The Virtual Museum of the Tiber Valley Project

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Resumen

El objetivo del projecto del Museo Virtual de la Valle del Tiber es la creación de un sistema digital integrado para el conocimiento, la valorización y la comunicación del paisaje cultural, arqueológico y natural lo largo del valle del Tíber, en la zona Sabina entre Monte Soratte y la antigua ciudad de *Lucus Feroniae* (Capena). Aplicaciones de realidad virtual, contenidos multimediales, junto con un sitio web, están en construcción y se tendrá acceso a los museos en el interior del territorio y en un museo central en Roma. Las diferentes fases de trabajo se centraran en la construcción de una base de datos arqueológicos geo-espacial, en la reconstrucción del paisaje antiguo potencial y en la creación de los modelos virtuales de los sitios arqueológicos más importantes. Este documento se centrará en las metodologías utilizadas y presentará los resultados presentes y futuras.

Palabras Clave: *realidad virtual, paisaje cultural, enfoque multidisciplinario, red de museos, GIS*

Abstract

The aim of the Virtual Museum of the Tiber Valley project is the creation of an integrated digital system for the knowledge, valorisation and communication of the cultural landscape, archaeological and naturalistic sites along the Tiber Valley, in the Sabina area between Monte Soratte and the ancient city of Lucus Feroniae (Capena). Virtual reality applications, multimedia contents, together with a web site, are under construction and they will be accessed inside the museums of the territory and in a central museum in Rome.
The different stages of work will cover the building of a geo-spatial archaeological database, the reconstruction of the ancient potential landscape and the creation of virtual models of the major archaeological sites. This paper will focus on the methodologies used and on present and future results.

Key words: *virtual reality, Tiber landscape, multidisciplinary approach, integration, museums network, GIS.*

1 THE PROJECT: GOALS, PHILOSOPHY, METHODOLOGY

There are no knowledge and communication without context, there is no museum without territory and is difficult to understand an area without a museum or a museum network. The Virtual Museum of the Tiber Valley has been conceived in order to increment and disseminate the knowledge of the territory and encourage the people to visit some important and beautiful places that are still marginal in relation with the main touristic itineraries, too much focused on the Capital. The Sabina area, north of Rome, between Monte Soratte and the ancient city of *Lucus Feroniae* (Capena) and along the ancient consular road via Salaria, has been taken in consideration.

Virtual reality applications, multimedia contents, together with a web site, will support the public before and during the visit of the real sites through the access to cultural contents while attending places, museums, sites, itineraries. From the same dataset many elaborations and specific communicative formats accessible from multiple platforms will be realized: a spectacular installation of virtual reality in the roman museum (conceived as a sort of ''portal'' to the discovery of the external territory) based on the use of natural interfaces to explore the landscape in its interpretative and emotional dimensions; narrative and multimedia guides for mobile devices to be used during the visit of archaeological sites or naturalistic oasis; movies and multimedia in the small museums of the territory dedicated, together with a web site, to the evolution of the cultural landscape during the centuries (prehistorical, pre-roman, roman, medieval and actual periods); multimedia iBooks multi-touch. In the virtual museum the information is organized as a network of data, paths, themes highlighting the relations among sites, settlements, human activities, land, memory and history, the river environment in its developments and transformations. The project, supported by Arcus s.p.a., started in July 20111 and it will be finished in 2013; it involves a multidisciplinary team composed by CNR and University researchers (archaeologists, art historians, geologists, ethologists, cognitivists, computer scientists, surveyors, computer graphics) but also by artists, musicians and public stakeholders.

2   THE ANCIENT POTENTIAL LANDSCAPE RECONSTRUCTION

a. Geology, soil-landscape and potentiality

One of the priorities of the project was to find a convincing method to simulate the ecosystems and the soil use in the past, finalized to the reconstruction of the potential ancient landscape of the Tiber Valley in different ages. A fundamental contribution comes from geological and pedological studies.

The area is composed mainly of sandy and conglomeratic sedimentary hills, which are partially covered by Middle-Pleistocene volcanic sediments, and to the east of calcareous mountain ranges reaching altitudes over 1200 m a.s.l. The

Tiber valley occupies the depression separating the two volcanic edifices, Sabatino and Albano.

The basis of the landscape study has been the existing semi-detailed Soil-Landscape map, a theme showing the soil distribution in its context of lithology, morphology and watersheds. From this map, in combination with the known phytoclimatic spatial variation, the production potential for cereals (eventually with vine rows), olive/fruit trees and forests was derived. Several relative density scenarios of the various cultures were proposed.
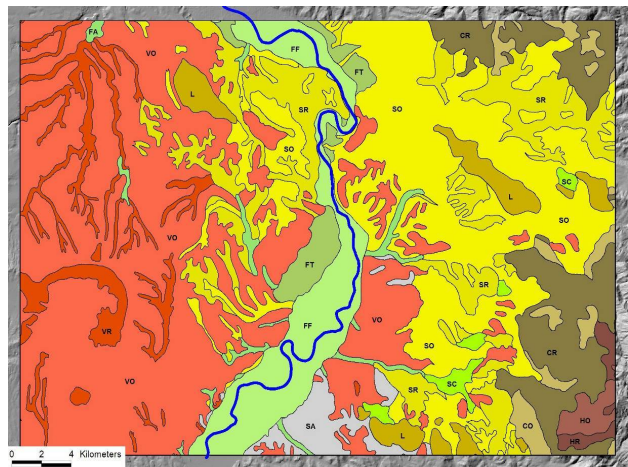

Figure 1. Eco-landscape map of the Tiber Valley Project area, with the proposed Tiber course for the Roman period.

In order to express the potential for the natural vegetation systems, the same data were used to create an Eco-Landscape map (fig.1). This map has a condensed legend with respect to the original, and has formed the landscape ''input'' for the reconstruction of the historical vegetation distribution. Striking for instance is the contrast in plant potential between the volcanic lands - with moderate slopes, a high water retention capacity, almost never stony and with a good natural fertility - and the pre-volcanic environments, with diametrically opposed characteristics.

During the historical time span relevant to the project, coinciding with the Upper Holocene, the morphology of the hills, mountains, river terraces and valley floor should not have undergone perceptible changes, but the valley floor drainage conditions and the Tiber river course may have varied sensibly. The reconstruction of the latter was based upon the present distribution of the river curves and the terraces, the presumed persistence in time of the narrow and steep passage near Nazzano, and moreover upon aerial photographs

and historical maps. Successively, the proposed Tiber courses for the various periods were checked against the archaeological data. Older landscape reconstructions, referring to the Upper Pliocene and the Pleistocene, were based upon existing literature (PAROTTO, 2008).

This project has thus been characterized by an strong integration and feedback between physical landscape and vegetation elements and historical and archaeological data. In fact all the geological and pedological data, as the natural ecosystems, have been compared and overlapped with the archaological data, in order to simulate how the natural and antropic landscapes could combine each other in different ages.

b. The archaeological GIS

One of the main goals of the project is the interpretation and reconstruction of the landscape in its diachronic dimension in three different phases: the Bronze and Iron Age, the Roman period and the Middle Age. In order to obtain the virtual reconstruction of the landscape through the time, we have crossed data coming from different disciplines (geology, archaeology, pedology, history, botanic, literature) and in different formats (GIS datasets, archaeological reports, scientific articles), to obtain a Geographic Information System of the landscapes in the three chronological phases (fig.2). Accordingly to this goal, we collected all the data that could help us understand the natural environment in the past and its interaction with the human population of the Tiber Valley. First of all, working on the actual Digital Terrain Model (TARQUINI ET AL., 2007; TARQUINI ET AL., 2012), it was possible to reconstruct the orographic evolution of the Latium area, with the different stages of digression of the coastline and of the raising and lowering of the terrain.

In the meanwhile, we needed as many data as possible regarding the modes of human settlement and land use through the time, so we made an in-depth research about the different ethnic and cultural *facies* that occupied the area and their habits of life: Etruscans, Sabines, Faliscans, Romans and so on. The main problem regarding this part of the project was that the Tiber Valley was the object of many research projects in the past, but really a few of them realized a detailed and avalaible cartographic output. Consequently, we started from scratch a new GIS project

collecting all the basic data concerning the area of the medium Tiber Valley. The basic cartographic support was provided through the use of 1:25000 scale maps produced by the Istituto Geografico Militare and avalaible by WMS and of 1:10000 scale maps produced by the Regione Lazio, the geological map and the Carta dell'Agro, which registers all the archaeological evidences of the city of Rome.
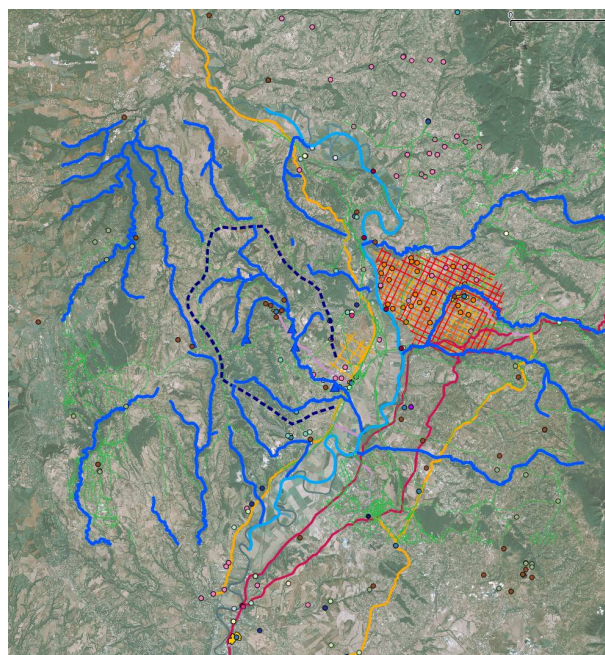

Figure 2.GIS of the archaeological evidences in the project area.

For the generation of the archaeological GIS, we made an extensive perusal of the bibliographic sources, interacting also with the Soprintendenza per i Beni Archeologici dell'Etruria Meridionale, to make accurate topographical and 3D reliefs of the sites of *Lucus Feroniae* and *Villa dei Volusii Saturnini*. Besides the study of the two main archaeological sites which will be the focuses of the Virtual Museum together with the natural protected area of Nazzano, we built a GIS which includes data for 200 sites classified by chronology (Bronze and Iron Age, Roman period, Middle Age), typology (sanctuary, town, villa, river port, ford, …) and extension. Another important part of the GIS implementention has been the study of the ancient communication routes: for reconstructing the itineraries of the Via Tiberina, on the right bank, of the Via Salaria on the left one, and of other secondary roads we used the published studies, the most recent archaeological data

coming from the excavations of the Soprintendenza dell'Etruria Meridionale and, finally, our own surveys in order to register the remainings of the ancient routes.

Another important aspect, especially for the Roman period, was the identification of the traces of *centuriationes* (agricultural divisions) (CAMBI, 2004; STERNINI, 2004): these data were particularly useful for the generation of the reconstructed landscape, since they allowed us - when avalaible - to clearly identify the portion of territory belonging to a given village.

At present, the elaboration of the Geographic Information System of the archaeological evidences is mantained updatable with new data and sources of information avalaible. The outputs of this work, impressive because of the lack of a comprehensive and open collection of all the archaeological sites falling in the project area, were the basis for the subsequent work aimed at reconstructing the distribution of ancient ecosystems and vegetation of the landscape through time.

c. Development and mapping of the natural and anthropic ecosystems

The first task after the GIS creation is the definition of different ecosystems characterizing - in each historical period - the different parts of the landscape. Each ecosystem is a collection of many plant species whose presence, height and density is highly interconnected and influenced by many factors such as geological soil composition, slope, sun exposition, closeness to water streams and so on. Two main steps are requested in such a perspective: the first one is related to the natural ecosystem: i.e. the part of the landscape not affected by human actions. This kind of areas are relatively easy to be set up, according to the already mentioned data, which are the fundamental influencing factors. Over this naturally-shaped landscape, a second series of layers has to be defined: the anthropic landscape. The working process is, in this step a bit more complex. starting from the settlements, known through the historical sources and the archaeological data, areas of main influence are drawn as circular buffers whose dimension can be defined according to specific studies. The so-called site-catchment analysis, is a spatial study used in archaeology since about 40 years ago (HIGGS AND VITA-FINZI 1970) and

applied to GIS analysis since 20 (GAFFNEY AND STANCIC 1992).

In our effort, we took into consideration many land factors: distance from settlements, from water supplies, from routes, kind of soil, sun exposition, slope, terrain elevation and cost (in terms of effort requested to reach each soil point from the settlement. All these factors were given different weight in relation to the technological and organization features of the community in the considered time span. The result is a map of the most suitable land units for cultivation (fig.3). The determination of a threshold in this whole was then performed calculating the harvesting needs of the community, and a further step has been the definition of two main cultivation classes for the terrain, according to the slope (0-7% and 7-20%) respectively assigned to cereals and to fruit trees (but it is important to keep in mind that, up to the middle ages, cultivation was performed mixing together different plant species).
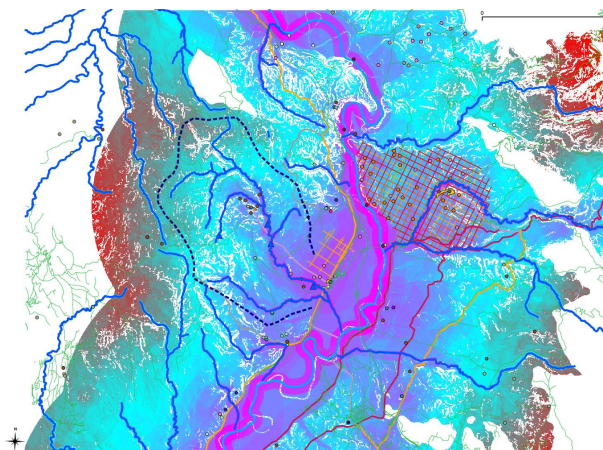

Figure 3. First elaboration of a cultivation potential map for the Roman period.

d. From GIS to the real time graphic engine

The data coming from GIS have been translated in a compatible format for two different kinds of visualization/outputs: video and real-time applications. We chose to export from GIS software (Grass) the height maps in GeoTIFF image format in order to keep the necessary geographical information associated to the terrain tiles and, as next step, to generate from the height maps the 3D model of the terrain inside other applications (Vue for movie and Unity3D for real time exploration).

Then geotiff grayscale images for the video applications were used without further modification to generate terrain in Vue with the technique of displacement mapping, while those destined for real time applications have been saved in RAW format, which is the only format suitable for the Terrain Modul of Unity 3D. It would be also possible to directly import 3D mesh in the real time engine, but in this way we could not take advantage of the enormous potential of terrain generator embedded in the software. In fact, using RAW images and generating the 3D model in real time, inside Unity 3D, a series of very useful tools become available such as the authomatic LOD function (Level Of Detail), that make the mesh more or less resoluted in terms of polygons in relation to the distance of the virtual camera from the ground; the terrain sculpting, useful to adapt perfectly the terrain to the 3d models of *Lucus Feroniae* or *Villa dei Volusii Saturnini;* the Splat Maps, useful to paint directly on the terrain textures such as sand, grass or gravel, and finally the possibility to put onto the terrain thousand of trees, bushes, flowers, grass, stones and so on just with a painting action.

3   From survey to the 3D models: Virtual recontruction of *Lucus Feroniae*

All the data coming from the archaeological survey and excavations, such as CAD, drawings, photos and historical sources, were collected and used to set the reconstructive models of *Lucus Feronie,* a small roman settlement placed in the north-est of Rome along the Tiber river. The reconstructive hypotheses were based on analogy, comparisons and deduction criteria (MORACHIELLO, FONTANA, 2009). For most part of the structures we referred to the 1st century architectures of Pompei, Rome and Ostia.

After the interpretative studies, the CG reconstruction was developed and the buildings were modeled using Autodesk 3DStudio Max. The 3D modeling work was approached using 2D plan and profiles as reference, coming from architectural survey with laser total station and GPS, then the height was extruded and the supposed volumes were built.

All the models were unwrapped and mapped with textures made "ad hoc" using a photographic campaign "in situ" in order to make them as real and likely as possible. Finally the most complex architectural elements, such as bas-relief worked altars and statues, were modeled using dense stereo matching techniques and after optimizing the polygons with sculpting software (for both uses, in real time application and movie rendering). Up to now, we obtained the followings models in the Traianus period: 4 roman *domus* and *tabernae* bloks, the *forum*, the *schola* (fig.4) and the sacred area composed by the *Basilica*, the A*ugusteum* and a *temple*. In the next steps we are going to add also the thermal baths and the *anphiteatrum*. As first output, the 3D scene have been integrated with landscape and vegetation and implemented in a real time engine (Unity 3D) in order to get an immersive VR application for cultural dissemination.

Figure 4. Rendering of the 3D reconstruction of the Roman city of Lucus Feroniae

4   Conclusions

The Tiber has always been a central presence for the development of the territory of Rome. Despite its economical importance has probably reduced, a strong tendency to regard the river as a mirror of our cultural identity still remains: the "God Tiber", author, witness and keeper of history, the repository of memory, shaper of the landscape, vehicle for transformation.

In the project the theme of the river is faced following a multidisciplinary and multidimensional approach: we offer both holistic and monographic representations (landscape and "landings"), in diachronical, evolving visions.

Starting from common resources we are developing a variety of outputs for many targets and contexts of frution, in order to support the

knowledge of the territory in different phases: from the preparation of the visit, to the moments of its execution, remembering and sharing.

The project is still in progress and we hope it will be able to promote local knowledge, creativity, development of local and foreign tourist flows, in order to overcome, at least partially, the fragmentation of the numerous museums, itineraries and local realities disseminated in the territory. contributing to the valorization and promotion of such an important context.

Acknowledgements

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