

Landscape Archaeology



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Overview of the activities

- Introduction and Concept of Landscape
- Methods, Methodologies and Technologies for Survey
- Paleoethnographic
- GIS in Archaeology
- Investigation of archaeological Landscape
- Historical Toponymy
- Reconstruction of Archaeological Landscape

- VR Lab IKDC LTH
- RAA map office
- Excursion (photogrammetry and photography for survey)

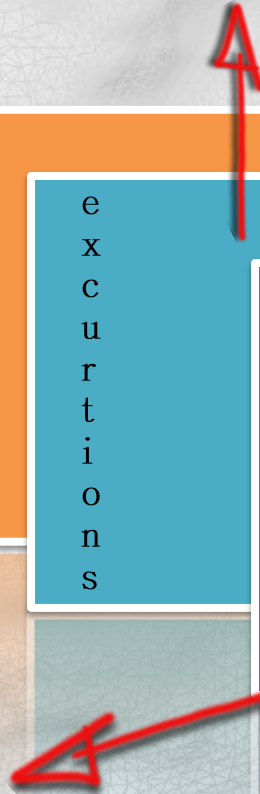
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- Introduction to ARCGIS
- introduction to ARC3D and basic use of MeshLab



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- Overview of how the investigation of Landscape has change in the last 15 years.
-What the possibilities today with the new technologies
- Overview of all most important technologies to use during the investigation process

-What is a GIS system?
-Why it is so important for the investigation of the landscape
-what the possibilities using a GIS ?

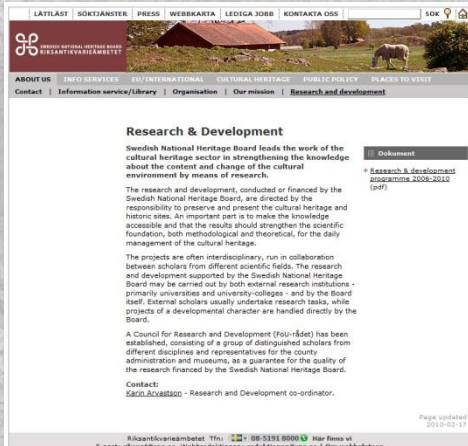
-We will analyze different case studies:
-Appia antica project
-Aksum project
-Flaminia project
-Tambo colorado project

-Virtual Reality and its potentialities
-Simulation systems in archaeology
-from the GIS to the VR
-instruments and tools

-VR Lab IKDC -LTH

-RAA map office

-Excursions (photogrammetry and photography for survey)



Cultural Heritage Board



City of Lund



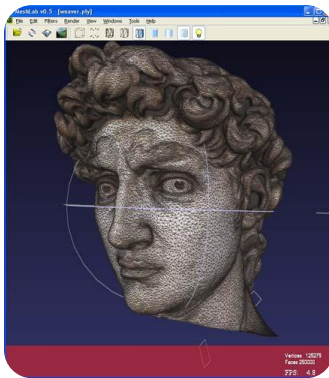
-Introduction to ARCGIS

-introduction to ARC3D and basic use of MeshLab

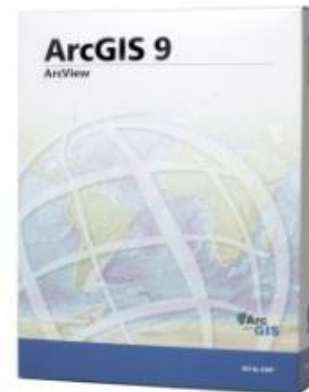
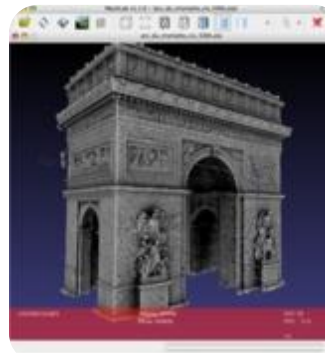
-Digital Camera



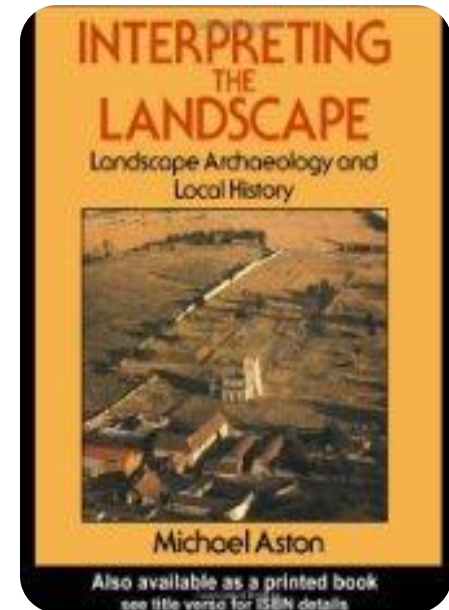
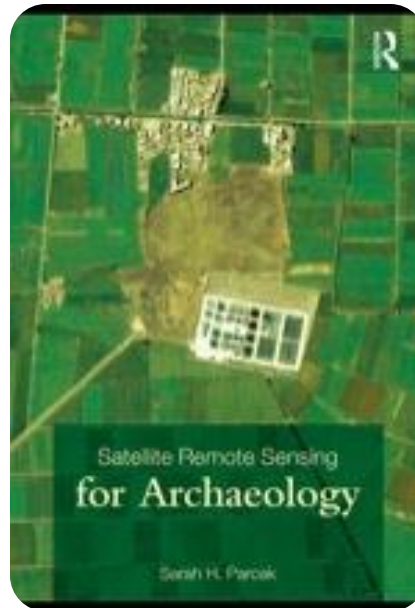
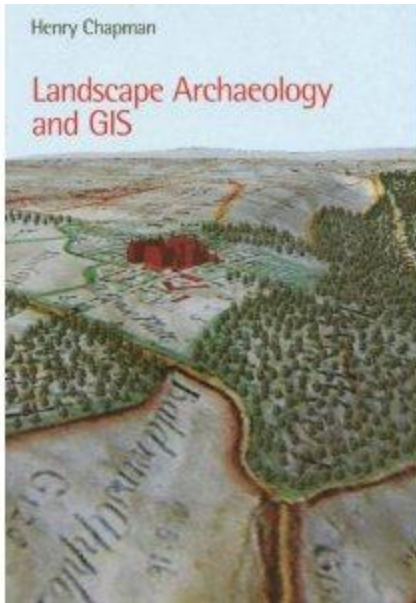
MeshLab



ARC 3D



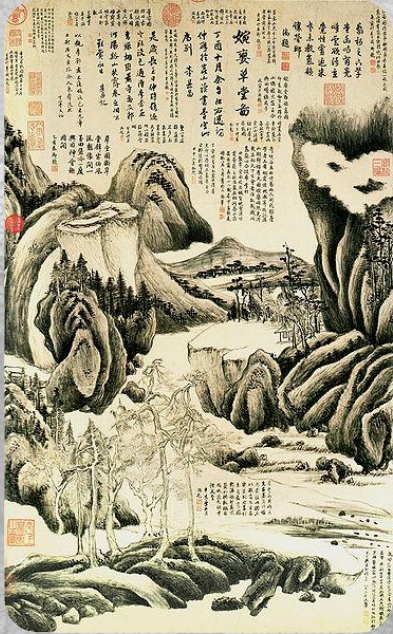
BOOKS and LITTERATURE



What does it mean landscape?

Can we classify the Landscape?

LANDSCAPE



Dong Qichang, Landscape 1597



Frescos Odyssey Landscape Rome 60-40 BC



Hand G, Bas-de-page of the Baptism of Christ, Turin-Milan Hours, Flanders c. 1425

Material...?
Subject...?
Information reported.....?



Cecilia Metella Landscape Rome Today

-What does it mean landscape?

LANDSCAPE

The word *landscape* is from the Dutch, *landschap* originally meaning a patch of cultivated ground.



What does it mean landscape?

Can we classify the Landscape?

LANDSCAPE



Dong Qichang, Landscape 1597



Frescos Odyssey Landscape Rome 60-40 BC

ANTHROPIC ELEMENTS



Hand G, Bas-de-page of the Baptism of Christ, Turin-Milan Hours, Flanders c. 1425

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Subject...?
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Cecilia Metella Landscape Rome Today

What does it mean landscape?

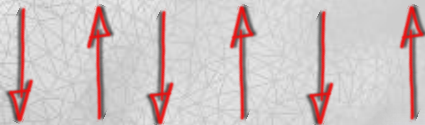
Landscape comprises the visible features of an area of land, including the physical elements of landforms, water bodies such as rivers, lakes and the sea, living elements of land cover including indigenous vegetation, human elements including land uses, buildings and structures, and transitory elements such as lighting and weather conditions. (wiki)

Can we classify the Landscape?

What does it mean landscape?

Landscape comprises the visible features of an area of land, including the physical elements of landforms, water bodies such as rivers, lakes and the sea, living elements of land cover including indigenous vegetation, human elements including land uses, buildings and structures, and transitory elements such as lighting and weather conditions.

Physical elements: water bodies, vegetation, natural resources



Human elements: land uses, buildings and structures

Can we classify the Landscape?



Cencelle, Italy.

What the literature suggests...

MINIMALISTIC:

[...] In minimalist terms, a landscape is a backdrop against which archaeological remains are plotted." [...]

ECONOMIC:

[...] Landscape provide resources, refuge and risk that both impel and impact on human actions and situations [...]

SOCIO-SYMBOLIC "sacred":

[...] Today, however, the most prominent notions of landscape emphasize its socio-symbolic dimensions: landscape is an entity that exist by virtue of its being perceived, experienced, and contextualized by people. [...]

What the literature suggests...

Traditionally, archaeology has incorporated attention to space and landscape
Particularly when talking of "settlement archaeology"

Today the Landscape is seen as an **ACTIVE** and more complex entity in relation to human lives

PASSIVE & ACTIVE
What does it mean?

But "space and Landscape" was considered has a **PASSIVE** backdrop

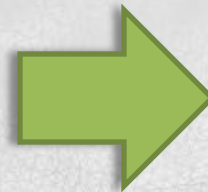
Why this change?

What the literature suggests...

[...] In part to expand their interpretative gaze beyond the isolable "Hot Spots" termed sites, in favour of a more comprehensive distribution of human traces in between loci [...]

(Cherry et al. 1991)

- THE SITE LESS ARCHAEOLOGY (Dunnell 1992)
- OFF SITE ARCHAEOLOGY (Foley 1981)
- DISTRIBUTIONAL ARCHAEOLOGY (Ebert 1992)



All this new trends went in favour of "diffuse Humans remains such as: field systems, farms, industrial sites , roads and no sedentary people

PROBLEM

These new approaches did not fit with the "traditional way to investigate sites"

What the literature suggests...

WHY?

Because taking a holistic landscape perspective compels us to stress the interrelationships among people and such traces, place and features, in space and throughout time .

What the literature suggests...

Several fields besides archaeology have grappled with landscape issues

- Geographers
- Historians
- Anthropologists
- Urban Planners
- Folklorists

Different aims

Different methods

Same topic

The American Geographer **Carl Sauer**(1925) first formulated the concept of a "cultural Landscape" as fashioned from the natural Landscape

What the literature suggests...

There are multiple different way of "knowing" the earth and the socially recognized places upon it

Three examples illustrate archaeological definitions for this common sense term:

Carole Crumley defines Landscape as [...] *the material manifestation of the relation between humans and the environment* [...]

John Barrett [...] *Landscape is thus the entire surface over which people moved and within which they congregated. That surface was given meaning as people acted upon the world with in the context of the various demands and obligations which acted upon them. Such actions took place with in a certain "tempo" and at certain "locales" . Thus landscape, its form constructed from natural and artificial features became a culturally meaningful resource through its routine occupancy.* [...]

Robert Johnston's [...] *there is no answer to what landscape is [;] it is very much a case of what it can be. Landscape is, in a broadest sense, contextual*

What the literature suggests...

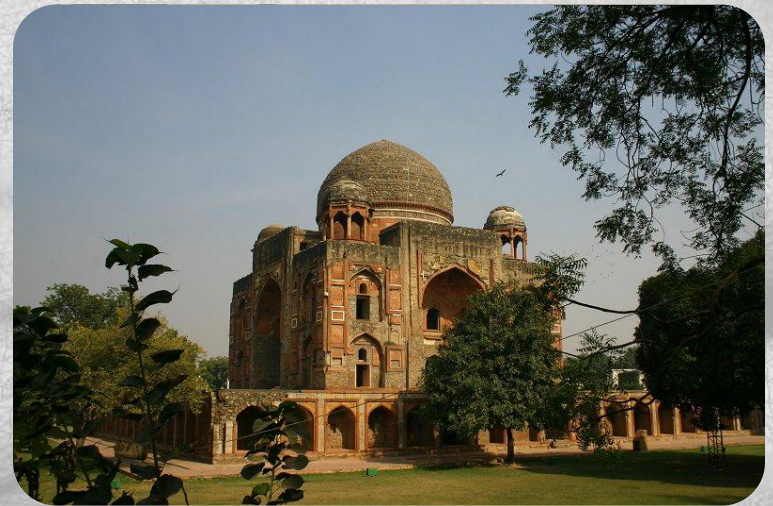
UNESCO

<http://www.unesco.org/>

<http://whc.unesco.org/en/culturallandscape>

Three criteria to define cultural Landscape:

-Clearly defined Landscapes were designed and created intentionally . These include gardens and parklands, often associated with religious or other monumental structures . ie. Versailles in France or the Garden tomb of Humayun (India)



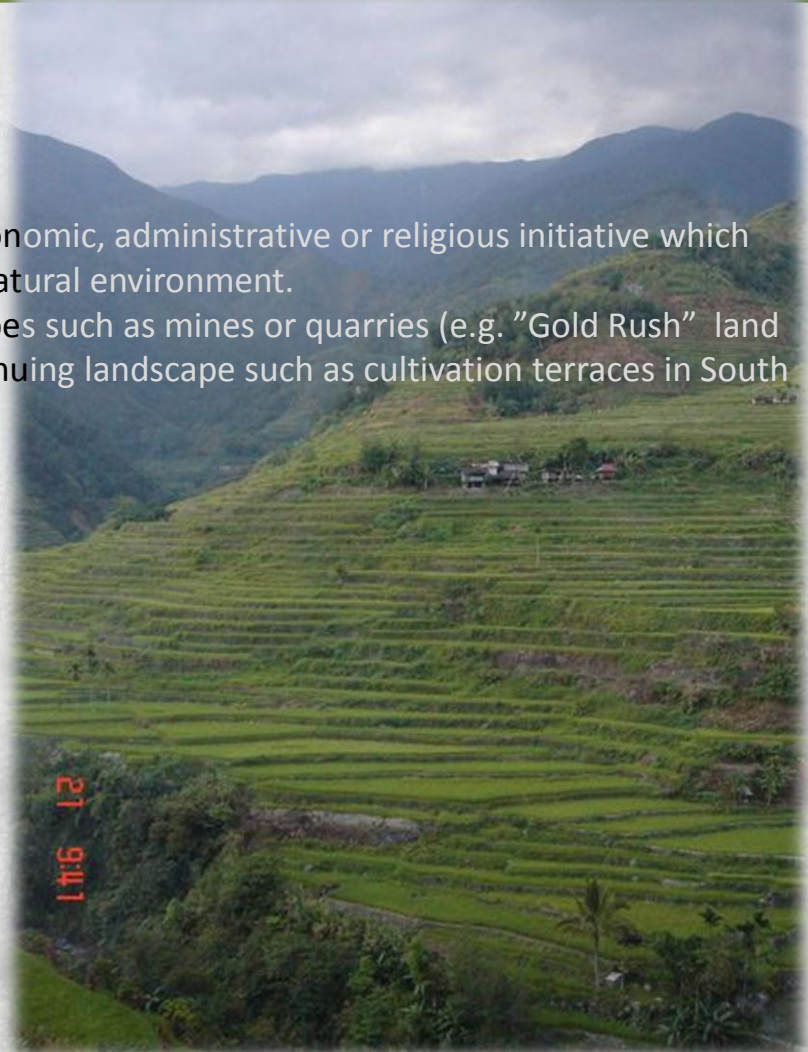
What the literature suggests...

UNESCO

Three criteria to define cultural landscape:

-“Organically evolved” landscape began as a particular socio economic, administrative or religious initiative which evolved subsequently in association with and response to the natural environment.

Sub –categories include relict (or fossil) archaeological landscapes such as mines or quarries (e.g. “Gold Rush” land of USA or Australia) or ancient agricultural complexes and continuing landscape such as cultivation terraces in South East Asia.



What the literature suggests...



Khoory Oman 2007



What the literature suggests...



Incense tree



Oman "Border with Yemen"

What the literature suggests...



Oman "Border with Yemen"

What the literature suggests...



Oman "Border with Yemen"

What the literature suggests...

UNESCO

Three criteria to define cultural Landscape:

“associative cultural” Landscape are identified by such features as sacred promontories, or “religious settlements in outstanding landscape.” ie. Mount Athos or Meteora



What the literature suggests...

The Landscape of Memory

Landscape is often regarded as the materialization of memory, fixing social and individual histories in space.

Research in cognitive science suggests that **human memory constructs rather than retrieves**.

The most frequently cited embodiment of memory in land is the intricately conceptualized landscape array of Aboriginal Australians



Appia Antica, Rome

Landscape as identity

People recognize, inscribe, and collectively maintain certain places or regions in ritual, symbolic, or ceremonial terms; these places create and express sociocultural identity.

Landscape provide a focus by which people engage with the world, and create and sustain a sense of their social identity.

Concepts and Definitions

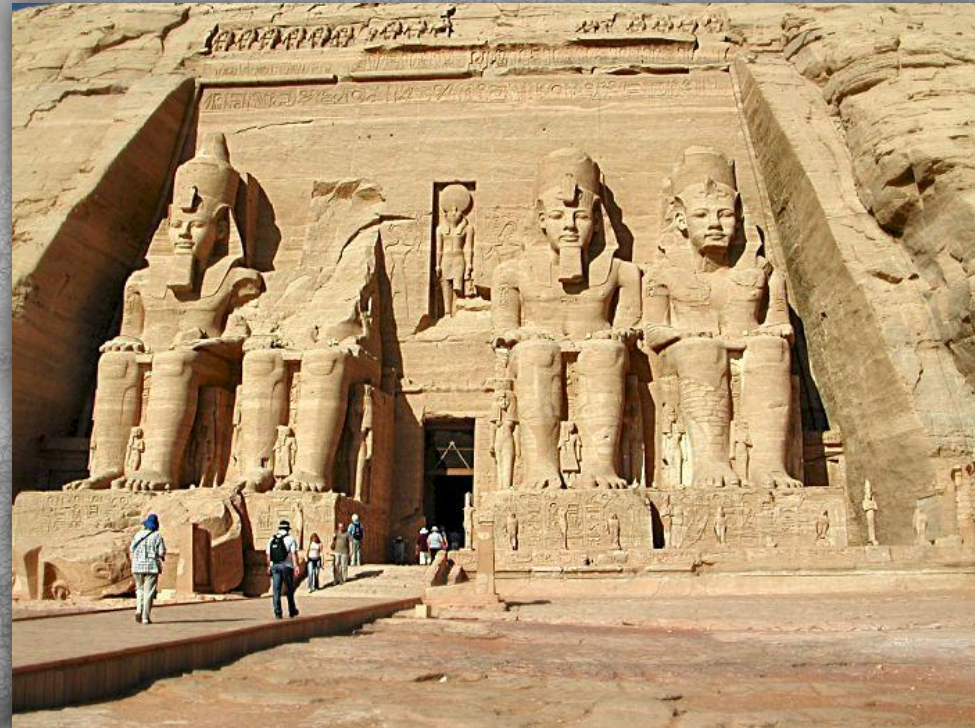
What the literature suggests...

The most obtrusive and formal marking, of course are architectural and depictive



Mount Rushmore

Temple of Abu Simbel



What the literature suggests...

Landscape of social transformation

-**The** landscape embody time at different scales as well.

Edward Casey notes that, phenomenologically, *"space and time come together in place"*

-**Since** landscape embody multiple time as well as multiple places, they thereby materialize not only continuity and sequence, but potentially change and transformation as well.

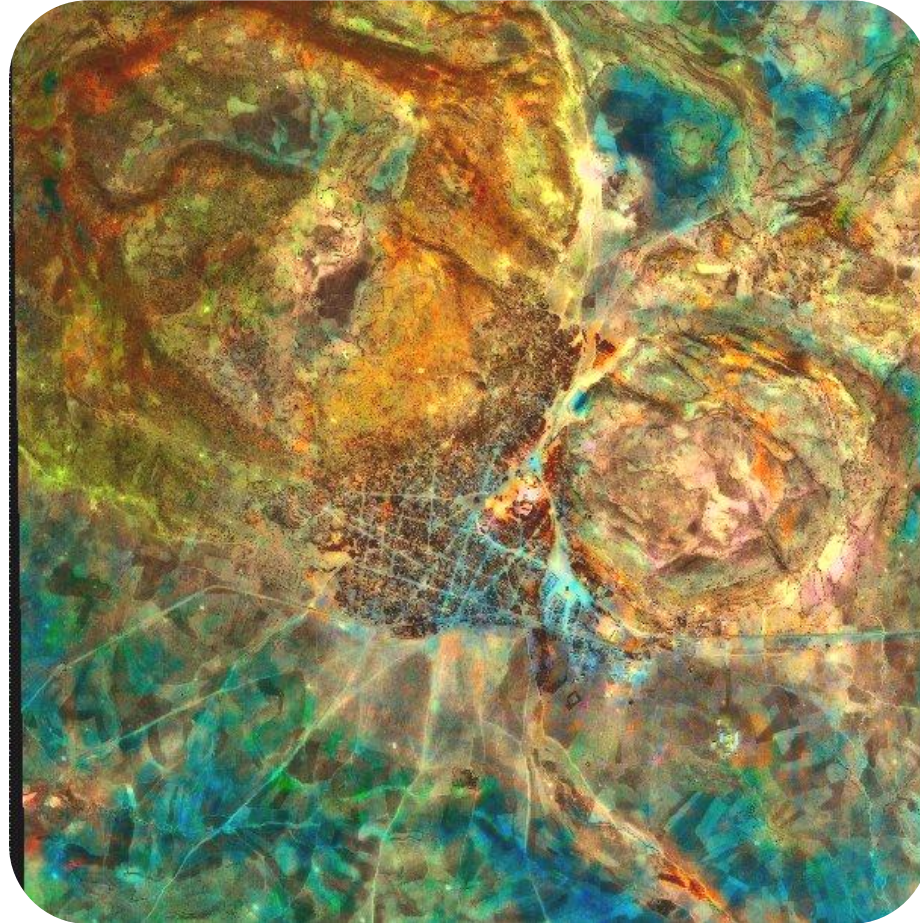
-**An** abandoned monument is still part of an active landscape

"Ancient sites, monuments and even entire landscape may be transformed and re-used as people encounter and interact with particular places, as they re-create the past ..." (Bender et al. 1997)



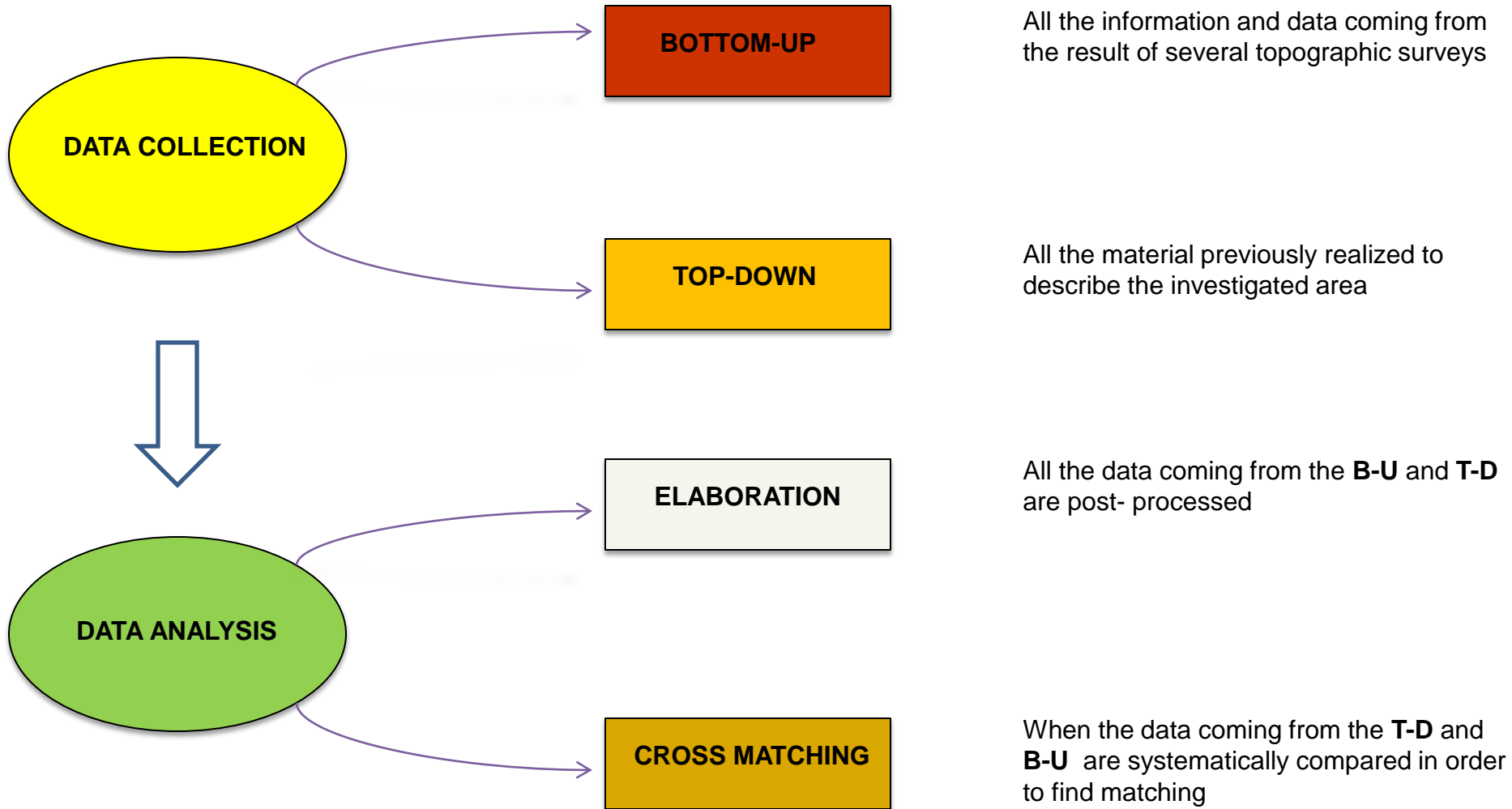
San Nicola in carcere, Rome

AKSUM - ETHIOPIA - 2000



Korzybski's "The map is not the territory"

Gregory Bateson, Steps to an Ecology of Mind 1972



"The *RE*-evolution of the last two decades"

PAST

TODAY

TOPOGRAPHIC SURVEY
 -Observation of the Landscape
 -Collection of material (soil samples etc.)
 -Notes for the integration of the maps

TOPOGRAPHIC SURVEY
 -Observation of the Landscape
 -Collection of material (soil samples etc. [geodetic position, etc.](#))
 -Notes for the integration of the maps **REAL TIME**
 -Prospective pictures

REMOTE SENSING
 -Aero photographic pictures (with distortion) grey scale (most of the times)

REMOTE SENSING
 -Aero photographic pictures (with distortion)
 -Multispectral Satellite Images
 -Images from Aerostatic Balloon
 -Images from Kite

TOPOGRAPHIC DOCUMENTATION
 Historical maps and administrative documentations

TOPOGRAPHIC DOCUMENTATION
 -Historical maps and administrative docs

POST PROCESSING
 Creation of new Maps
 Creation of predictive models (bi-dimensional/not interactive)

POST PROCESSING
 -Creation of Digital Elevation Models
 -Creation of predictive Models for the simulation and reconstruction of the ancient Landscape
 -Creation of thematic interactive maps (raster/vector)
 -Creation of Cultures



- GPS
- DGPS
- Photogrammetry
- Geo Informatics System
- Virtual Reality Techniques

The landscape is a process and the possibility to explore it is proportional to our capacity to built new information and new codes

TOPOGRAPHIC SURVEY

PAST

Field work

walking across the landscape recording features seen on the ground

- 1:10000 MAP of the area
- notebook
- plastik docketts of A4 size together with a board to write on
- compass
- ?camera?

Earth work

Provide very good information, particularly for the more recent periods.

- preparation on maps of all kinds
- study of names
- local geology
- Local history

Arable land and finds

Field work on ploughed land is more likely to produce scatters of finds, pottery especially

- consult local specialist from museums etc.
- systematic search (10 metre or so strips)
- bugged up properly identified everything

Round mounds

Most of them are not prehistoric burial mounds!



TOPOGRAPHIC SURVEY

TODAY

Field work

-1:10000 MAP of the area

No problem of scale

No problems of copyright

Multiple resolution Maps

GOOGLE MAP

-notebook

Digital one

Real time database

Digital Camera

-plastik dockets of A4 size together with a board to write on

GIS

notebook GIS

-compass

DGPS

GPS

NOTES: Usually are required multiple

surveys during different seasons of the same area

For every survey a kind of equipment



TOPOGRAPHIC SURVEY

TODAY

Earth work

Provide very good information, particularly for the more recent periods.

-preparation on maps of all kinds

Internet-intranet systems

New digital archives of digital maps

-study of names

-local geology

Local history



Arable land and finds

Field work on ploughed land is more likely to produce scatters of finds, pottery especially

-consult local specialist from museums etc.

More easy to find books and reports using internet

-systematic search (10 metre or so strips)

DGPS

-bugged up properly identified everything

PAST

REMOTE SENSING

[...] in its most basic definition, has existed in archaeology for as long as practicing archaeologists have lived as it can be defined as a means to observe the surrounding landscape [...] Sarah Parcak 2009

Aerial Photographs

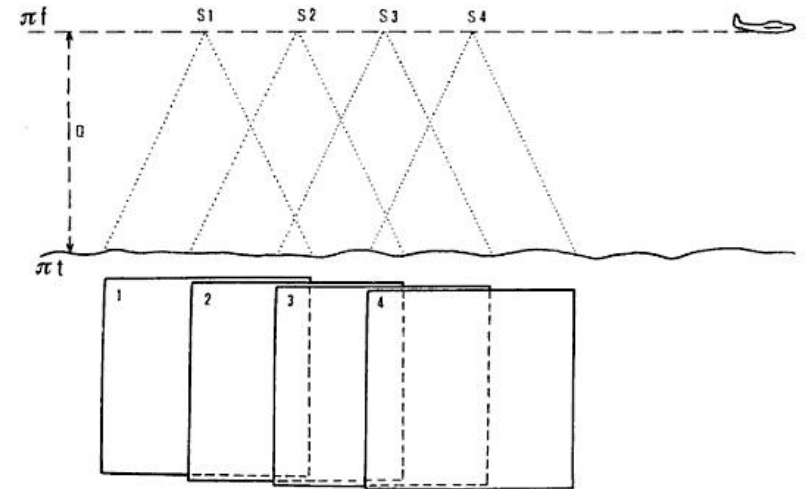
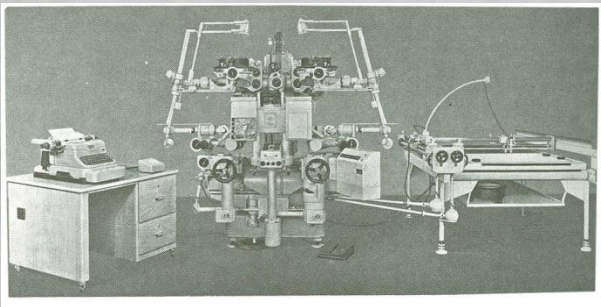
Vertical pictures

-provide photographic map- but with considerable distortion-



Oblique pictures

-Shows sites in great detail "bird eyes view"

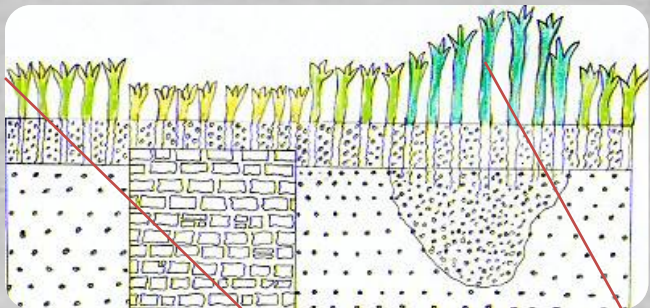


Notes: this kind of source is today still very important

Because is able to show the landscape before the coming of the satellite images

Today it is possible to find this images online

POST PROCESSING



Vegetation it is strongly influenced from the seasons



REMOTE SENSING

TODAY

-Aerial Photographs

-Images from Aerostatic Balloon

- Possibility to have a smaller and more detail map of the area
- allow stereo image processing
- quite cheap instrument, easy to postprocess
- possible image rectification

-Images from Kite

- Possibility to have a smaller and more detail map of the area
- VERY cheap instrument, easy to elaborate difficult to manage
- possible image rectification

-Satellite Images

- Image acquired from Satellites
- different prices
- most of them have already been rectify
- A satellite image contain a higher number of information



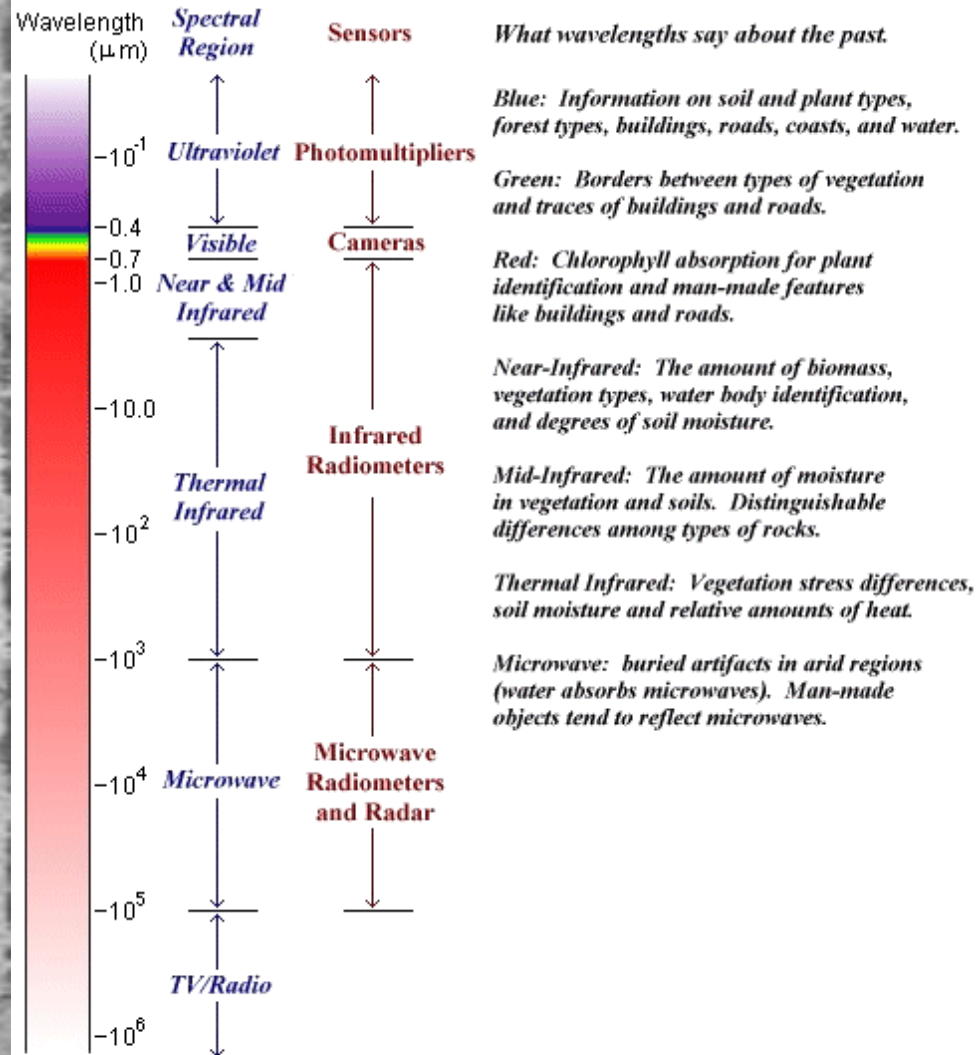
REMOTE SENSING

TODAY

Satellite Images



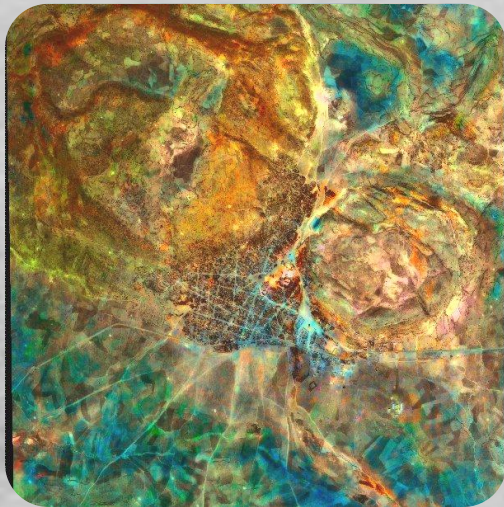
SPOT- SATELLITE



REMOTE SENSING

TODAY

Satellite Images



Satellite image	Cost	Spatial resolution	Spectral resolution
Google Earth™	Free-US\$400	10cm-30 m	Visual
World Wind	Free	10 cm-30 m	Visual-pseudocolor
Corona/KH7/KH/9	\$30	1-120 m	Visual
KVR-1000	US\$1000-4000	2-3 m	0.49-0.59 μm
Landsat	Free-US\$600	15-60 m	Visible (0.45-0.69 μm) IR (0.76-0.90 μm) Middle (1.55-1.75 μm) Thermal (10.4-12.5 μm) Mid-IR (2.08-2.35 μm)
SPOT	US\$1200-11,750	0.8-20 m	Visible (0.43-0.47 μm; 0.50-0.59 μm; 0.61-0.68 μm) Near infrared (0.79-0.89 μm) Mid-infrared (1.58-1.75 μm)
ASTER	Free-US\$80	15-90 m	VNIR (0.520-0.600 μm; 0.630-0.690 μm; 0.760-0.860 μm; 1.600-1.700 μm) SWIR (2.14-2.225 μm; 2.360-2.430 μm) TIR (8.125-8.825 μm; 8.925-9.275 μm; 10/120-11.650 μm)
SRTM	Free	0.3-90 m	N/A
Quickbird	US\$10-28 per km ²	0.6-2.4 m	Panchromatic (0.526-0.929 μm) Blue (0.445-0.516 μm) Green (0.506-0.595 μm) Red (0.632-0.698 μm) Near IR (0.757-0.853 μm)
IKONOS	US\$7.70-13.20 km	1-3.2 m	Panchromatic (0.526-0.929 μm) Blue (0.445-0.516 μm) Green (0.506-0.595 μm) Red (0.632-0.608 μm) Near IR (0.757-0.853 μm)
SIR-A/B/C/X-SAR	US\$40-50	15-45 m	HH, VV, L-Band, X-Band, C-Band

Note: IR = infrared, VNIR = Visible Near Infrared, SWIR = Shortwave Infrared, TIR = Thermal Infrared.

REMOTE SENSING

TODAY

Satellite Images

Georeferencing

Band combinations

Normalized Difference Vegetation Index

Land Use Land Cover Changes

DEM techniques

Filtering

Most of satellite images once downloaded from internet are already georeferenced or mapped to a specific projection system.

Every multispectral image types has various numbers of bands and each band will show a different range of the electro magnetic spectrum. i.e. ASTER images has 15 bands, SPOT has 4 bands etc. Not more than 3 bands can be viewed at once on any satellite images. i.e. Landsat satellite image (21 bands) can have 343 (7X7X7) possible combinations.

Is a method for measuring vegetation vigor in satellite imagery. This analytical technique compare the IR and the reds bands from multispectral satellite imagery. Buried walls or decomposing organic matter may retain higher amounts of moisture and increase vegetation density in these areas.

This technique can show how much landscape have changed over time or how much of an archaeological site remain after destruction from natural or anthropomorphic factors

Is used to highlight differences in tonal image variations, and has many applications for archaeological contexts. Edge detection is generally the most useful filter the archaeologists can apply in their work.

REMOTE SENSING

TODAY

Satellite Images

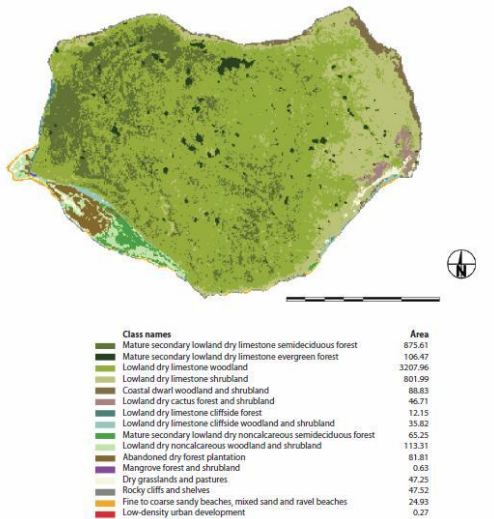
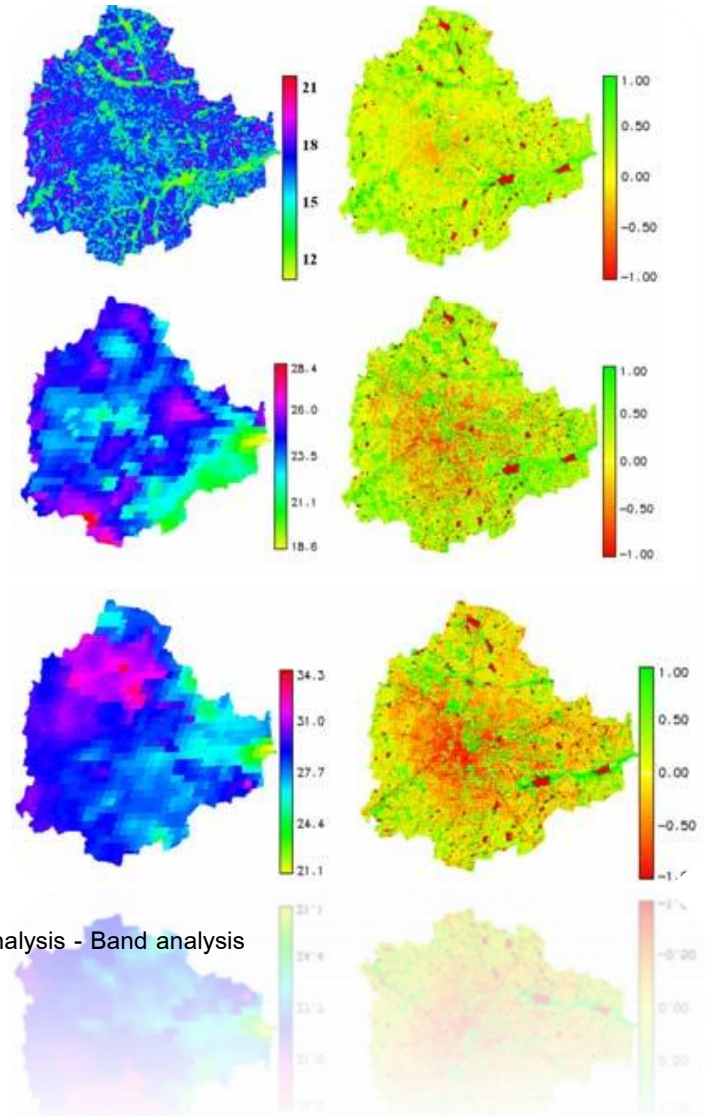
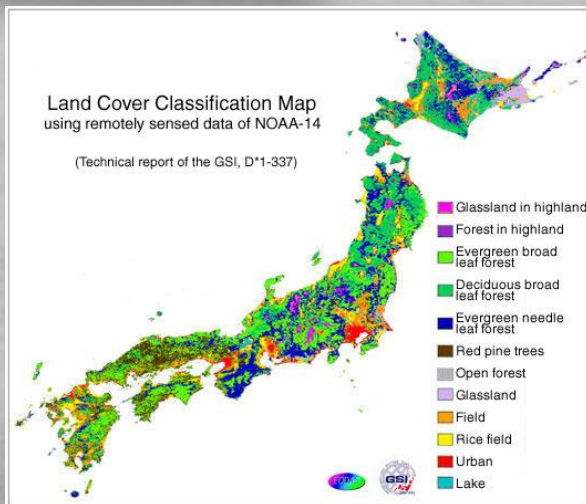
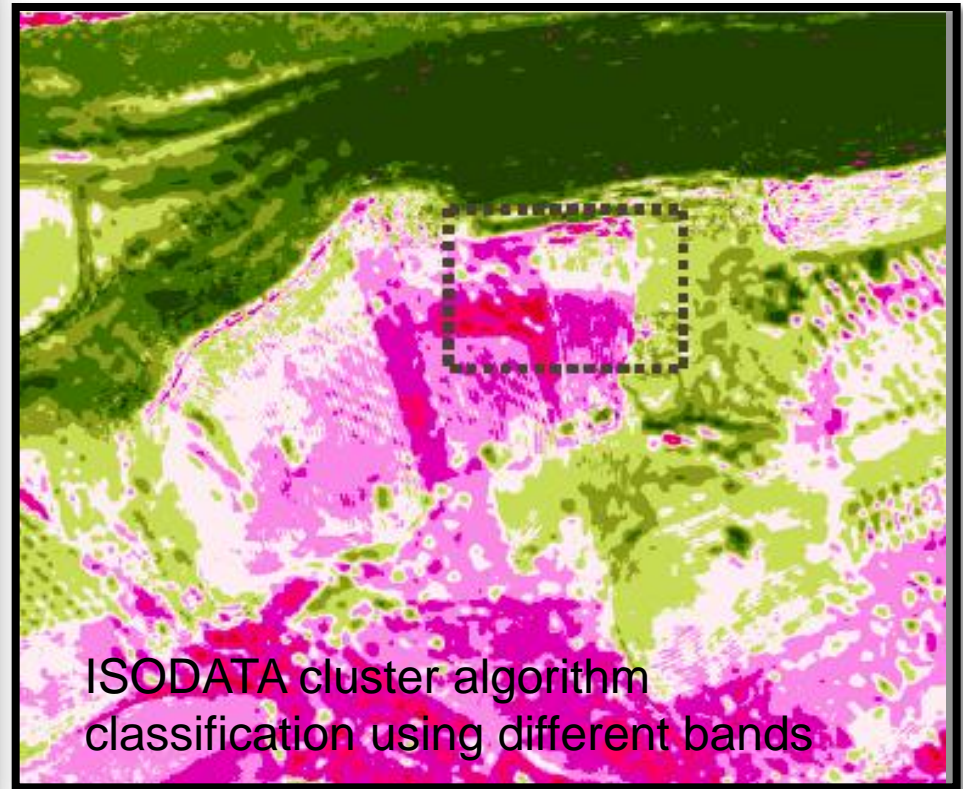
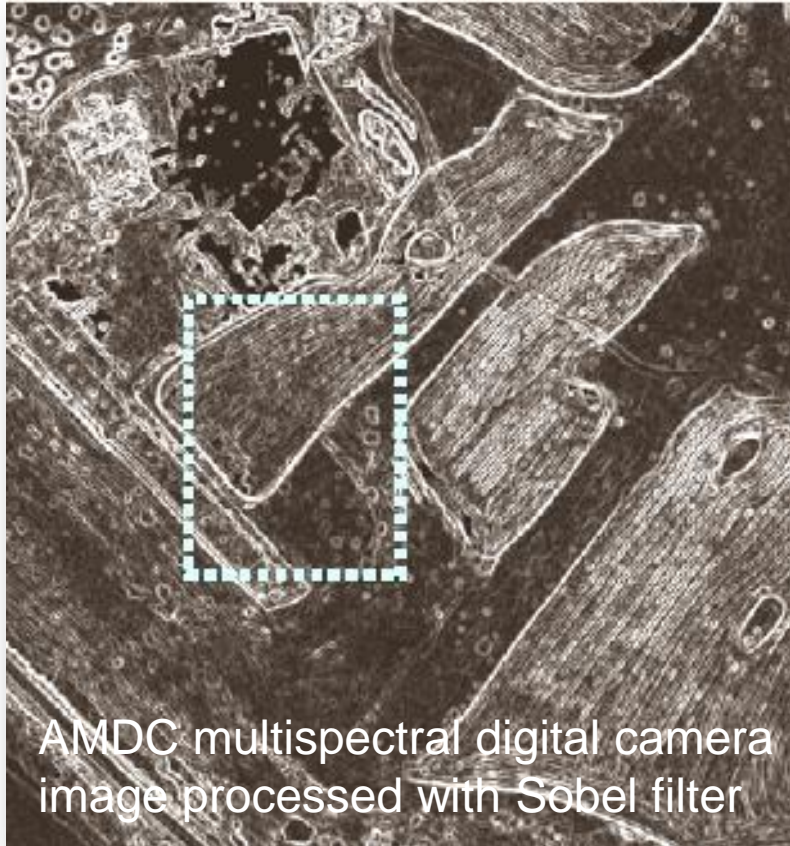


Fig. 4. Final land cover map of Mona Island, including the extent in ha for each class.

NDVI analysis

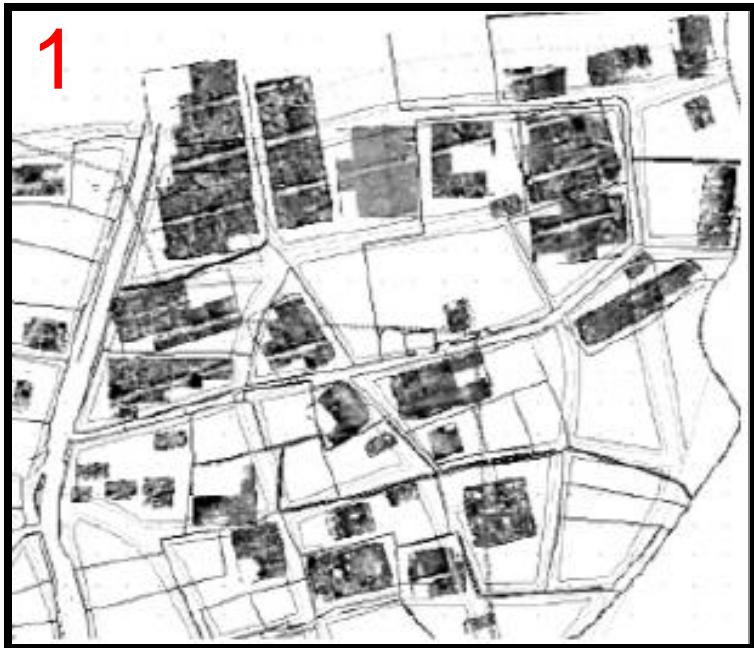




Farjas, Mercedes *, Rejas , J.G.** , Gómez , J. A.** , De Miguel, Eduardo ** , Fernández-Renau, Álix **
* *E. U. I. T. Topográfica, Universidad Politécnica de Madrid (UPM), Spain*
** *Laboratorio Central de Teledetección, Instituto Nacional de Técnica Aeroespacial*

- vertical magnetic gradient
- soil resistance mapping techniques

Results of vertical magnetic gradient survey



Layout and codification of the geophysical grids, as seen through their overlay on the aerial image of the site

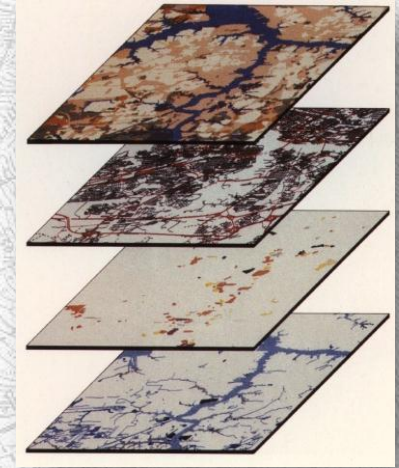
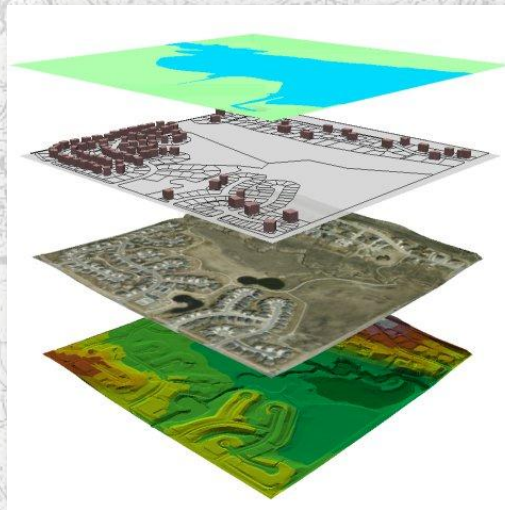
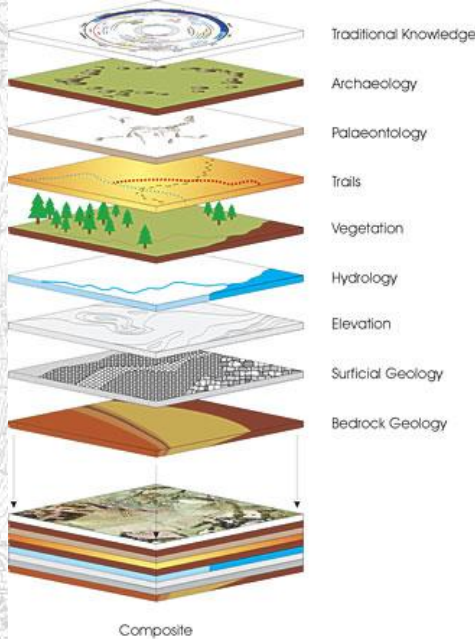


Aerial photos and geophysical survey maps were integrated in a single geodetic reference system and into a GIS (site management for modern urban development).

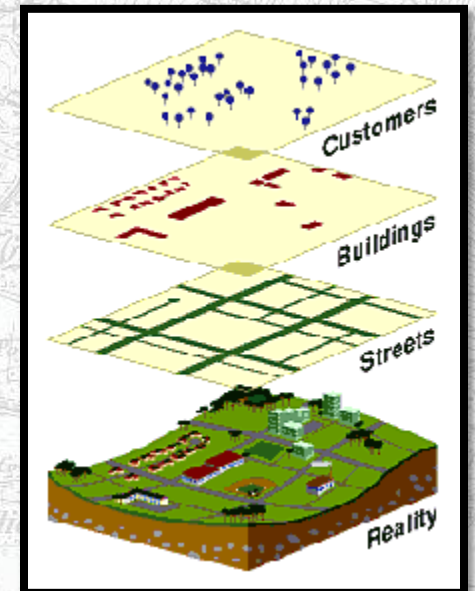


GIS in Archaeology

[...]GIS can be interpreted in a number of different ways though, fundamentally, the name GIS describes a range of softwares packages displaing the common abilities to store, manage, manipulate, analyse and display spatially referenced information[...] (H. Chapman, 2009)

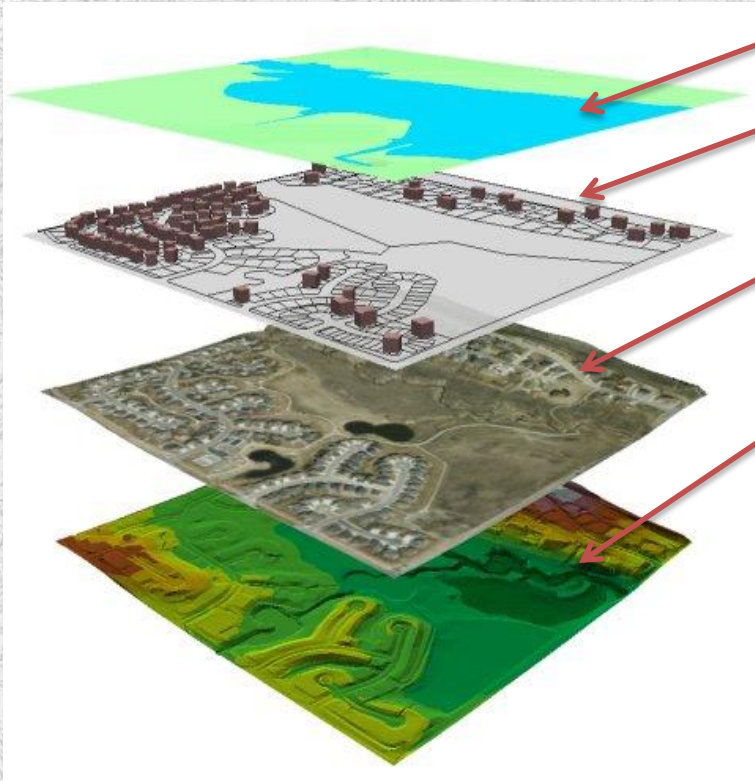


[...]A GIS is a sophisticated database management system designed for the acquisition, manipulation, visualization, management and display of spacially referenced (or geographic) data [...]
(Aldenderfer 1996)



GIS in Archaeology

[...]A GIS is a sophisticated database management system designed for the acquisition, manipulation, visualization, management and display of spatially referenced (or geographic) data [...]
(Aldenderfer 1996)



Multiband image

Shape file - vector image

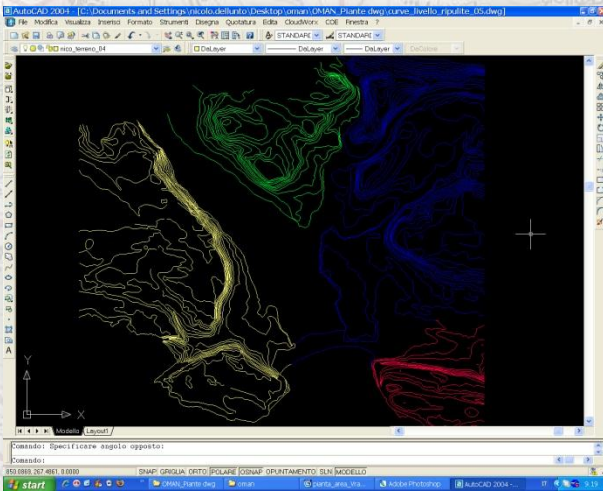
Satellite image

DEM (digital elevation model)

1-These data are **bi-dimensional** and **tridimensional**

2-The layers are all georeferenced in the same projection system

GIS in Archaeology



CAD elevation model Oman 2007

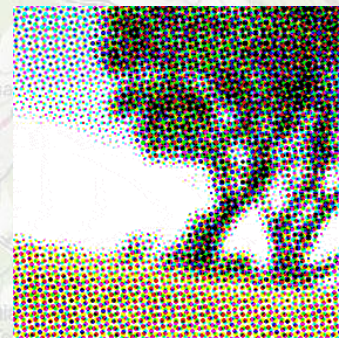
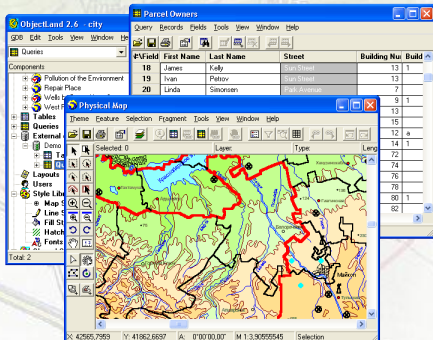
VECTOR RASTER



Orthomosaic Cencelle 2003

Vector graphics is the use of geometrical primitives such as points, lines, curves, and shapes or polygon(s), which are all based on mathematical equations, to represent images in computer graphics.

raster graphics is a data structure representing a generally rectangular grid of pixels, or points of color, viewable via a monitor, paper, or other display medium. Raster images are stored in image files with varying formats



GIS in Archaeology

VECTOR

Vector data come from the "manual" or "automatic" digitalization –using CAD Systems- of the cartography or excavation maps,
Or through the use of instruments for the geometrical documentation.

- CAD
- GPS data
- Total Station

The good advantage of this kinds of data is the possibility to scale all the maps without losing detail or resolution

RASTER

Raster is a regular grid, where for every cell (pixel) it is recorded a color information (0;255)

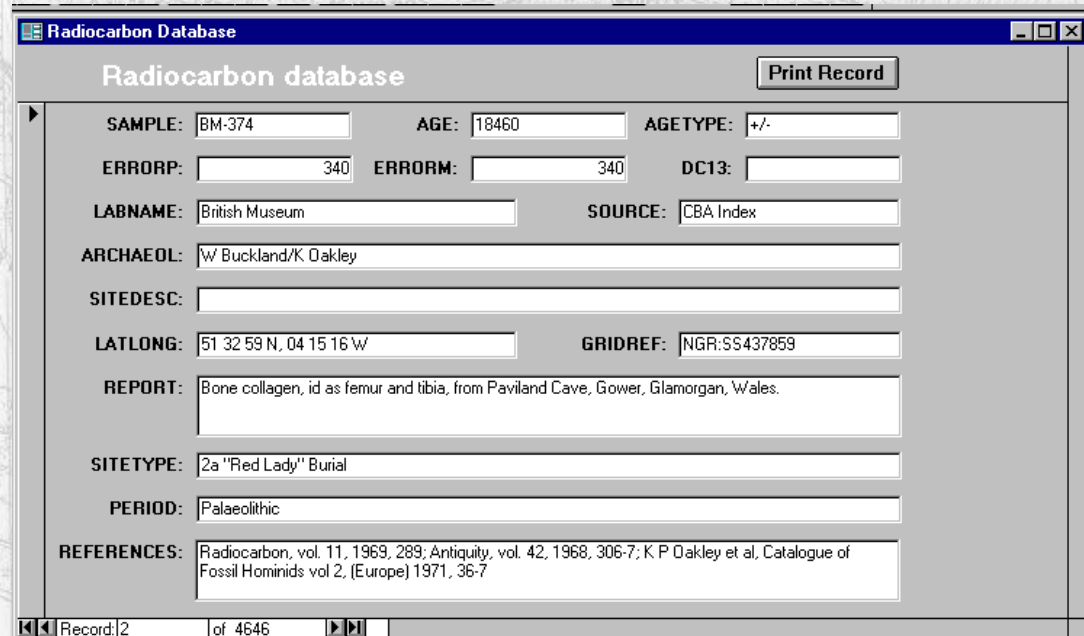
The raster data are usually represented by the following class:

- aerophotos
- orthomosaics
- satellite images
- photomosaics
- Cartography
- DEM (every cell represent an elevation point)

GIS in Archaeology

A **database** consists of an organized collection of data for one or more uses, typically in digital form.

A **database management system** (DBMS) consists of software that operates databases, providing storage, access, security, backup and other facilities. Database management systems can be categorized according to the data base model that they support, such as relational or XML



The screenshot shows a window titled "Radiocarbon Database" with a "Print Record" button. The record details are as follows:

SAMPLE:	BM-374	AGE:	18460	AGETYPE:	+/-
ERRORP:	340	ERRORM:	340	DC13:	
LABNAME:	British Museum	SOURCE:	CBA Index		
ARCHAEOLOGIST:	W Buckland/K Oakley				
SITEDESC:					
LATLONG:	51 32 59 N, 04 15 16 W		GRIDREF:	NGR:SS437859	
REPORT:	Bone collagen, id as femur and tibia, from Paviland Cave, Gower, Glamorgan, Wales.				
SITETYPE:	2a "Red Lady" Burial				
PERIOD:	Palaeolithic				
REFERENCES:	Radiocarbon, vol. 11, 1969, 289; Antiquity, vol. 42, 1968, 306-7; K P Oakley et al, Catalogue of Fossil Hominids vol 2, (Europe) 1971, 36-7				

At the bottom of the window, it shows "Record: 2 of 4646" with navigation arrows.

GIS in Archaeology

WHAT CAN I DO WITH MY GIS?

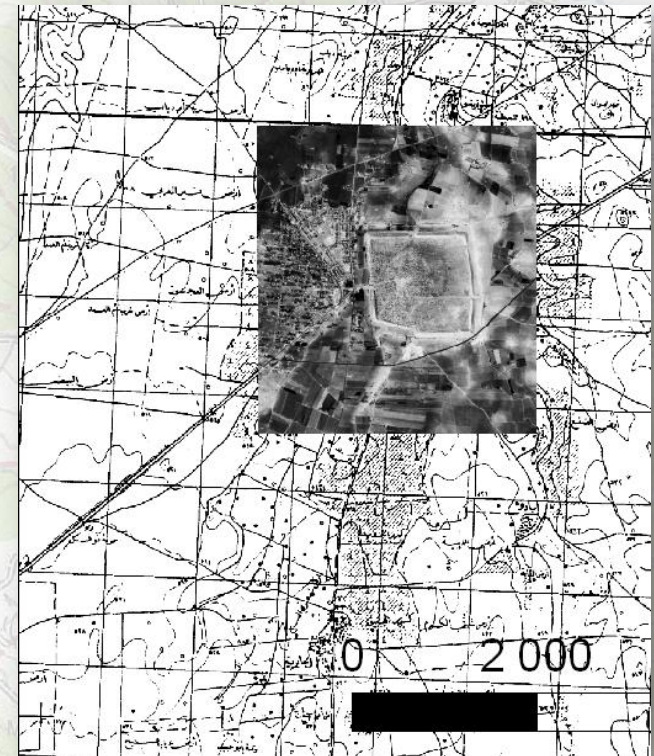
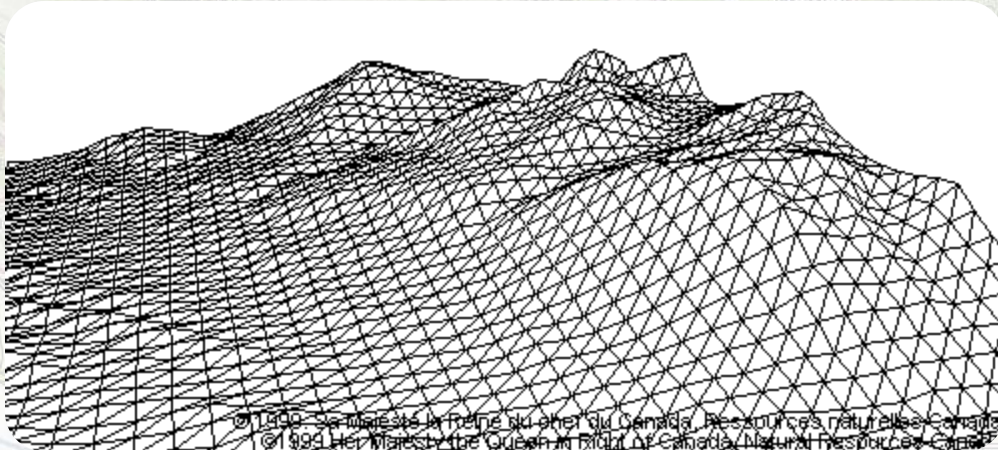
Query: Possibility to interrogate the system through connection database –raster/vector data

Overlap and Visualization: Overlap in transparency all the geo-referenced spatial data

Spatial Analysis: elaboration of all the geo-referenced data

Statistic analysis: visualization of the interpolation between database and elaborated maps

3D: Creation of DEM or DTM (Digital Elevation Models)



GIS in Archaeology

WHAT CAN I DO WITH MY GIS?

Digital Elevation Model:

is a digital representation of ground surface topography or terrain. It is also widely known as a digital terrain model (DTM). A DEM can be represented as a raster (a grid of squares, also known as a heightmap when representing elevation) or as a triangular irregular network

Interpolation systems:

Inverse Distance Weighting (IDW)

Regular distribution of points

Kriging

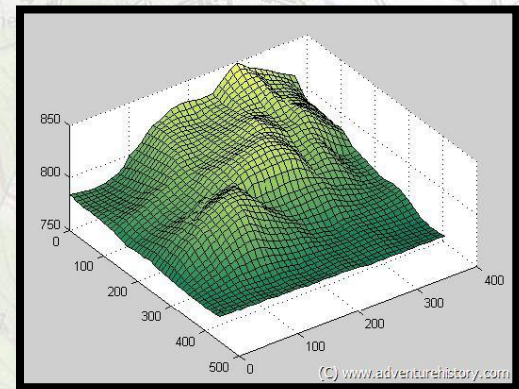
this interpolation method is able to create a DEM starting from data with random disposition

TIN

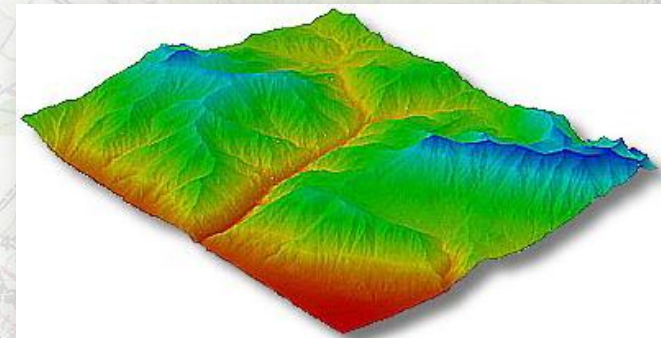
A TIN is a vector based representation of the physical land surface or sea bottom, made up of irregularly distributed nodes and lines with three dimensional coordinates (x,y, and z) that are arranged in a network of nonoverlapping triangles

GRID

It is a regular grid of z values organized lines and colomnus , where for every grid interpolation point a z value is recorded



GRID



TIN

GIS in Archaeology

WHAT CAN I DO WITH MY GIS?

ArcGIS 9

Choose from the following installation options:

[Install ArcGIS Desktop](#)

[Administrative Install of ArcGIS for Network Distribution \(Advanced\)](#)

[Install ArcGIS License Manager](#)

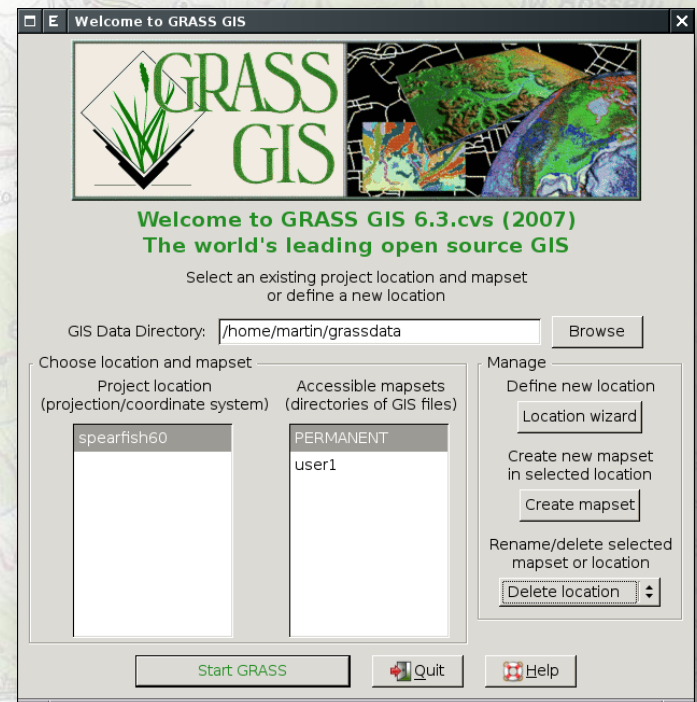
The ArcGIS Documentation is on the
ESRI Software Documentation Library CD.

Help

Exit



GIS by ESRI®

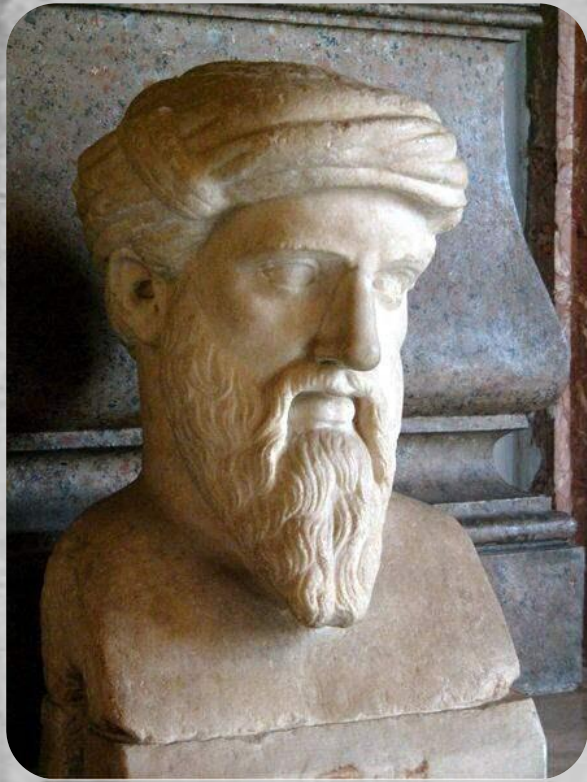


“What versions of ArcGIS are possible to use together with Intras Analysis 1.1?”

You can use either 9.2 or 9.3 of ArcGIS. If you upgrade from ArcGIS 9.2 to 9.3 please uninstall (by Add or Remove programs) both ArcGIS Desktop and ArcGIS Engine Runtime 9.2 before installing ArcGIS 9.3.”

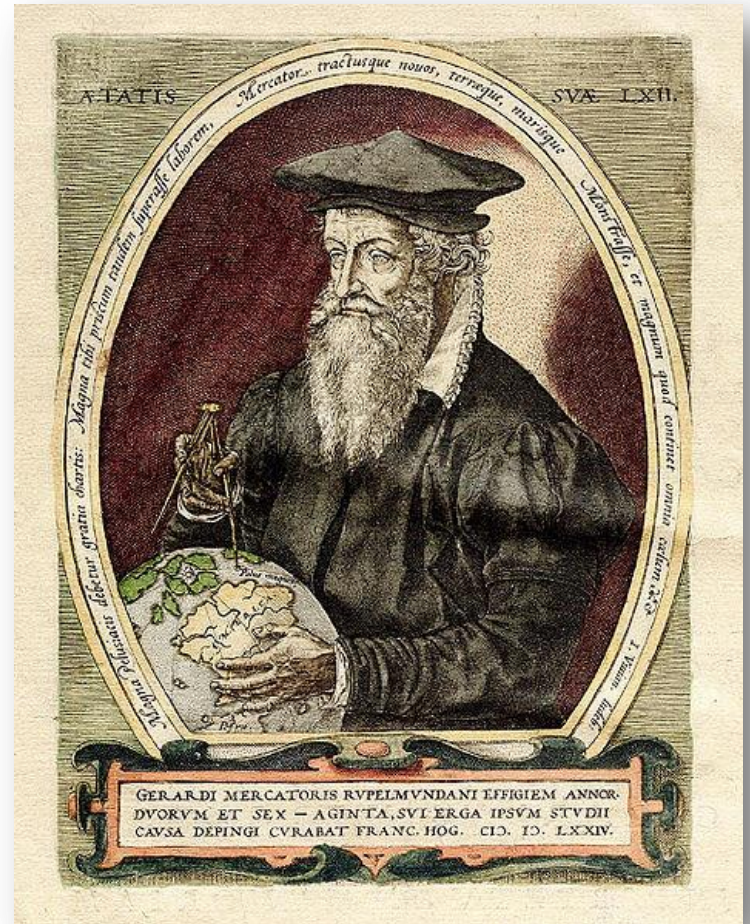


Projections and national grids -Georeferencing-

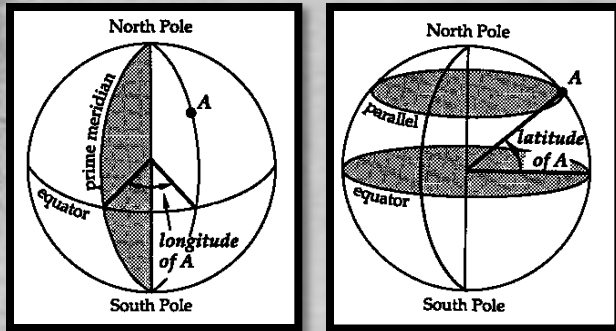


Pythagoras 580-495

Gerardus Mercator 1512-1594



Projections and national grids -Georeferencing-

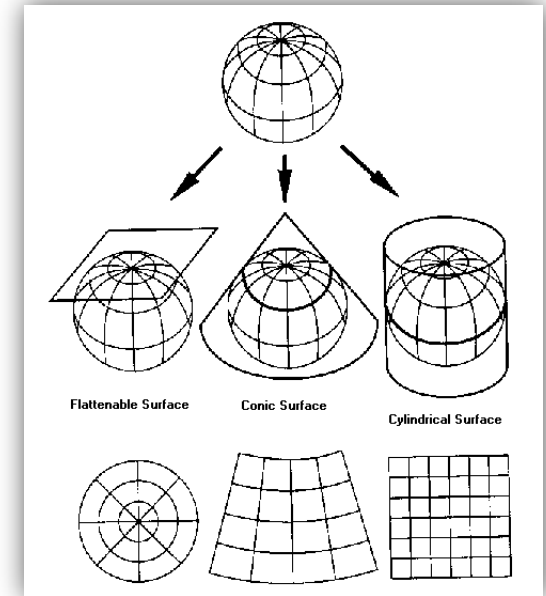


Latitude and Longitude Coordinates

In order to describe positions on a sphere we use the Latitude, Longitude coordinate system.

Latitude is the angular distance of a point away from the equator measured from the center of the globe 90 degrees North (0 to +90) or South (0 to -90) .

Longitude is the angular distance of a point from the Principal Meridian measured from the center of the globe 180 degrees East (0 to +180) or West (0 to -180). The Principal Meridian is also referred to as the Prime Meridian or Greenwich Meridian.



Map Projections

Map projections are a **representations of a sphere** (the Earth) in two dimensions. A **mathematical transformation** is required in order to convert Latitude & Longitude coordinates into **Cartesian Coordinates** on a two dimensional surface. This transformation results in **distortions** of the original three dimensional surface in two dimensional maps.

Projections and national grids -Georeferencing-

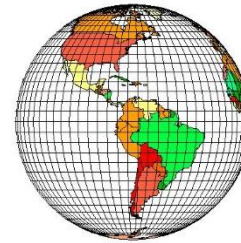
TODAY

1 **Orthographic Projection (Equatorial)**: Preserves the appearance of a globe and shows only half the Earth at a time. Distorts shape and direction and is useful for *illustrations*.

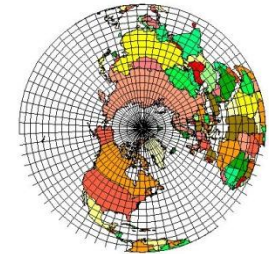
2 **Planar (Azimuthal) Projection (Lambert Equal Area Azimuthal Projection)**: Used to represent the projection of a region (northern hemisphere) onto a plane tangent to the globe, in this example, the north pole is used.

3 **Conic Projection (Lambert Conformal Conic)**: Made by fitting a cone over part of the globe. The projection *depicts mid-latitudes* shapes and areas well. It is used to depict large regions up to the size of the USA.

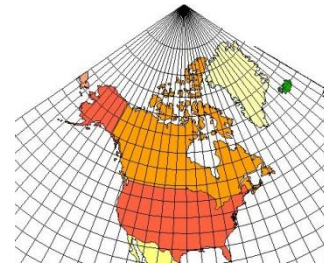
4 **Cylindrical Projection (Mercator)**: is based on a cylinder tangent to the equator. Good for *equatorial regions* but greatly distorted at high latitudes. This one of the oldest and most common projections



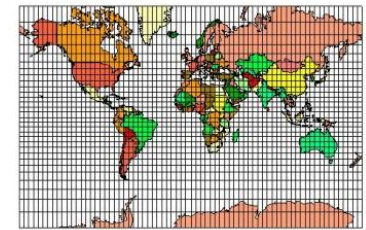
1



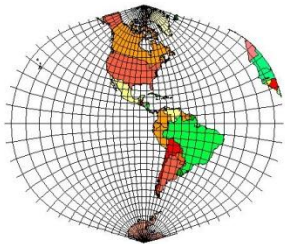
2



3



4



Transverse Cylindrical Projection (Universal Transverse Mercator, UTM): is based on a cylinder tangent to the globe along a chosen pair of opposite meridians. The scale of the map is constant only along the *central meridian*.

UTM is a commonly used projection for **USGS maps** ranging in scale from 1:24,000 to 1:250,000. The UTM projections are based on **60 UTM Zones** each defined by a central meridian and covering **3 degrees of Longitude** to the East and West.

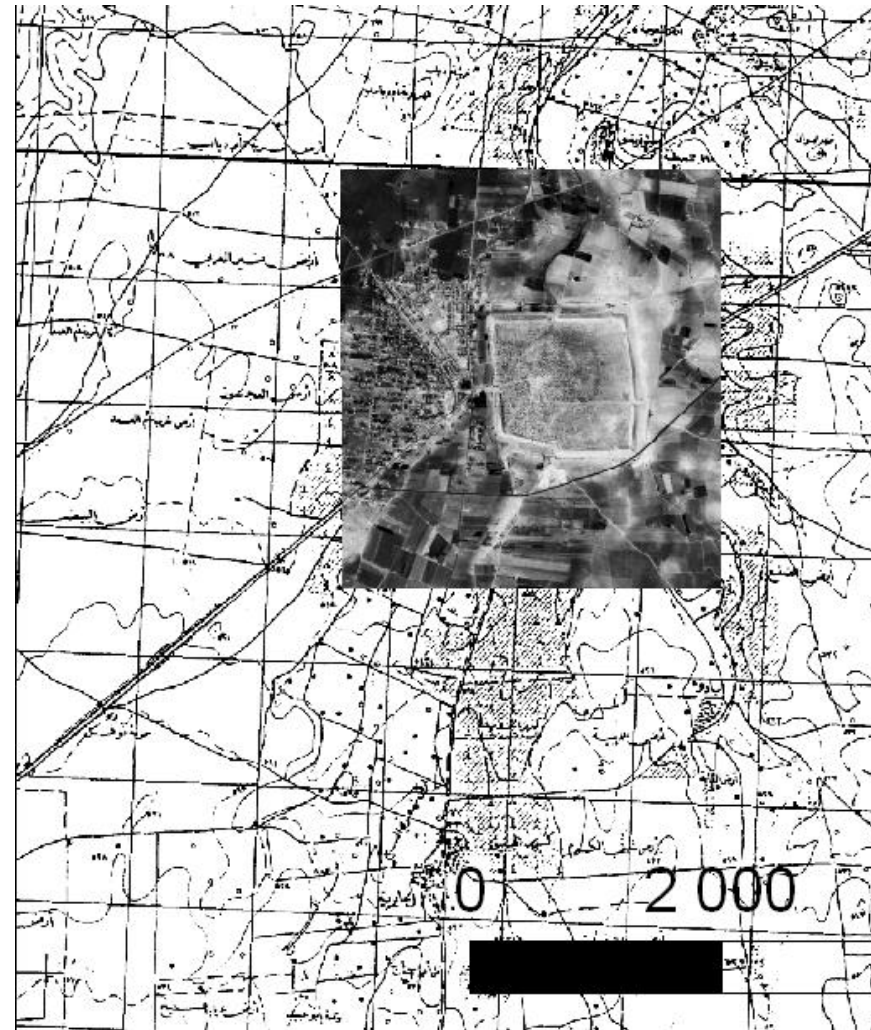
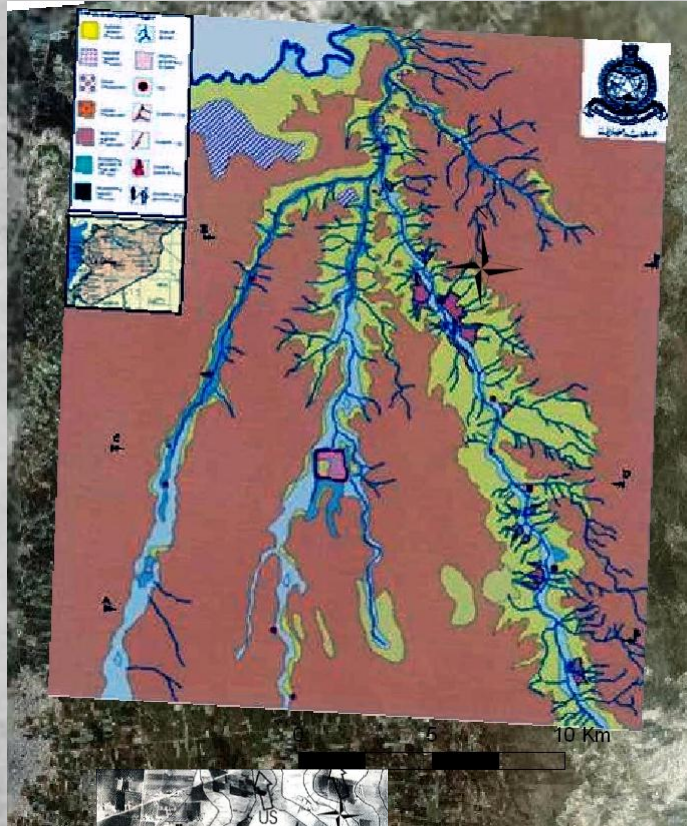
Map Distortion

Distortions result in changes to the **shape, size, area,** and **direction** on a map.

Conformal Projections are characterized by **shape retention** (i.e. *Lambert Conformal Conic*). So that a small circle on globe will remain a circle on the projection, but the scale or size may be different.

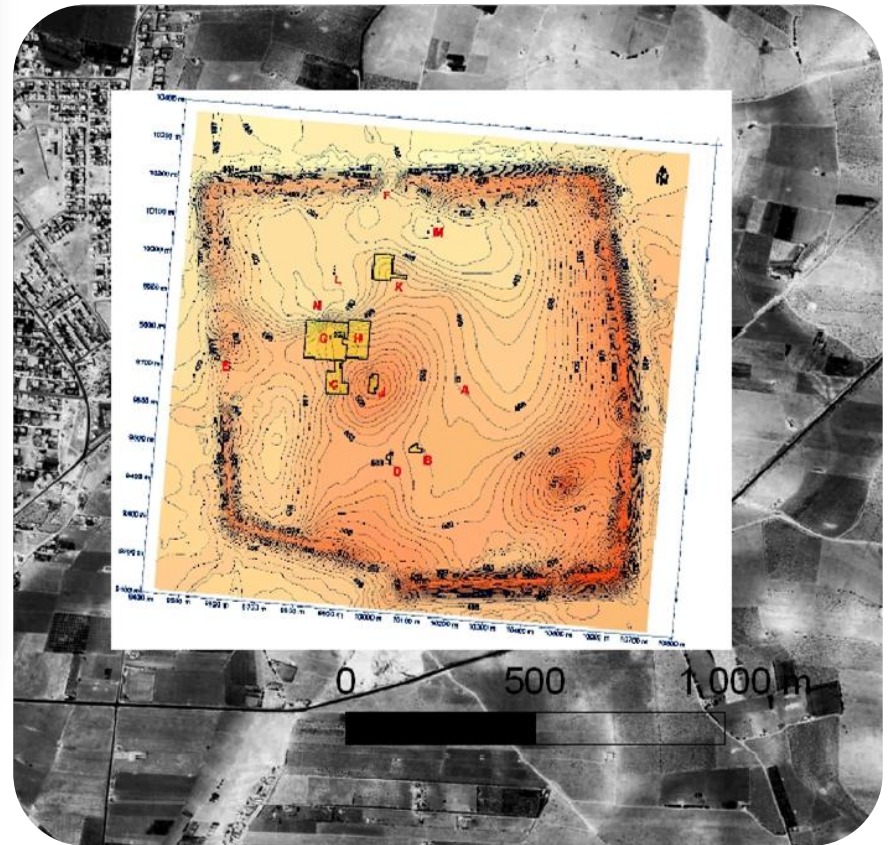
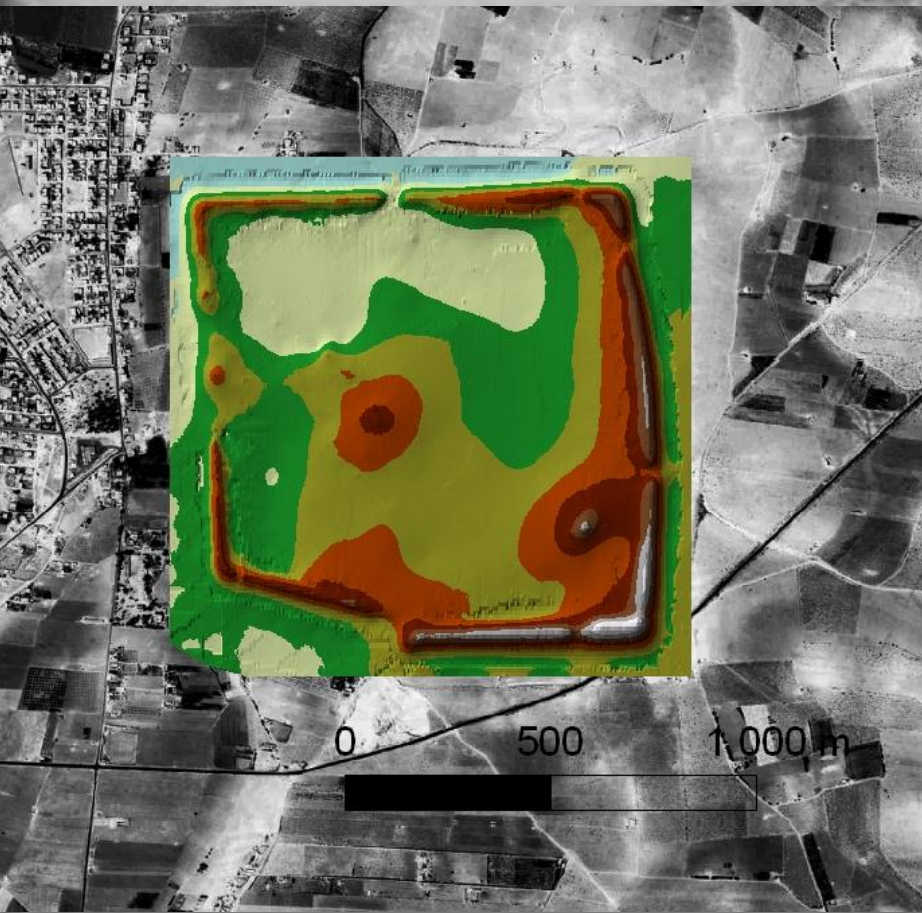
Equal Area (or Equivalent) Projections are characterized by **area retention** (*Albers Equal Area Conic*). So if South America is eight times larger than Greenland on the globe, it will also be eight times larger in the projection.

Projections and national grids -Georeferencing-

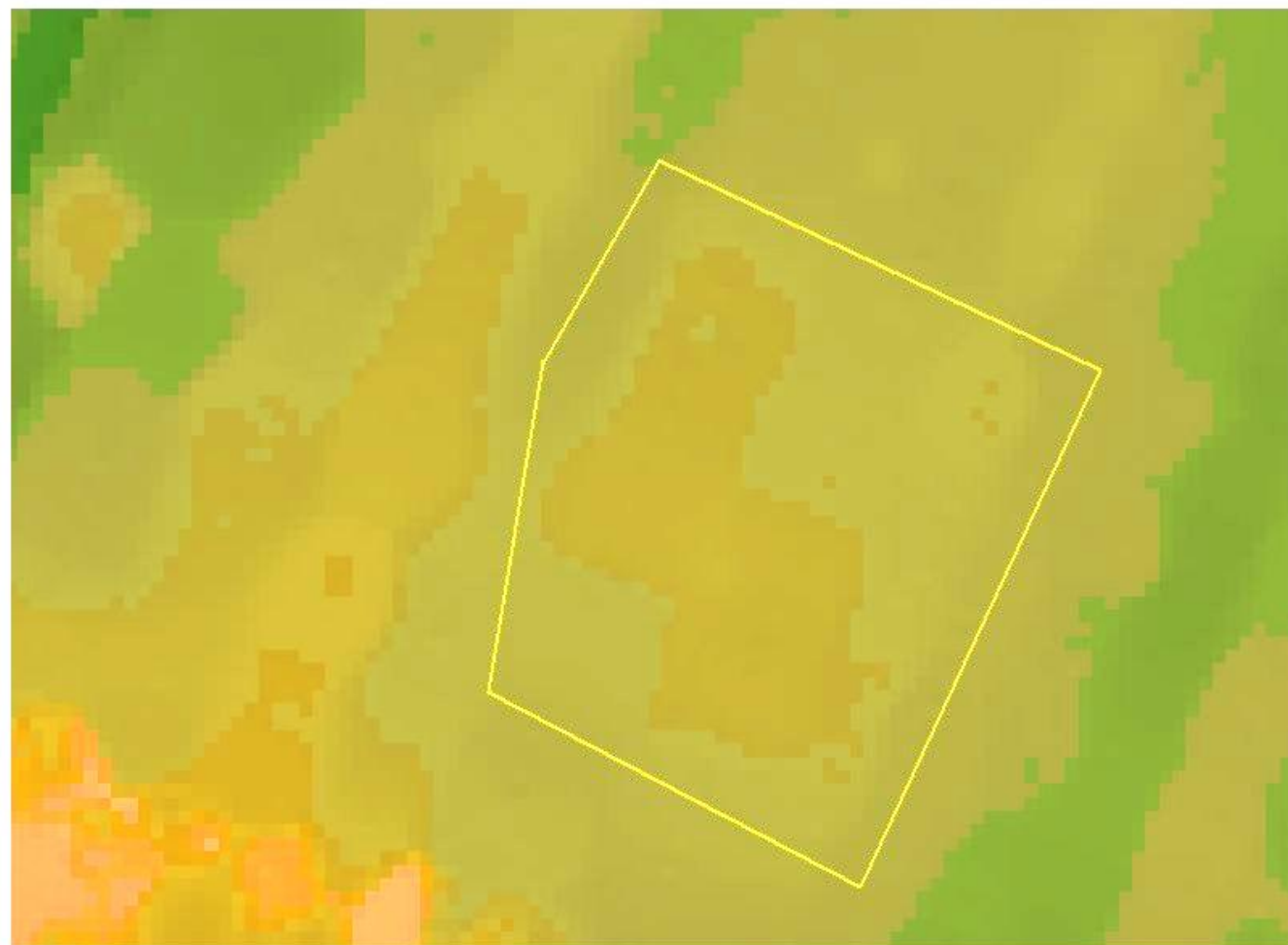


Old map geo-referenced

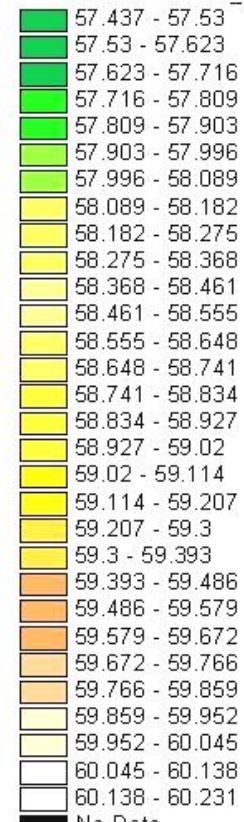
Projections and national grids -Georeferencing-



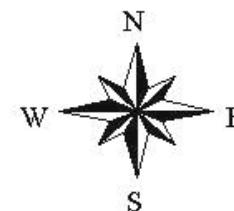
DGPS: identification of a Roman villa



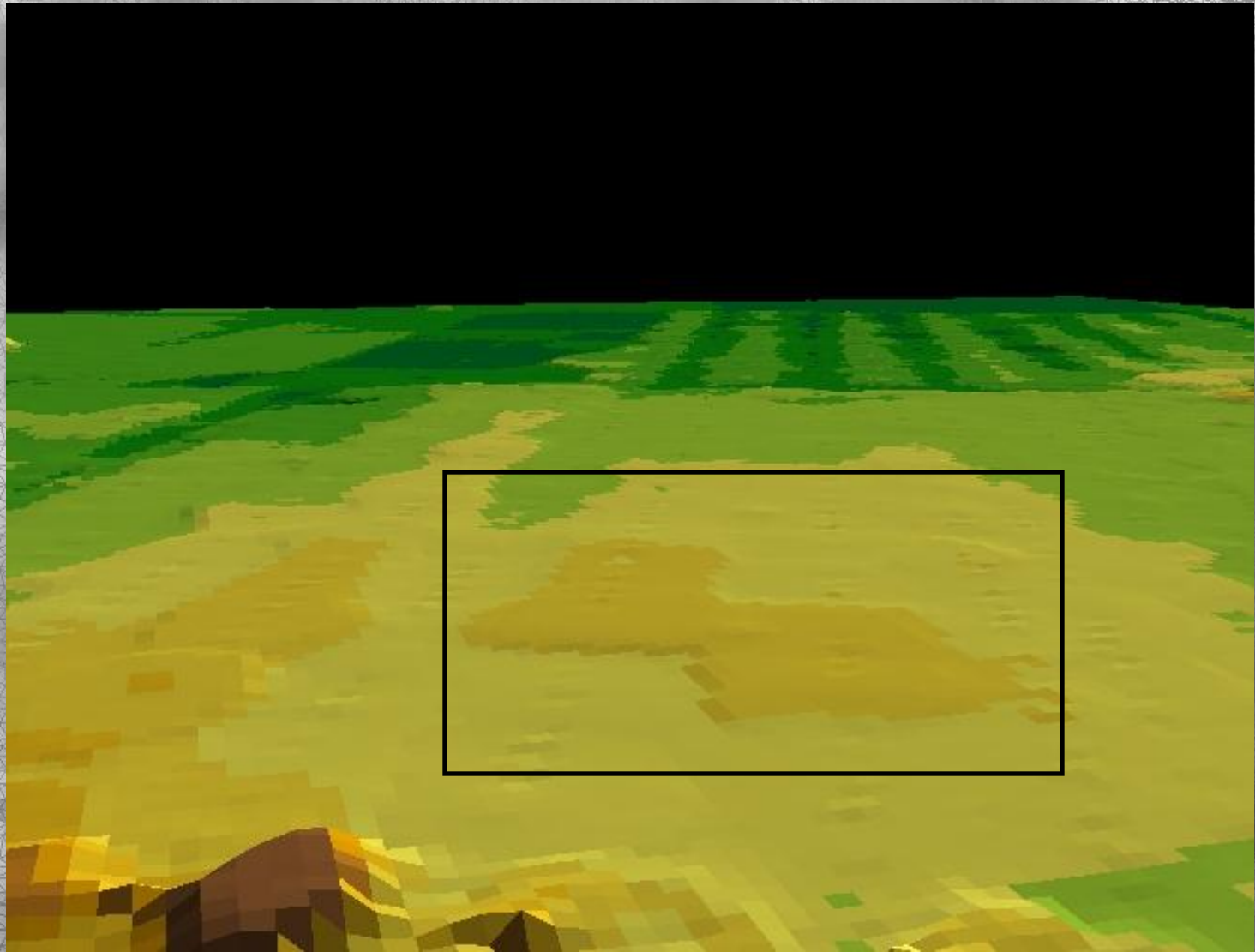
Surface from Srosall_dem5.txt

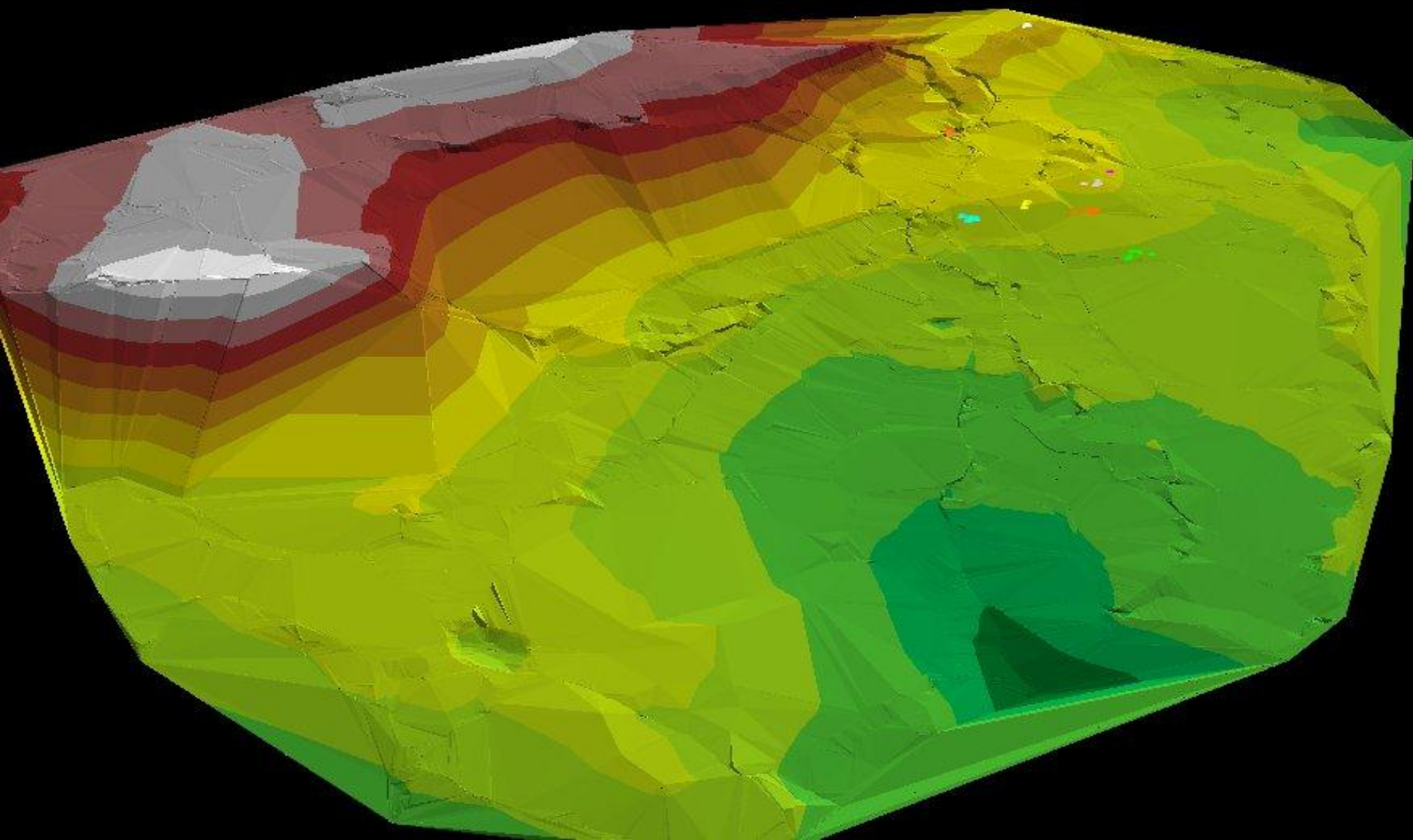


Geop_besselok.txt



**DGPS survey: 3D visualization of the DEM
concerning a Roman villa**





Via Flaminia project

AIMS:

To develop a Virtual Reality multi-user application for the communication of Flaminia Archaeological landscape, based on surveyed scientific data.

an important consular road
constructed in 220 b.C. by Gaius Flaminius.

The project started in 2005,
promoted and supported by Arcus s.p.a and
in collaboration with the Archaeological
Superintendency.

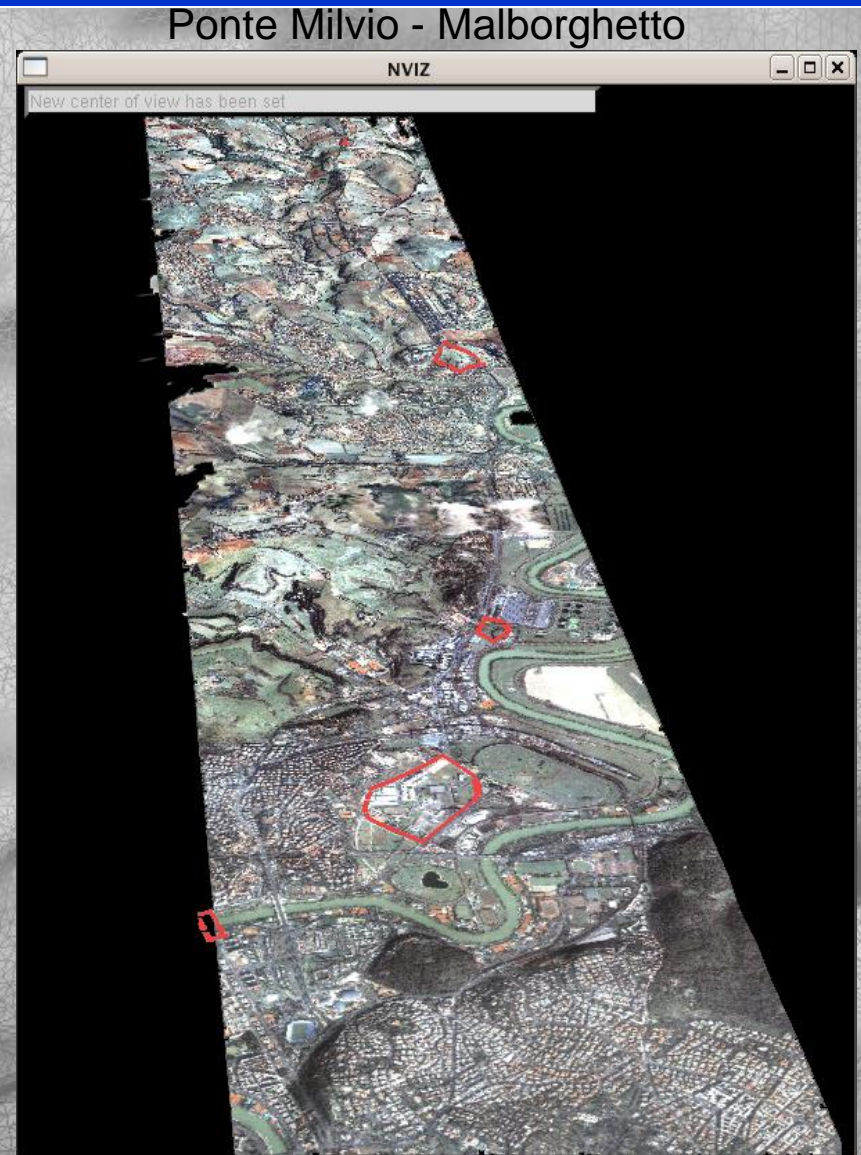
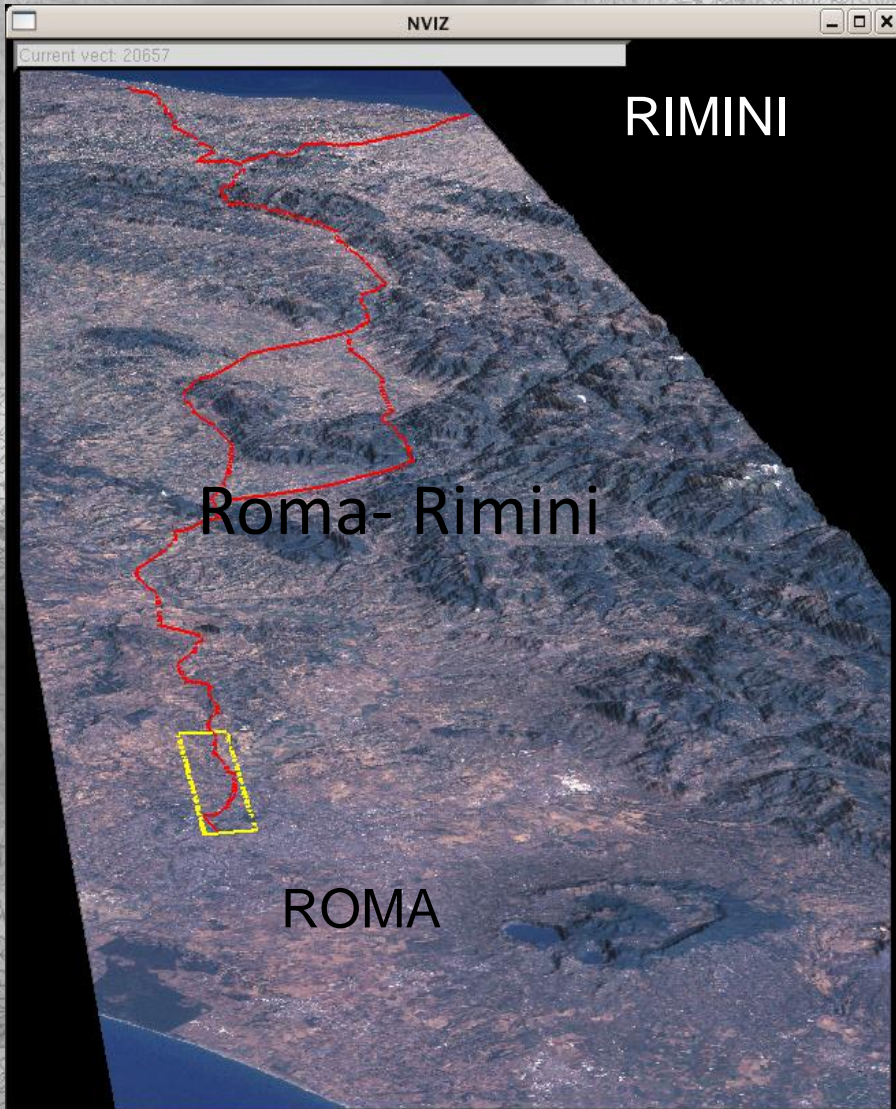
Main goal: cultural dissemination,
valorization, communication of these
important areas.

Final destination of the application: Museum
of Diocleziano's thermae in Rome.



Two levels of representation of via Flaminia archaeological landscape:

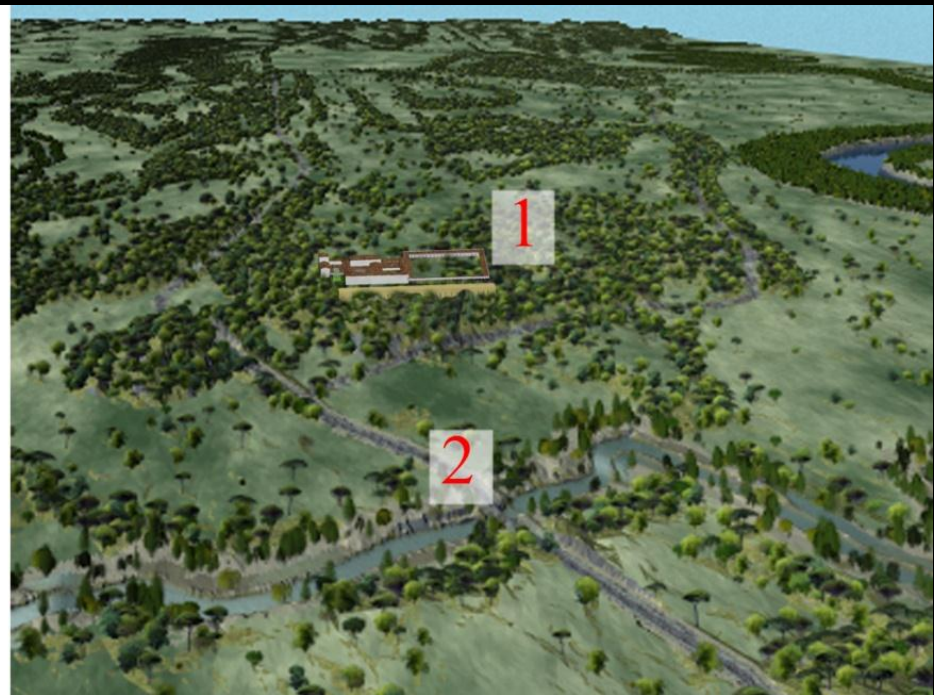
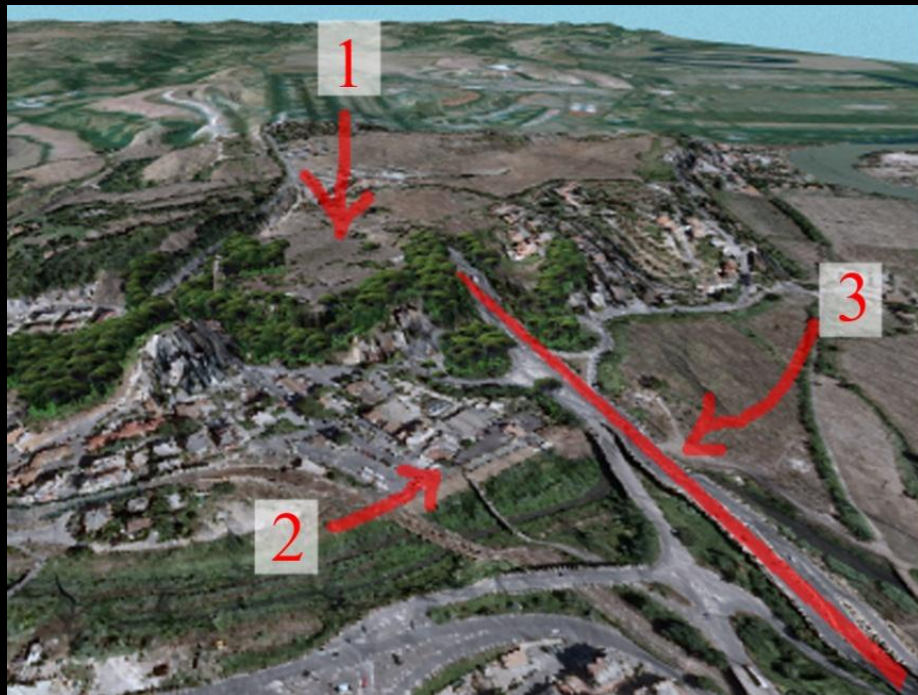
1) OLISTIC LEVEL



Landscape

Observed
archaeological landscape

Potential ancient landscape



2) MONOGRAPHIC LEVELS:

Ponte Milvio (on III mile of via Flaminia) III century – IV the famous battle 312 a.C.



Malborghetto, at the XIII mile of via Flaminia, ancient roman triumphal arch, half of the IV c.C



Grottarossa, at the VI mile of via Flaminia, necropolis dated between I b.C.-II a.C.



Villa of Livia Drusilla: different phases, from I b.C. to IV a.C. (augustean phase I a.C.)



Documentation, elaboration, communication involve many activities and techniques according to:

- characteristics of site and structures
- contents and detail we want to extract

Activities on the field:

1. Topographic survey with RealTime, Double Frequency, GPS;
2. Topographic survey and RealTime DEM construction: with PDA connected to the GPS (ArcPad);
3. Digital acquisition of the monuments: photography (also with aerostatic baloon);
4. Topographic and architectonic Survey with Laser Total Station



Grottarossa, DGPS survey

Global Position System

TODAY

The Global Positioning System (GPS) is a space-based global navigation satellite system that provides reliable location and time information in all weather and at all times and anywhere on or near the Earth when and where there is an unobstructed line of sight to four or more GPS satellites



GPS was created and realized by the U.S. Department of Defense (DOD) and was originally run with 24 satellites. It was established in 1973 to overcome the limitations of previous navigation systems.

Global Position System

TODAY

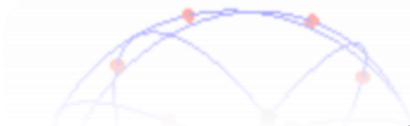
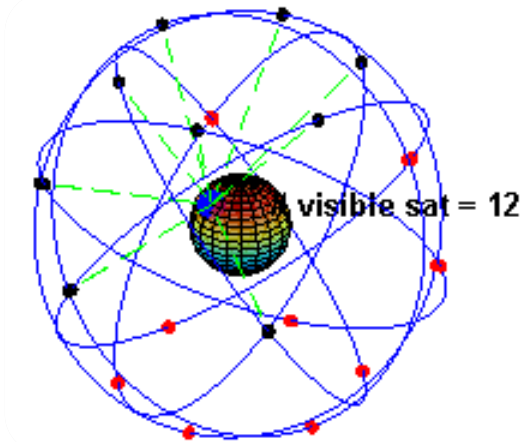
The segment System

The current GPS consists of three major segments:

The space segment (SS)

The control segment (CS)

The user segment (US)



-A pool for the reception and the amplification of the signal.

-One or more electronic card for the elaboration of the received signals

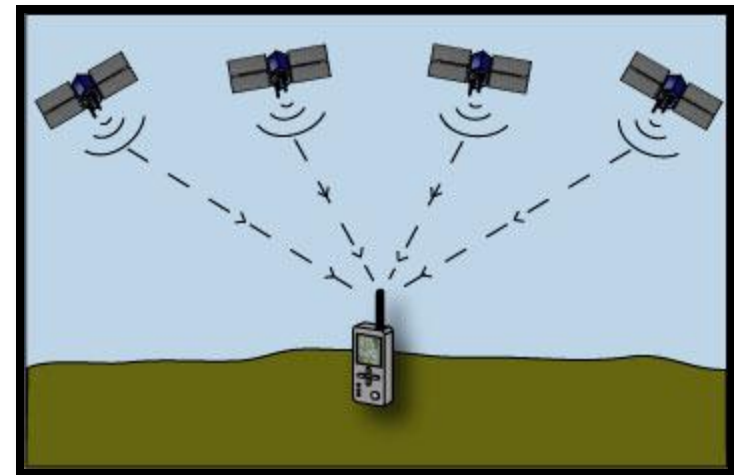
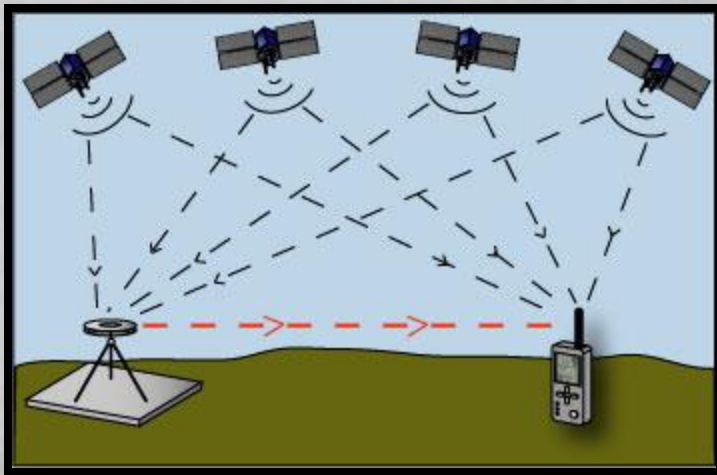
-A device to record and elaborate the data.

Global Position System

TODAY

The Differential Method

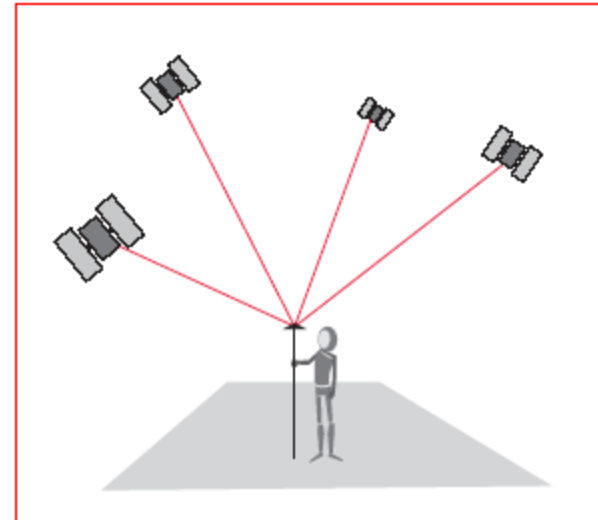
Differential correction techniques are used to enhance the quality of location data gathered using global positioning system (GPS) receivers.



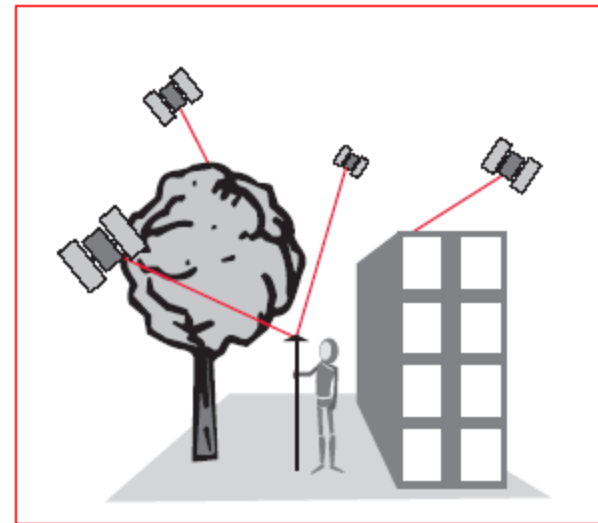
Differential positioning uses multiple receivers to increase the positioning accuracy. One receiver remains stationary on a site with precisely known coordinates. The other receiver takes readings at unknown locations. If the receivers use the same satellites for positioning, the errors and biases should be close to the same.

The receiver at the known location then compares its GPS-determined location with its known location. These satellite distance errors at the known location are then used to correct the coordinates determined independently by the roving receiver. This correction may be done real-time or afterwards (post-processing), assuming the correction information is precisely maintained. Accuracy using this method may reach the sub-centimeter level.

- In order to operate with GPS it is important that the GPS Antenna has a clear view to at least 4 satellites. Sometimes, the satellite signals can be blocked by tall buildings, trees etc. Hence, GPS cannot be used indoors. It is also difficult to use GPS in town centers or woodland.



Clear view to four satellites



Large objects can block the GPS signal

- But what if you have no objects around you ?
- What if you are in the middle of the desert or in the middle of the ocean ?
- For many centuries, this problem was solved by using the sun and stars to navigate. Also, on land, surveyors and explorers used familiar reference points from which to base their measurements or find their way.

Why use GPS?

GPS has numerous advantages over traditional surveying methods:

1. Intervisibility between points is not required.
2. Can be used at any time of the day or night and in any weather.
3. Produces results with very high geodetic accuracy.
4. More work can be accomplished in less time with fewer people.

Global Position System

TODAY

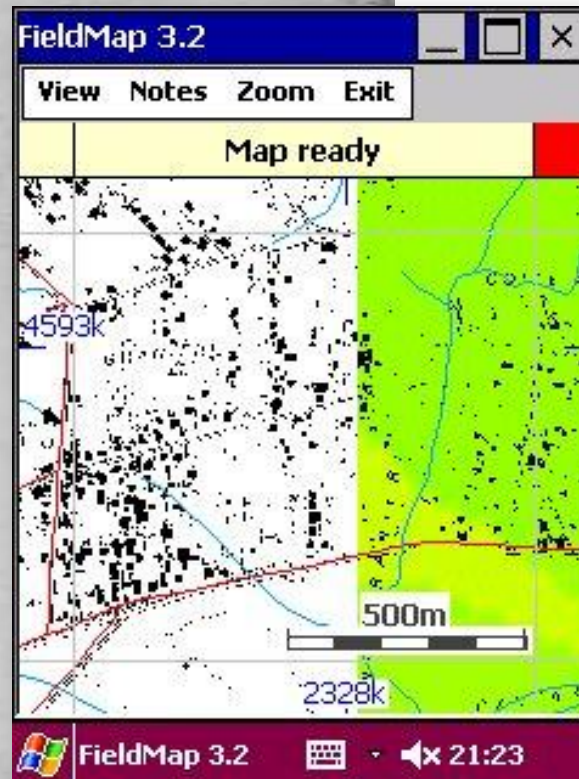


GIS-ArcMap-PDA-Esri

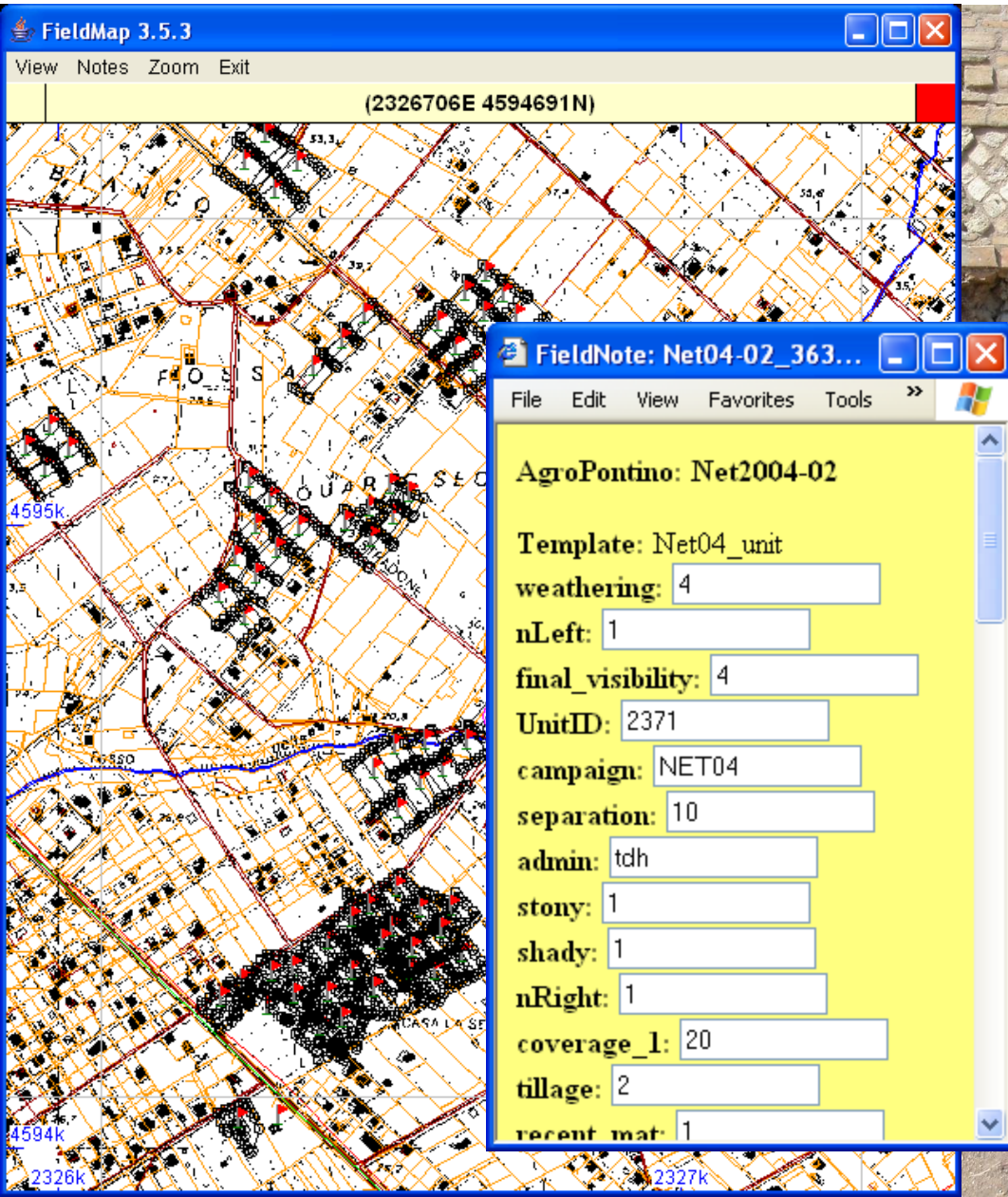


FieldMap: the user's view


- Simple handheld GIS
- also runs on desktop/laptop
- Select map project and layers
- Various option displays
- Map display
 - raster and vector layers
 - zoom, pan, ...
- Track current location by GPS



Mobile-wearable-ambient systems

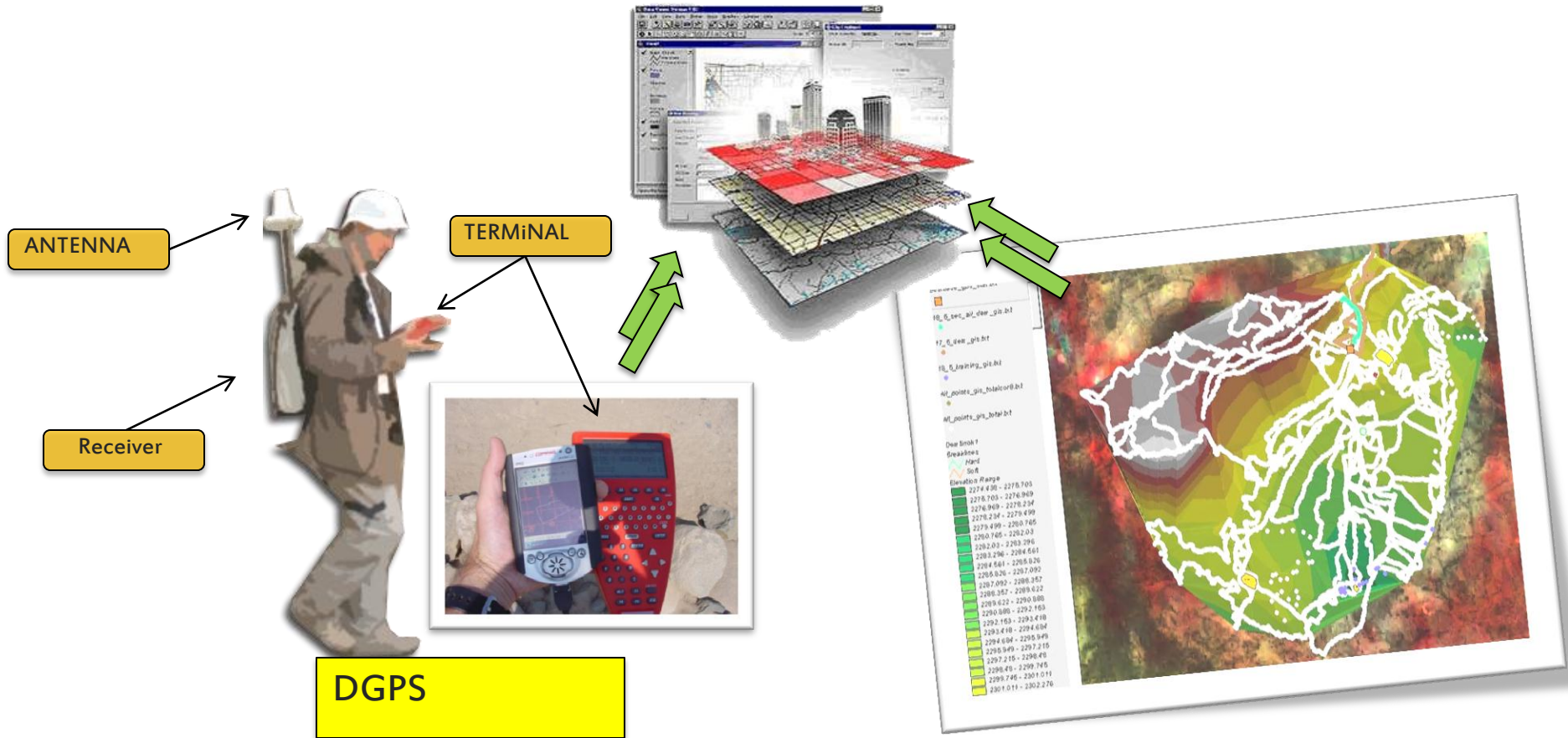
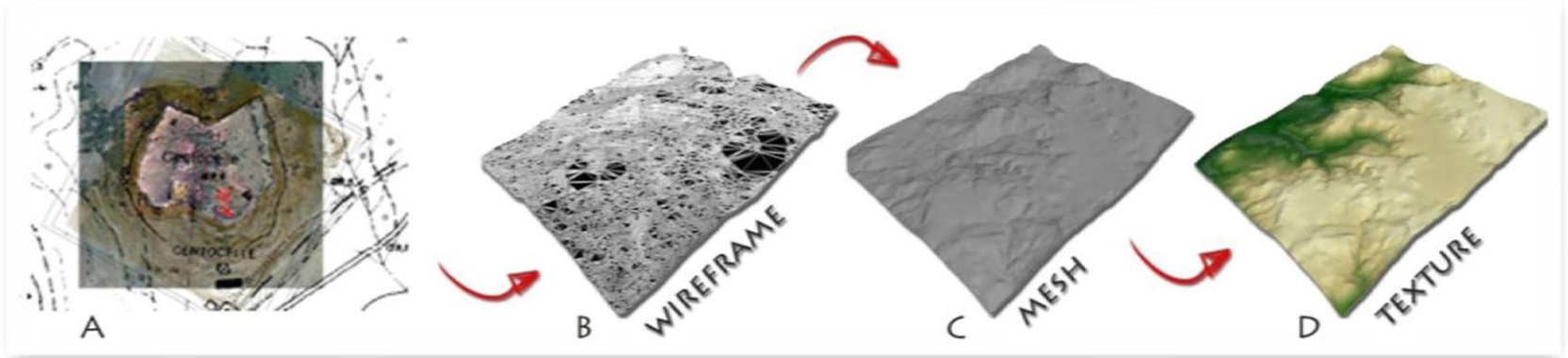




An aerial photograph of a large, multi-winged building complex with a dark, corrugated metal roof. The building is situated in a semi-rural area with a mix of green trees and dry, brownish ground. A swimming pool is visible in the courtyard area between the building wings. A dirt road or path curves along the left side of the property. The overall scene is captured from a high angle, providing a clear view of the building's layout and its surroundings.

Livia's Villa Hill
Aerial photo Seat - Nuova Telespazio
Resolution: 16 cm

Simplified example of a topographic survey



Simplified example of a topographic survey

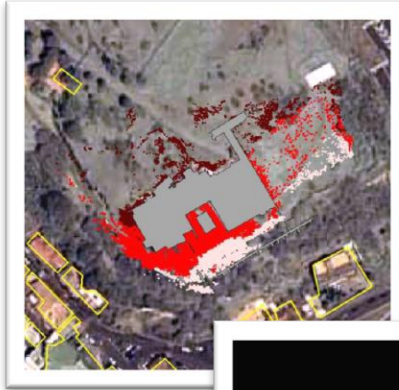


VIA FLAMINIA PROJECT

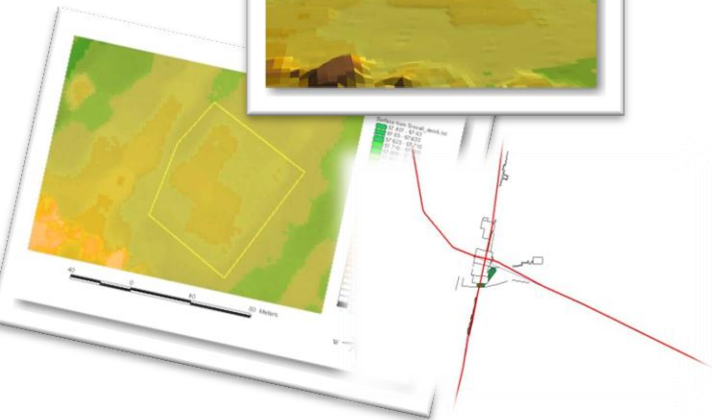
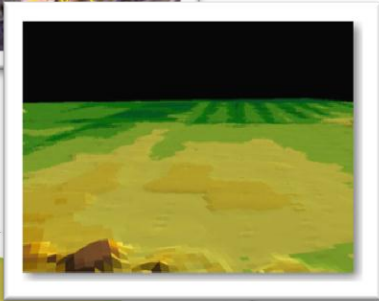


Project of reconstruction and interpretation of the archaeological landscape through the application of new research methodologies

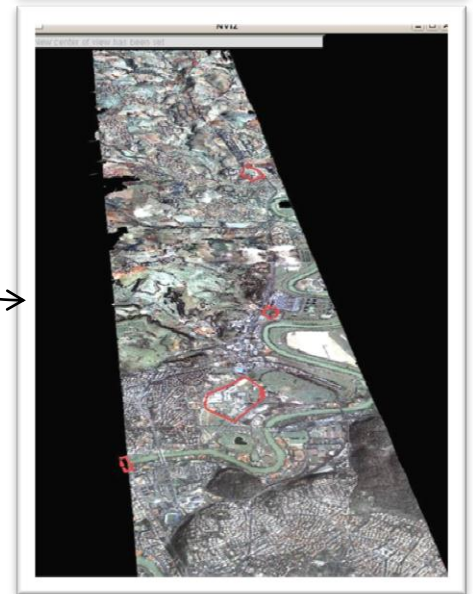
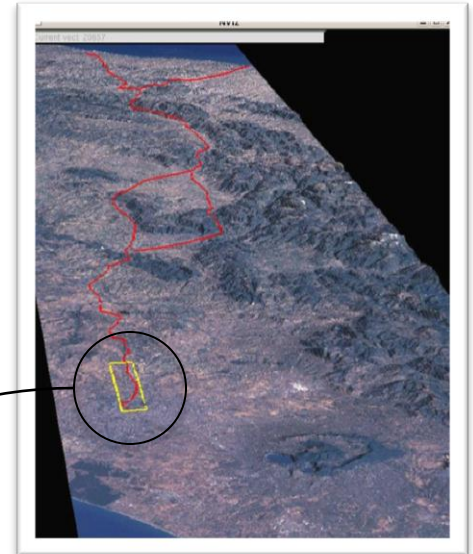
Main Goal: increasing the investigation and the knowledge of the infrastructures realized during the Roman Empire, along this ancient street.



Macro-scale
Micro-scale
Definition of cultures
Import of digital historical maps



Virtual Reconstruction of the ancient Flaminia with different level of details



VIA FLAMINIA PROJECT



HD Digital Camera

Differential GPS



Grottarossa, DGPS survey,
digital orthophotomosaic
through aerostatic balloon
Roma



VIA FLAMINIA PROJECT

<http://www.vhlab.itabc.cnr.it>



VIA FLAMINIA PROJECT

<http://www.vhlab.itabc.cnr.it>



The reconstruction of the archaeological Landscape



Premise

- There are many tools for reconstructing and interpreting the archaeological landscape but a few for reconstructing the ancient landscape
- Most part of them are GIS oriented based on a bottom-up approach
- GIS and spatial tools are aimed to identify and classify tangible landscapes and relationships
- What about intangible information in the landscape?
- Intangible data regard all the hidden relations perceivable by ancient minds.

Affordance-perception

- According to Gibson, by affordance is meant the relational property entrusted to objects.
- "Information is already present in the stimulus array, in the stimulus as it presents itself directly to the subject.
- And information can be directly received by the subject without recourse to computational systems, information flows, or representational structures. Information makes sense for the organism that collects it directly from stimulus (there is a reference here to the theory of direct perception) in the form of affordances"

Affordance-perception

INCA LANDSCAPE: HUACA
(sacred anthropomorphic stone)

Landscape's affordance

The link between the stone and the
wodden pole is a modern sciamanic ceremony

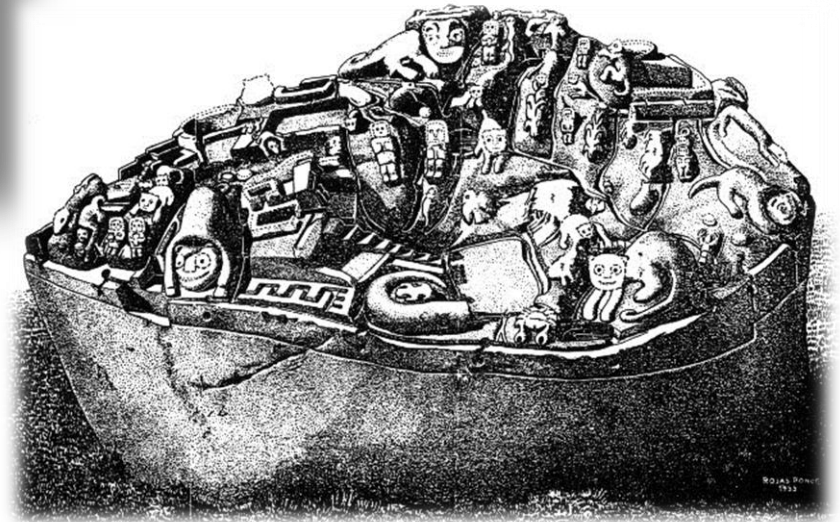


Affordance-perception



Inca Stone of
Sayhuite, Cuzco Peru

The power of landscape:
representation of a
sacred landscape
(totally intangible)



Bottom-up (from landscape to mind)

- Reconstructive research in the field of the virtual archaeology uses **top-down** and **bottom-up** rules in interpretative processes, integrating multiple methodologies.
- The bottom-up pattern starts from the interpretation of **spatial data** captured on the field (for instance a monument or an archaeological feature).

Top-down (from mind to landscape)

- On the other side, top-down rules use the mental faculty of making reference **patterns (mental maps)** for interpreting and reconstructing the past.
- Showing **3D relations** through interactive and inclusive activities means to develop new rules of perception, that is the virtual environment becomes a place of knowledge established by relations.
- Final interpretation: integration of bottom-up and top-down

Cultural Landscape ontologies

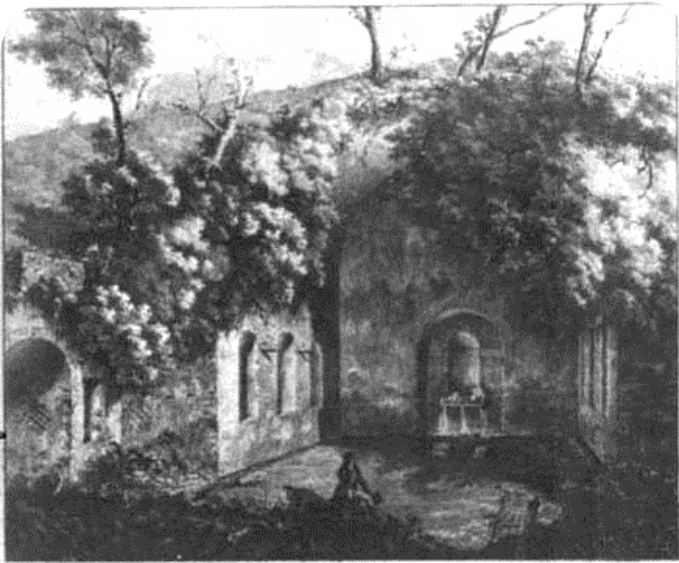


Ancient landscape
(they were in the landscape)

Archaeological landscape
(we are in the landscape)

Mental maps
(perception of places through the time)

MINDSCAPE: perception landscape through places,
spaces, maps, minds



GROTTA DI EGERIA

Antica la Cappella del. Annunzio di S. Maria in Via della Pace n. 116.

Nymphaeum of Egeria, Rome, II cent.A.D., print of Piranesi, XVIII cent.





Mindscape

- The mindscape regards all the ecosystem's relations needed for constructing the "map" in ancient and modern minds; mindscape is the way with which it is possible to perceive the landscape.
- We aware that only cultural and anthropological background can help us to imagine and to construct a mindscape in diachronic and territorial terms.

VR LANDSCAPE

Contents

Relational Databases

Movie, audio, Html, editors etc.

Media

3d Models

Modelling software: FLT (Multigen Creator); 3DS (3DStudio Max...)
[Models are create at different LODs]

Graphic software for texture generation

Libraries of Vegetation
Libraries of Textures

GIS software, Remote Sensing, etc.

DEM
(ascii, geotiff, grid)

GEOIMAGE
(GeoTiff, Tiff+tfw)

CULTURE
(ESRI shp)

TERRAIN GENERATION:
- OpenSceneGraph (OSGD~~EM~~)
- Terravista
- Multigen Creator Terrain Studio

VIRTUAL TERRAIN (VTP):
Interactive and 3D design 3D of the landscape:

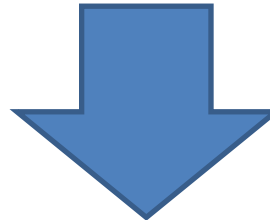
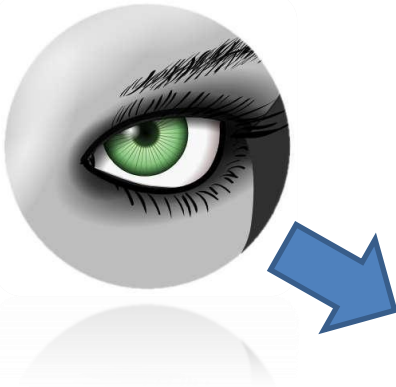
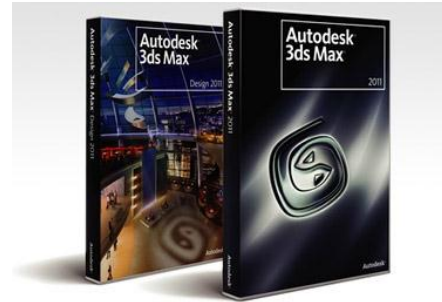
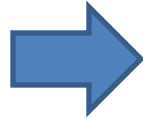
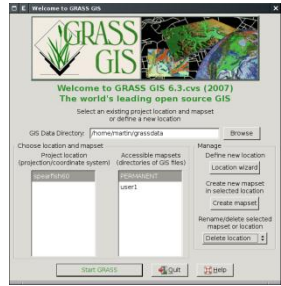
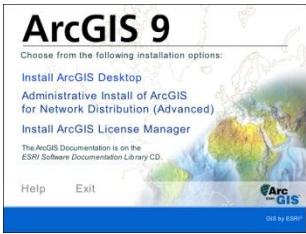
GENERATED TERRAIN:
- IVE e OSG: Terreno 3d creato da dem e geoimage
- TERRAPAGE (TXP)
- FLT :Modello completo

VTBuilder:
elaborazione dati GIS - export in formati proprietari o xml

VR application

ENVIRO: 3d and real time landscape designer

WEB



Now Shipping:

Unity 3.1

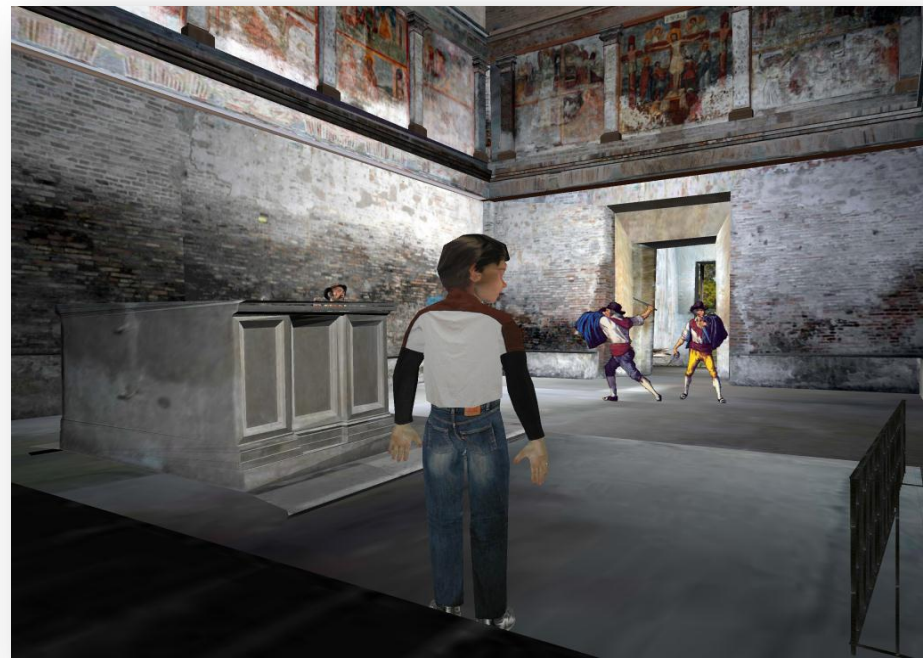
Discover the Asset Store
See What's New

Landscape design

vegetation, animals, characters, avatars, light, atmospheric effects, animations...



Appia Antica project, CNR-ITABC, 2005



Activities on the field

1. Topographic survey with RealTime, Double Frequency, DGPS;
2. Topographic survey and RealTime DEM construction: with PDA connected to the GPS (ArcPad);
3. Digital acquisition of the monuments: photography
4. Topographic and architectonic Survey with Laser Total Station;
5. Monoscopic and stereoscopic Photogrammetry
6. Survey and acquisition with 3D Laser Scanner



PDA connected to DGPS



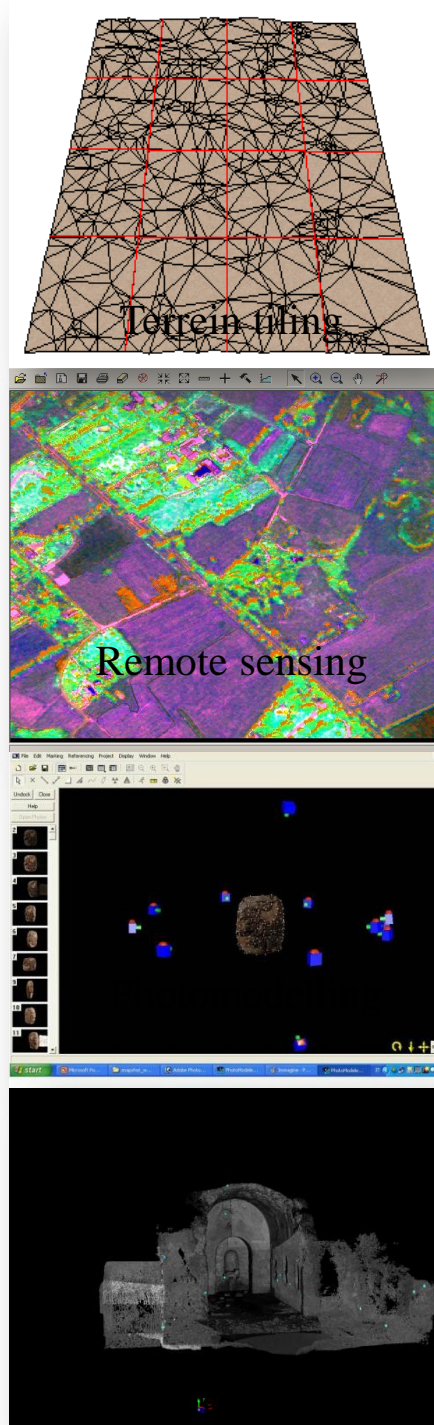
Laser scanner

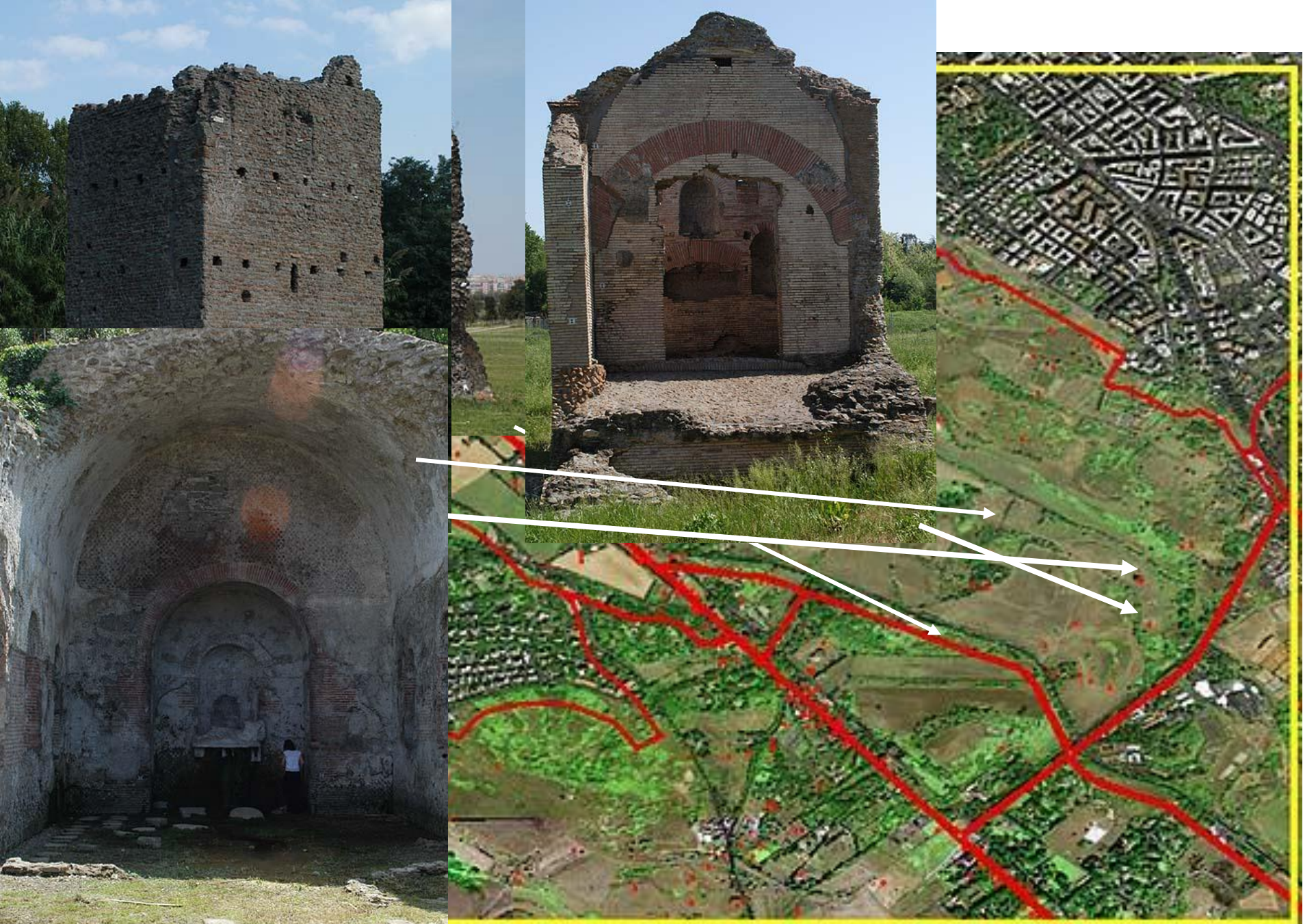


3D Photogrammetry with photographic stereo pairs

Post-processing activities

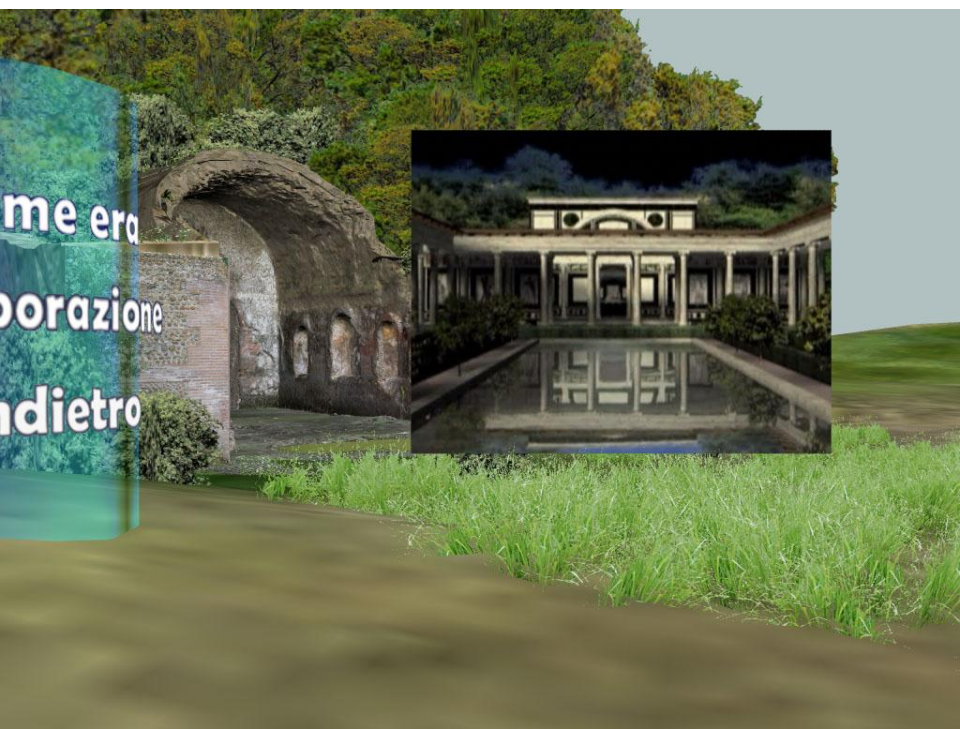
1. DEM: Rendering from GPS, cartography and GIS data.
2. Topographic integration with satellite data.
3. Remote sensing and photo-interpretation
4. Interpretative vectorial layers (cultures)
5. Photomodelling
6. 3D modelling from photographic stereo pairs
7. Elaboration of monographic 3D models from Laser Scanner
8. Design of the landscape
9. VR WebGIS (Open Source)
10. Implementation in real time graphic engine for DESKTOP VR applications.





1) Digital acquisition of the monuments, photo-interpretation: photography

MOVIE-1



Transparency

Very rarely VR applications encourage a real discussion about methodological approaches, interpretative processes followed in the reconstruction of present and ancient cultural contexts.

Making a model transparent means to communicate the methodological process followed (Bottom-up and Top-down), so to develop the educational value and the cultural impact of the VR project.

"London Charter", London, February 2006 –
King's College 3D Visualisation Laboratory.



The room in the National Roman Museum, Diocletian Thermal Baths

