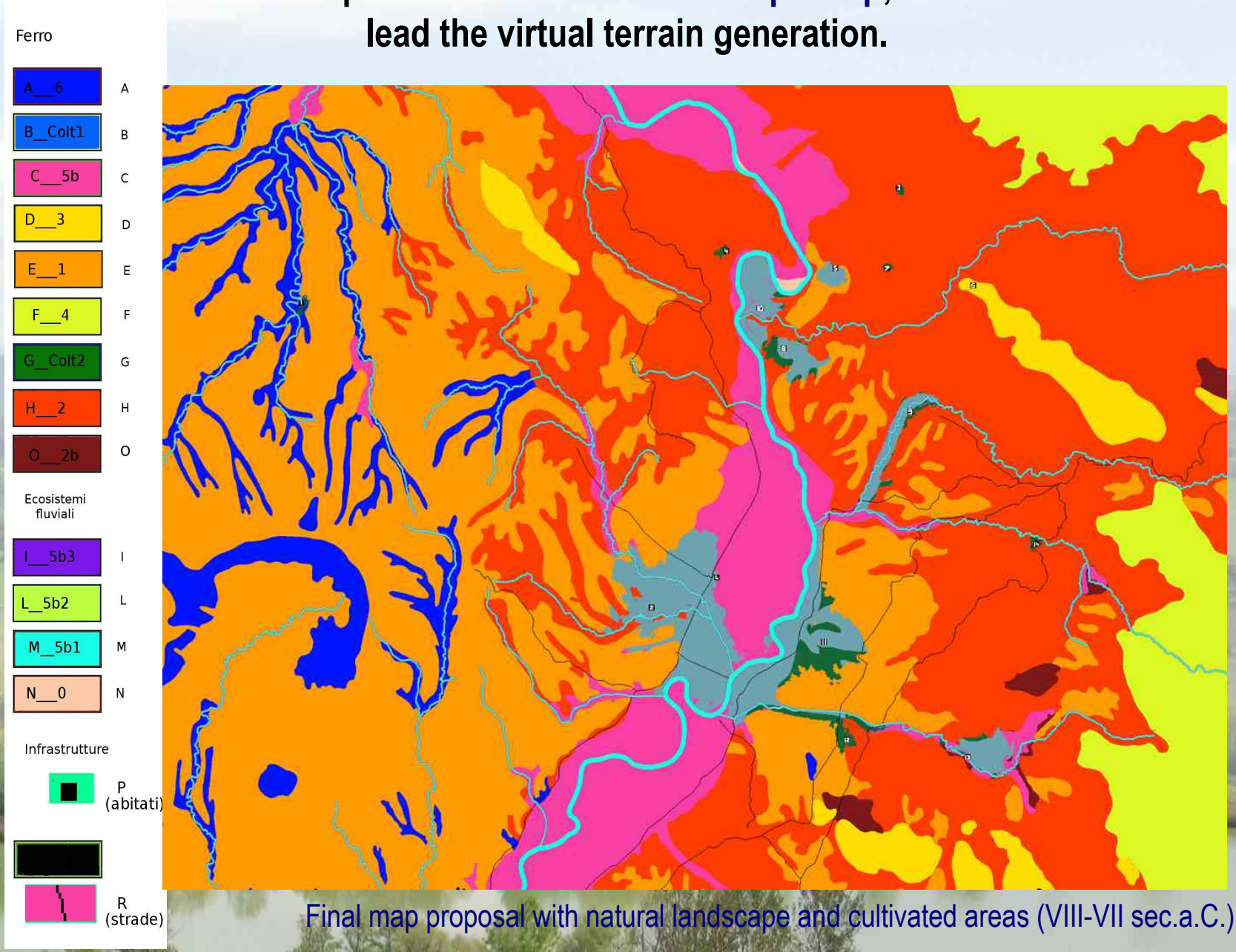
According to our analysis we can fix an area limit



3204 hectares: cereals

541 hectares: fruits, olives

The cultivated land is patched on the eco-landscape map, and this is the basis to lead the virtual terrain generation.

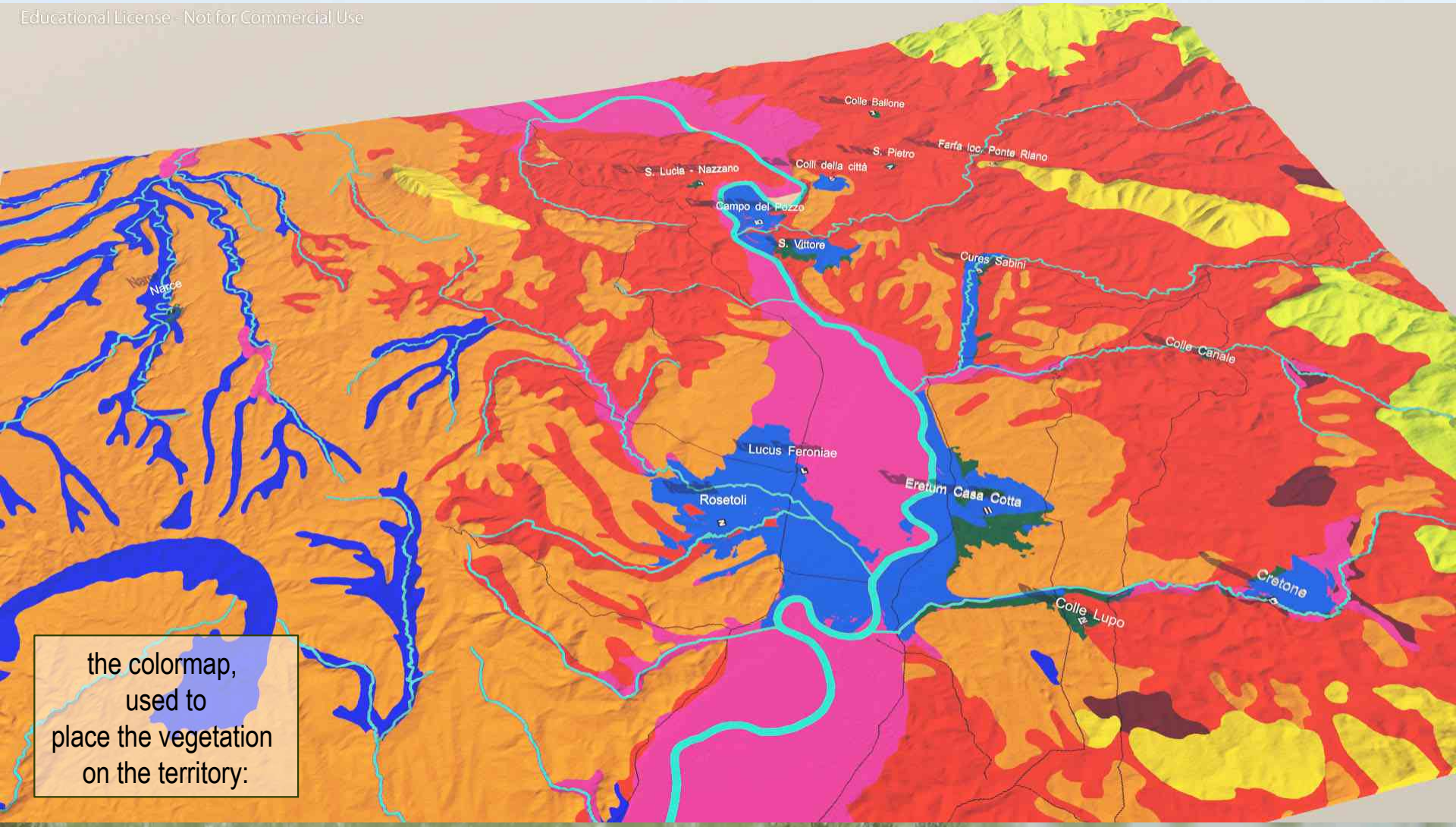


Final map proposal with natural landscape and cultivated areas (VIII-VII sec.a.C.)

Virtual reconstruction of the landscape in the VII sec. B.C. for off line rendering (Vue Xtreme)

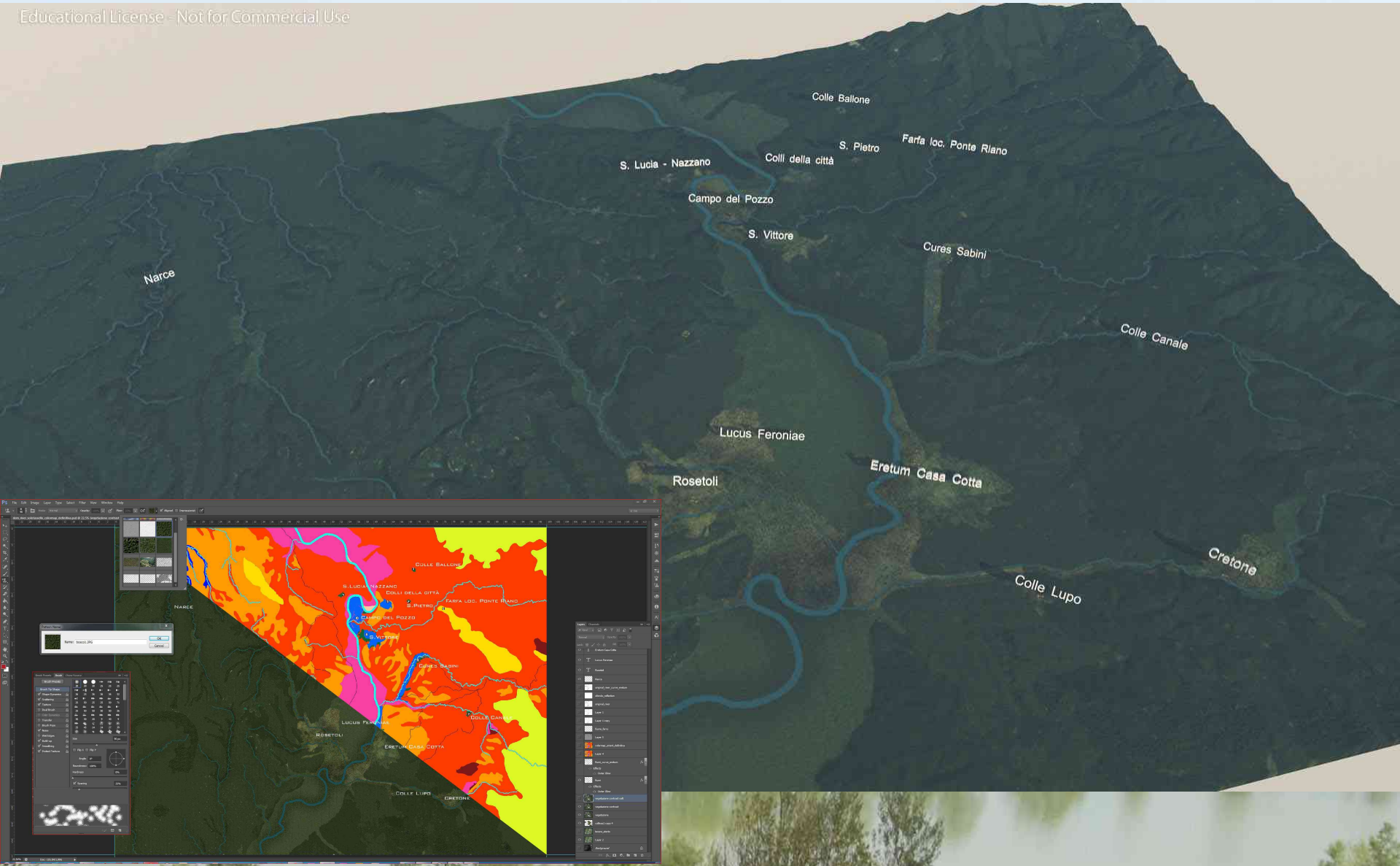
the shape of the land, imported in VUE as heightmap (geotiff) or USGS/SDTS DEM (. dem o. ddf),

Vue Xtreme



the colormap,
used to
place the vegetation
on the territory:

Vue Xtreme



Vue Xtreme

Ecosystems are distributed according to a procedural programming approach, (es: the density and the presence of plants is calculated on the base of the terrain slope, the fog on the base of the altitude, etc.).

The population can also be positioned manually with editable Paintbrushes

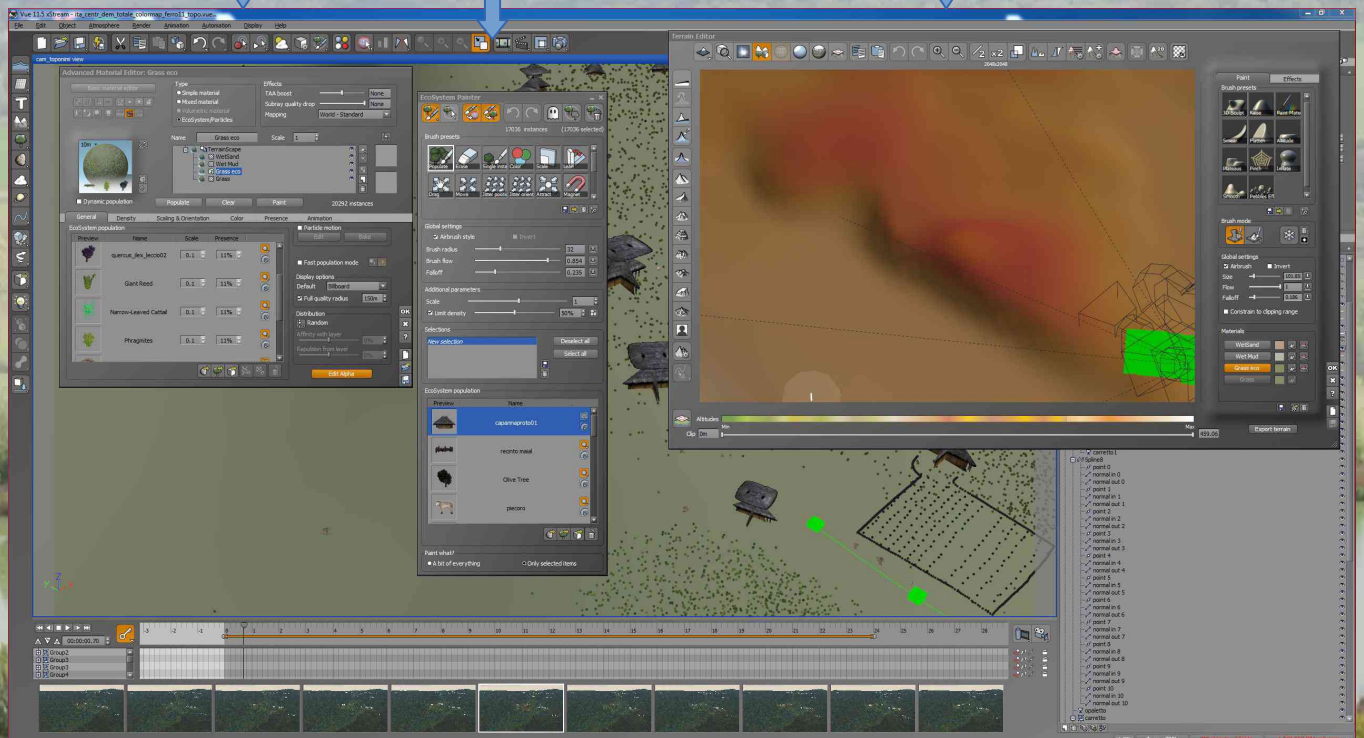
3D models of the plants are processed with the Vue Plant Editor

three fundamental tools to distribute materials and plants on the terrain

material editor

ecosystem painter

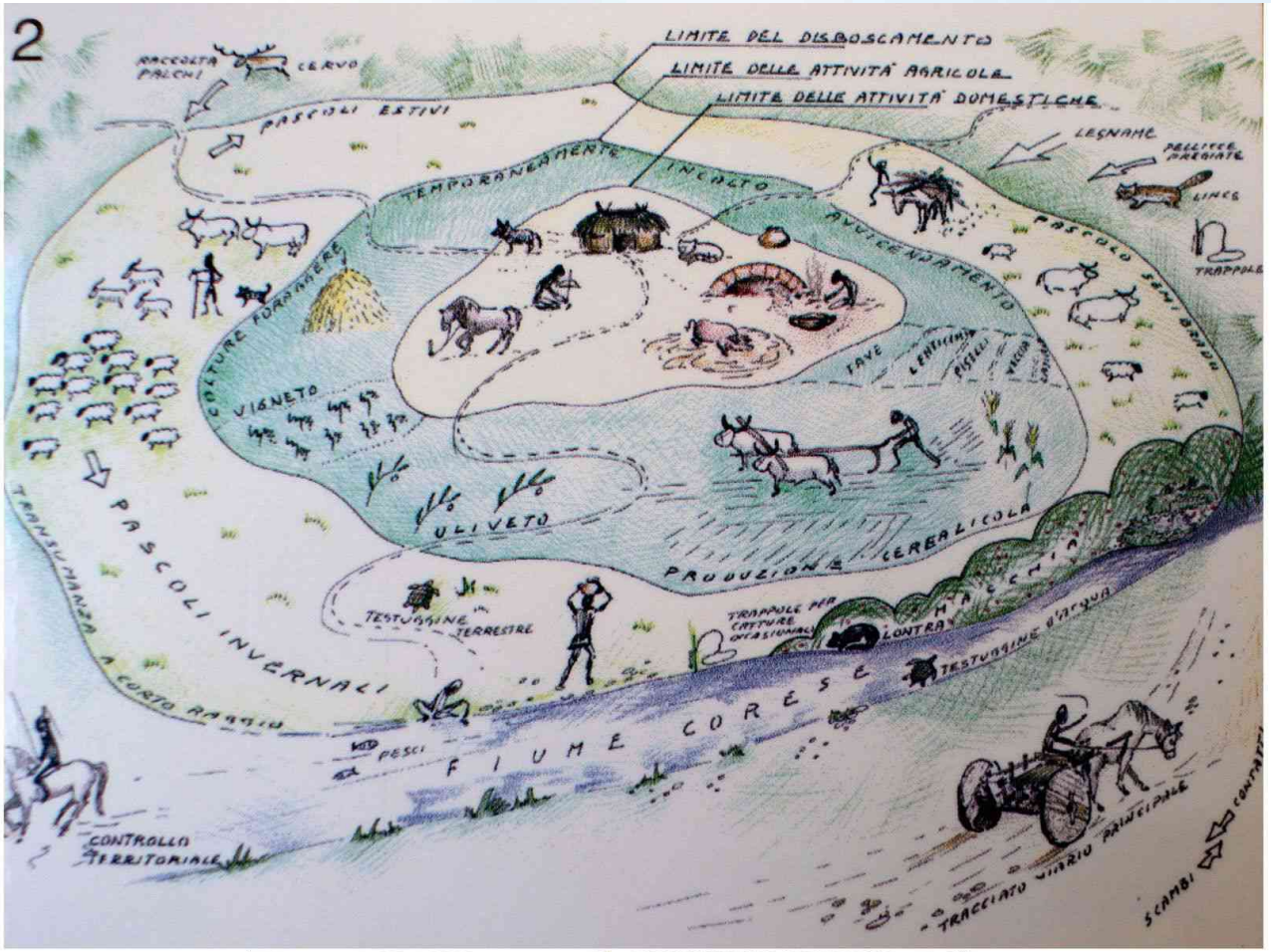
terrain editor



2 billions polygons!

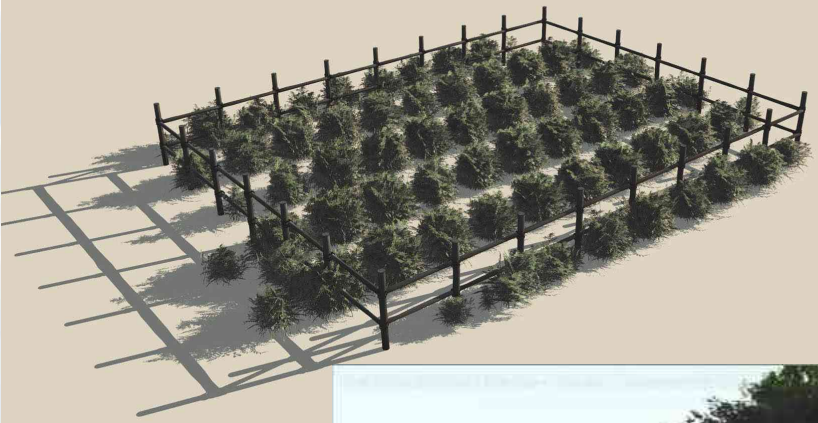
A typical village
of the late Iron age -
early orientalising period.

Initial sketches that guided
the 3d model



Virtual reconstruction of Eretum village in the 'VIII-VII sec. B.C. (Vue XTreme)

Z-Brush, 3D studi Max, Mudbox: Animals, humans,objects, then imported in Vue



Lentils plantations

Vine rearing

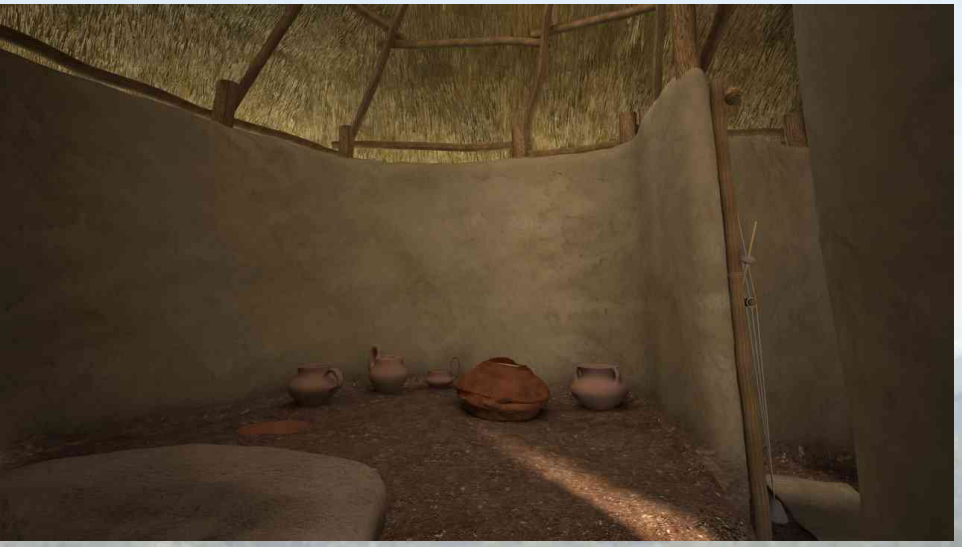
From the huts of the VIII century B.C....

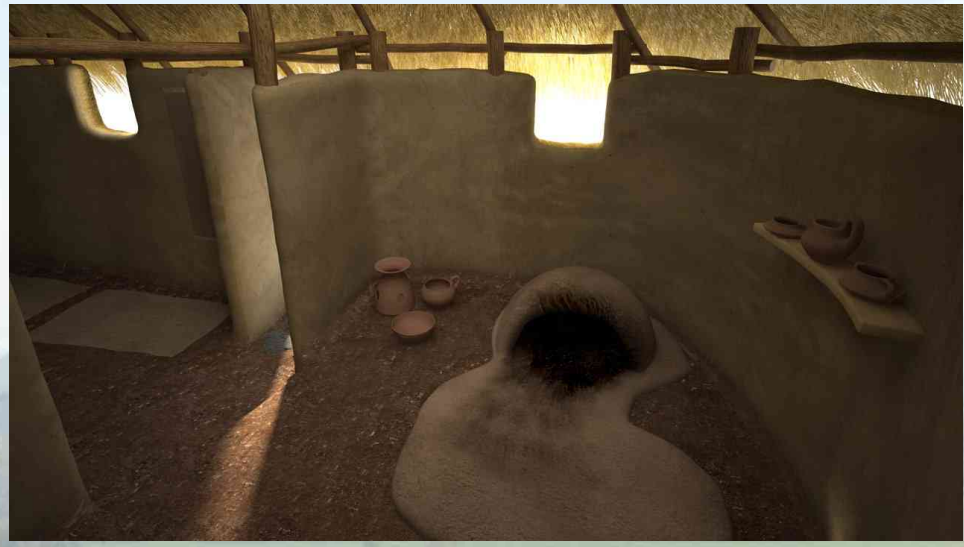
3d model of Cures Sabini hut
(3D Studio Max)

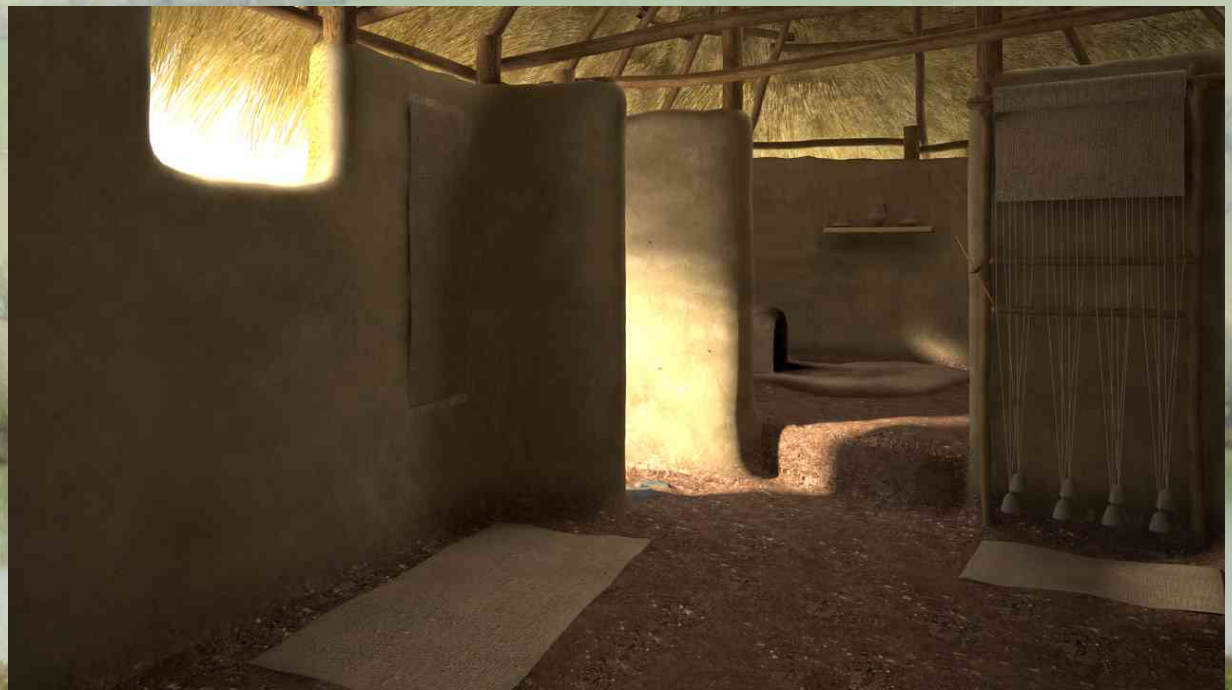
Thanks to STEP srl and
Massimiliano Forlani (E.V.O.CA.)

Sceintfic supervisor: P. Santoro
CNR ISMA

From the huts of the VIII century B.C....







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CNR ISMA

From the huts of the VIII century B.C....

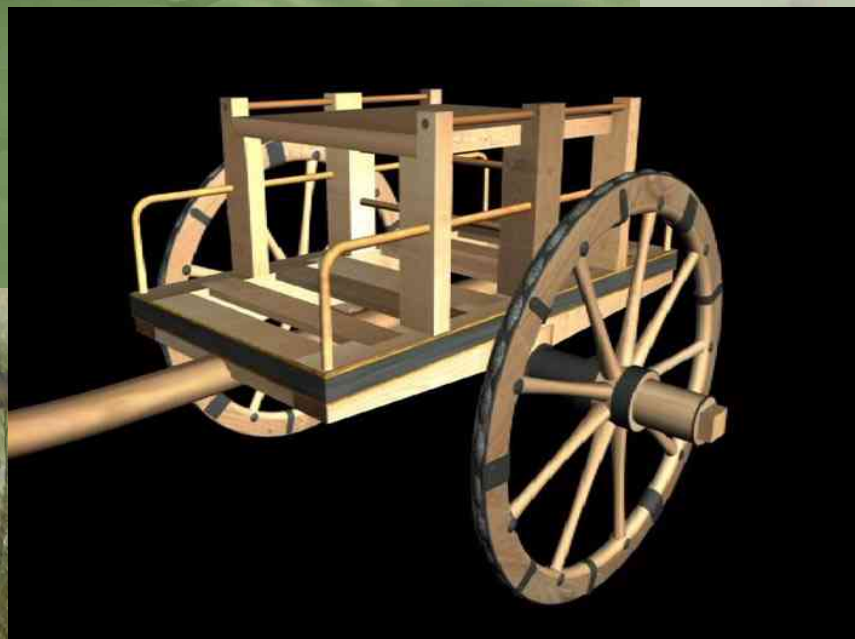
…….to the built houses of the orientalising period, VII century B.C.

We are going to leave now...
goodbye....
and thank you for the attention!

Eva.pietroni@itabc.cnr.it

Augusto.palombini@itabc.cnr.it

Boats sailing in the river (from little pottery models found in Fidaene)



Chariot
(from Eretum findings)