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Representing the Identity of a Territory: The Drawing [a Tool] to Investigate, Systematize and Know. The "Bacino delle Acque Albule"as a Case Study

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Abstract

Recognizing the identity of a territory and examining its balances means recognizing a complex and delicate system in which all its elements are interdependent and linked to each other. For this reason, the study shows partial results of an inter-disciplinary research carried out on Acque Albule Basin, located in the North-East of metropolitan areas around Rome (Lazio Region in Italy). In particular, a trial of methodological protocol to define the knowledge system is proposed. This system is useful to draw up guidelines to the sustainable regeneration of cultural heritage. In this operating environment, the drawing, through its aspects, confirmed its function as a tool for knowledge. The acquisition, the integration and the systematization of data allowed the identification of main and minor themes, showing their mutual connections. In fact, landscape study is carried out from soil superior layers to the deepest ones, linking information that is very different in the scale of analysis and language. The study about historical and iconographic documentation, the integrated surveys, and 3D digital reconstruction highlight that the area is characterized by its peculiar balance, as a result of natural and human aspects and their combined action in time. The methodological protocol wants to combine natural resource information (water and Lapis Tiburtinus) and natural hazard data with anthropogenic and cultural aspects, due to industrial exploitation (travertine mining), agricultural use of soil and archaeological and architectonic heritage in the area. Comparing data is possible thanks to peculiar cognitive and organizational filters. Some aspects dealt with by the research are: a) the cataloguing of territorial elements, divided in anthropic, cultural and natural aspects through texts, ancient and actual cartographies, geological maps, iconographies, photos, and instrumental survey analysis; b) data vectorization to create maps and diagrams and to render historical information with scientific language; c) the cataloguing of natural hazards, obtained from a preliminary study about geomorphological and hydrogeological structure and its consecutive graphical representation, connected with territorial aspects; d) the cataloguing and graphical representation of related sceneries to mapping empathic balance or affected landscapes, according with temporal steps. In conclusion, the aim of this study is to identify an algorithm to discretize a complex landscape. Data management, due to a multidisciplinary approach and led by representation, is useful to rendering the cultural identity, nowadays cancelled by recent urban and territorial transformations.

Keywords: Cataloging, Filing, Geo-cultural landscape, GIS, Representation.

Introduction

Nature and culture in Italy define areas of great importance in landscape, which show traces even in contexts where the overall equilibrium has been compromised. However, the Italian territory is subject to natural seismic and hydro-geological hazards whose dramatic impact on the population is exacerbated by urbanization, which is too often little concerned with safety.

In recent years, due to enforced regulations imposing a drastic reduction in new land usage, project activities are increasingly targeting the recovery and redesign of what is available. It is necessary, however, that choices in programming and planning be guided by an in-depth historical knowledge of the territory and the environment, so as to link the analysis on a territorial scale with those on the scale of the historic construction. The objective of this preliminary exploration phase should be to investigate, in a stratigraphic sequence, landscapes that have succeeded each other and deposited over time, considering the "cultural models that these landscapes have motivated and conformed" [1]. The analysis of the historical organization of the territory is included in a broader picture of environmental risk analysis, that is, cognizance of the geological nature of the territory and the transformations that have affected the subsoil. This analysis makes it is possible to relate events and phenomena in radically different periods and manifestations, but in a synchronous reading reveals long-term land uses and anthropic settlements.

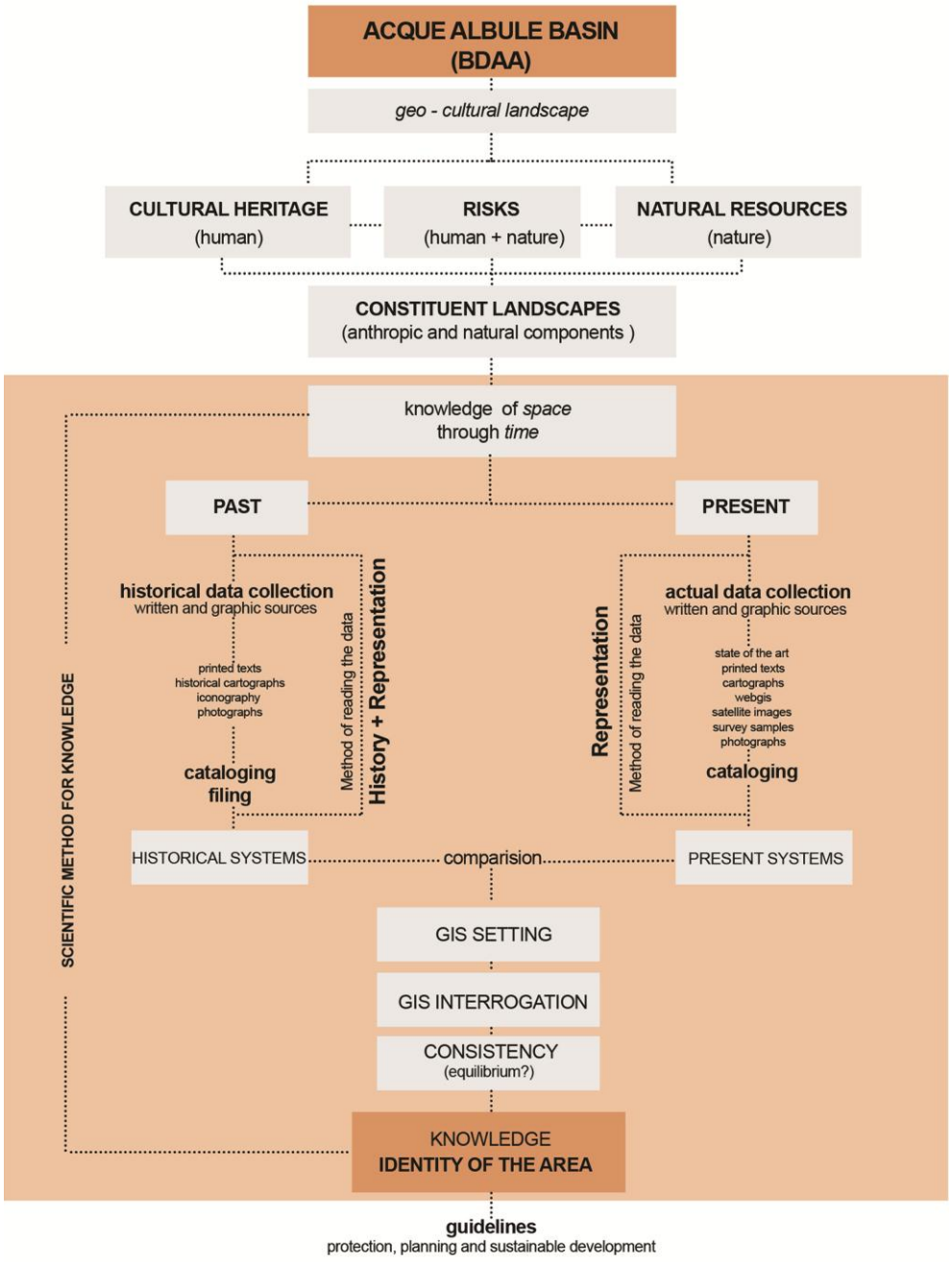
The present contribution is but a part of this broader topic and illustrates a *working methodology* based on the use of the *drawing* to investigate, systematize and obtain knowledge of geo-cultural scenarios. The Committee for the World Heritage defines as "cultural landscape" *those geographical areas that represent the combined activity of nature and man*. Recognizing the “geo-cultural” value of a landscape also means identifying the presence of those *structural elements* that resist transformation and affect the processes of anthropization: natural-cultural resources and geological-natural hazards.

The work presented here is being undertaken in the field of interdisciplinary research[1], which the writers have been carrying out for a few years now at the “Bacino delle Acque Albule” (or Albule Basin, hereinafter also BDAA). This portion of Tiburtino territory, crossed on the south by the Aniene River, is located in the northeast quadrant of the Metropolitan City of Rome Capital and is characterized by a geological conformation that rendered possible hydrothermal springs and travertine deposits. To date, the territory reveals a series of changes driven mostly by uncontrolled industrial exploitation, while actions aimed at enhancing the historical-cultural, landscape and environmental assets or addressing the complex recognition of the *identity* of the area are still too few. From the

[1] Research was carried out thanks to the work of a group of colleagues from the Dipartimento di Scienze della Terra dell’Università degli Studi di Roma Tre (Department of Earth Sciences of the University of Roma Tre) who are interested in *natural aspects*: that is geological, structural, geomorphological, hydro-geological, stratigraphic, seismic, and geochemical aspects, such as retrieval of quarrying sites through the specific analysis of compatible materials.

knowledge acquired[2] of the area, a method of investigating and obtaining results, illustrated below, has been developed and refined in BDAA, which can be applied to all geo-cultural landscapes presenting similar features (Figure 1).

Figure 1. *Scheme of Sperimental Process to Know a Geo-cultural Landscape*



Source: Silvia Rinalduzzi.

[2] A first result of this research was published in Land and Use Policy article *Geo-cultural landscaping: Guidelines and conceptual framework to design future scenarios of exploited lands* (Rinalduzzi et al., 2016), where those factors that made it possible to define the basin Bacino delle Acque Albule a geocultural landscape.

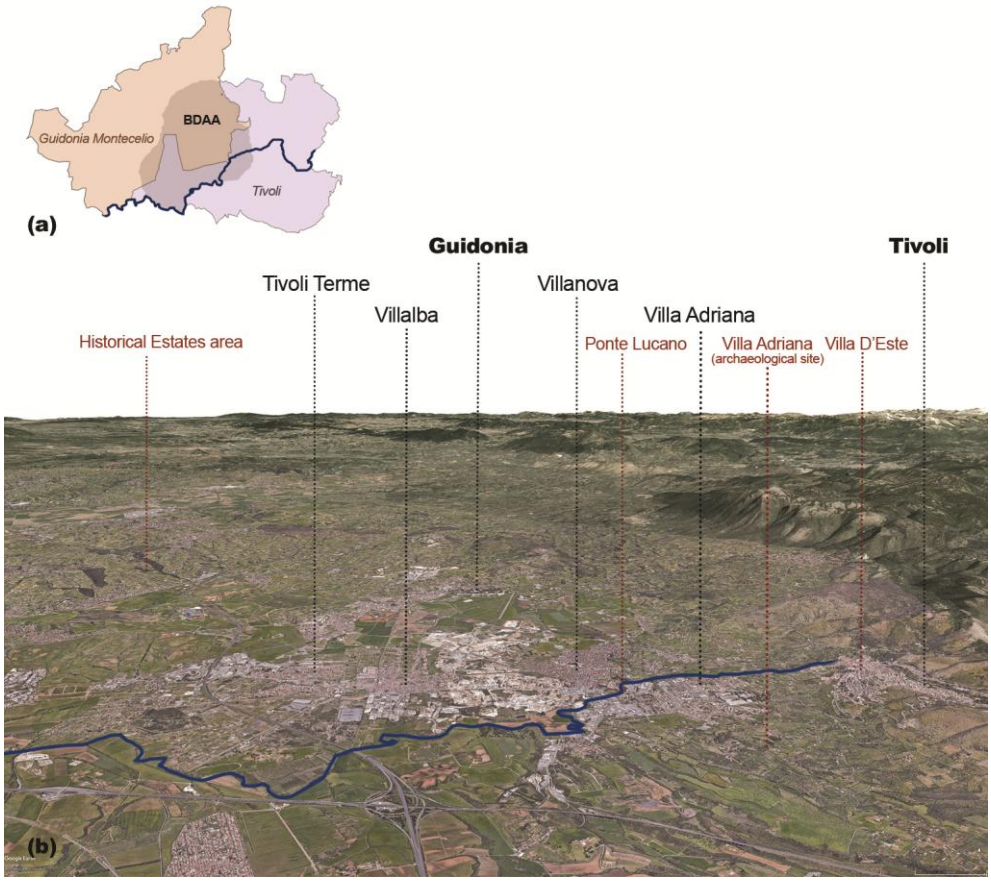
It, in fact, foresees varying degrees of flexibility in its application, given the differences that may be found among different scenarios. The aim was to come up with a relational database that implements the information systems already proposed by both local and national authorities through the creation of a specific database. The *heterogeneity* of the elements and the *multiplicity* of relationships found within the area of study find in drawing the transversal tool for the analysis, interpretation and discretization of data of a diverse nature and different spatial and temporal stratification. After the initial analysis phase, there follows always through drawings the re-composition of the interpreted data. Presently there are several databases (WebGIS) that can correlate the territory, the environment, the risks and the cultural assets present in the BDAA, but not all are easily consulted. Most are used only as containers of information.[3] The GIS setting, described further, is intended as a place of integration and critical return. Because of this, the *relational database* can handle general-level *data* in relation to data from investigations of specific fields and on the scale of details. In the following paragraphs, the present scenario of the Basin, the general working methodology, and the application to the specific case study will be outlined.

BDAA. Interaction between Settlements and Urban Development, Resources and Risks

The Acque Albule Basin is the scene of an unstable and precarious balance between environmental resources and risks that, over centuries, has contributed to making this site unique in its kind. The close link between a valuable architectural heritage and the abundance of water and travertine allows us to consider the Basin a "cultural landscape heritage". From an administrative point of view, this area is divided between the two municipalities of Tivoli and Guidonia, two neighboring areas but with very different approaches to the management of land and heritage (Figure 2).

[3] Among the best known: a) Regione Lazio: PTPR, SITR; b) Ministero dei Beni Culturali: SITAP, Vincoli in Rete, Carta del Rischio; c) ISPRA: Geoviewer, d) Ministero dell'Ambiente: Geoportale Nazionale; e) Città Metropolitana di Roma.

Figure 2. *BDAA (Acque Albule Basin): a) Location of the Basin between the Administrative Limits of Two Municipalities: Guidonia Montecelio (Pink) and Tivoli (Lilac); b) 3D Model taken from Google Heart of BDAA with Main Town and Sub Township (Black) and Most Important Historical Sites (Red)*



Source: Silvia Rinalduzzi.

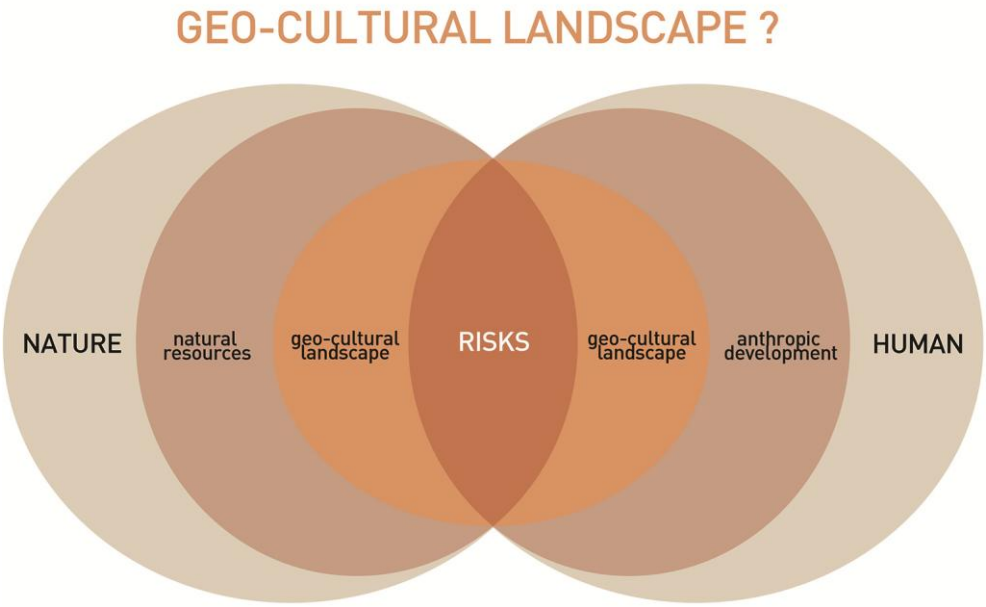
The Regulatory Plans of both municipalities, dating back to the 70s, identified possibilities for the area in the following: the service sector, tourism, quarrying, industrial and agricultural (in particular olive cultivation). However, the predominating interest is the quarrying sector. In fact, the quarries and related activities are still the protagonists of the present landscape, and even though characterized by their independence, they dominate urban development, to this day uncontrolled and oblivious to the natural hazards of the site. An example of this is the building of a sub township of Guidonia, Villalba located on the edge of a quarry and thus subjected to dusts and acoustic pollution, or inadvertently built above limestone sinkholes. Here, the houses are situated in an unorganized and non-continuous context. The territorial transformations are thus generated by heavy industrial exploitation: travertine quarrying today reaches very great depths and is a permanent and highly invasive activity, whose economic advantage is for only a few.

One must also not underestimate the desolation of abandoned quarries, both when left open and when covered over. In this context, however, there are important archaeological remains, some of which have almost

completely disappeared, whose traces can only be found in ancient iconography, and some distinctive buildings, testifying an anthropic process evolving since ancient Rome. Such buildings, however, are partially absorbed by urban transformations in which they play only a marginal role. Emblematic is the case of Ponte Lucano (Lucano Bridge), a key hub for ancient economy and viability, but today in a degraded state. Another is the example of Casale del Barco, only recently under the protection of the *Sopraintendenza Archeologia, Belle Arti e paesaggio per l'area metropolitana di Roma, la Provincia di Viterbo e l'etruria Meridionale*, and which is completely embedded in an industrial quarrying context containing traces of the ancient Roman quarry. The Casale Nuovo, also called Casale Bernini, is in a state of degradation as well, next to existing or covered quarries.

These contexts were analyzed in a recent study by the authors, in which they endeavored to reread the history of the ways in which anthropization occurred, linking this process to the relationship among natural resources, settlements - considering their location and extent - and the presence of geological or hydro-geological hazards. The study of human occupation and exploitation of this territory has thus evidenced aspects of BDAA's *cultural landscape*. Collaboration with geologist colleagues in the Land and Use Policy article [2] has linked this historical survey with studies they conducted on the presence of natural resources and environmental hazards (Figure 3).

Figure 3. *Diagram about Constituent Sets of Geo-cultural Landscape*



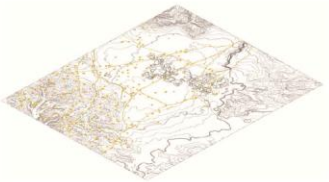
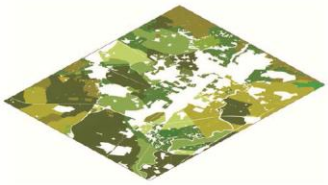
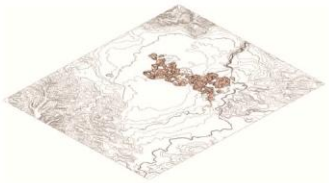
Source: Silvia Rinalduzzi.

Thus the definition of *cultural landscape* is expanded to become *geo-cultural landscape*, a macro context in which the constituent landscapes of the Basin may be identified as: the "stone landscape", the "water landscape", the "rural landscape", the "pre-existence landscape" and the "urban landscape" [3, 4].

Methodological Approach

These pages illustrate the application of a working methodology, oriented towards the verification of the *consistency of the anthropic and natural components* of the constituent landscapes. If we consider the landscape a system, in order to outline a critical view of the present situation it is necessary to compare the *present* systems to those of the *past*. The point of integration between the *past* and the *present* systems is GIS, which the authors are elaborating and preparing for critical data collection and retrieval. Both written and graphic sources have been consulted. To delineate the *systems present* printed texts, the thematic papers on geology (morphology, hydrography, lithology), Piani Paesistici Regionali (Regional Landscape Plans), Piano Regolatore and Carte del Rischio (Regulatory Plan and Risk Papers) were taken into consideration. Further digital sources, WebGIS prepared by ministries and regional authorities collecting and linking the cartographic data, as well as satellite images and photographs were consulted. The data acquisition was of details and surveys of sample data. The identification of *past systems* required a more articulated process. Specifically, the analysis drew from previously used methods of investigation [5, 6], though demonstrating obvious differences regarding application themes all agree in considering landscape “stratified phenomena” over time. Thus, the knowledge of the various temporal phases of BDAA occurred through a "virtual excavation"; that is through the reading of the information obtained, which allowed the site to be analyzed as a set of elements and processes located on the territory that generate an "interconnected" system of *shapes* located in a *space*. The *shapes* were recognized following the definitions of environmental archeology as existing testimony to natural (*eco-facts*) and anthropic-cultural (*artifacts*). The macroscopic *eco-facts* identified in the area of study are divided into: orography, hydrography, and vegetation. The macroscopic *artifacts* are divided into: urbanized areas, roadways, historical-architectural preexistences and outstanding buildings. *Natural resources* are travertine and water supply, while *natural hazards* are related to floods and subsidence phenomena. To individual landscape elements a time has been attributed: continuous, discontinuous, cyclic or interrupted, able to define their duration so as to link them to future monitoring and control activities. The interdisciplinary approach ensured the environment would be studied from the upper down to the deeper layers of the soil, thus defining, for each area of the landscape, what *remains* are still recognizable (Figure 4).

Figure 4. *Cataloging and Filing of Constituent Landscapes, through Time and Traces of Artifacts and Eco-facts*

CONSTITUENT ACTUAL LANDSCAPES	TIME	TRACES OF HISTORICAL LANDSCAPES	
		artifacts	ecofacts
urban landscape 	discontinuous	/	old town centre
preexistence landscape 	interrupted	/	archeological traces archeological streets
rural landscape 	continuous	cultivated filds	game reserve historical estate
⬆ UPPER LAYERS OF THE SOIL ⬆		⬇ DEEP LAYERS OF THE SOIL ⬇	
stone landscape 	cyclic	quarries	forni di calce Casale del Barco Casale Bernini Vapor train Guidonia …
water landscape 	continuous	Anienre river moats sulfurous lakes (lago delle Colonnelle, lago della Regina) drain lakes (lago dei Tartari)	cisterns drainage canals acqueducts thermal baths Villa D Este Villa Adriana Hydroelectric central paper fabric ….

Source: Silvia Rinalduzzi.

The methodology proposed for the preparation of historical systems and their relation to present systems will be illustrated below. As a *trait-d'union* among systems, the IGM 1872-1949 [7] was selected: initially adopted as a cartographic base for the planning of historical systems with CAD, and, for present ones, later geo-referenced in GIS.

Elaboration of Historical Systems

A reasoned bibliography was prepared, expanded during the course of the study and divided by constituent landscapes. The extrapolated information was linked to *keywords*, as a basis for the database and the links.

Data Retrieval through Written Sources

The consultation of written sources proved to be necessary, particularly for the understanding of the most ancient anthropization phases, from Prehistory to the 14th century AD, lacking figurative sources. The printed material were always examined keeping in mind the ultimate goal of locating, albeit with due approximations, the *artifacts* and *eco-facts* on the IGM paper. The terminologies used in the literature were also analyzed by cross-referencing with other sources to obtain a unique definition, where possible, of the interpretation. In texts relative to BDAA, for example, the term *Casales* is often used that does not always refer to a building (point location), but in maps refers to castles, fiefs or estates (spatial location). The toponyms are thus considered *keywords* linking the IGM card, the contents extrapolated from the texts and their relative bibliographic references (Figure 5).

Figure 5. *Sperimental Cataloging and Filing of Written Sources Information and their Location on IGM Map through Toponyms*

CATALOGING AND FILING - written sources print texts

CONTENT	KEYWORDS	BIBLIOGRAPHY
1) Scendendo a valle da Tivoli troviamo altre due testimonianze archeologiche connesse con l'acqua : **Ponte Lucano** e **Mausoleo dei Plauzi** […] Il primo risalente al I sec a.C., è un ponte a cinque archi, oggi solo in parte conservato , che consentiva alla via Tiburtina il passaggio e l'attraversamento sul fiume Aniene, in prossimità del punto di divergenza degli acquedotti dalla Valle dell'Aniene, dove si raggiunge Villa Adriana. La sua immagine, nelle numerose rappresentazioni d'epoca, è sempre associata al Mausoleo dei Plauzi, notevole edificio cilindrico (fine I sec. a.C. – inizi I d.C), rivestito in blocchi di travertino, sul cui prospetto si leggono le iscrizioni funerarie del fondatore Marco Plauzio Silvano e di suo figlio Tiberio. […]	**Ponte Lucano** **Mausoleo dei Plauzi**	1) M. Cogotti, *Il Paesaggio del Lazio. Tutela, conservazione, qualità della trasformazioni*, De Luca editori d'arte, Roma, 2008, pp. 141-175

LOCATION OF TOPONYMS

Source: Silvia Rinalduzzi.

Data Retrieval from Graphic Sources

The critical approach was even more essential in reading and recording *graphical sources.* Considering that historical cartography up to the 18th century is essentially represented by pseudo-perspective views, the orientation of the maps had to be identified and the reciprocal spatial relations, between the elements represented broadly evaluated. Historical cartographs, engravings, drawings, views, photographs reviewed belonging to a time span between the 14th century and the late 19th century were cataloged, identifying three macro levels of reading for each source analyzed: the first level covers the identification of mode and technique of representation, the second was a textual transcription of the image of the territory, and the third analyzes the

type of graphic discourse. In brief, the records were labeled A, B and C (Figure 6).

Figure 6. *Sperimental Cataloging and Filing of Graphic Sources Information: Historical Cartography and Maps. Table A) Raw Data Gathered. Presence of Components; Table B) Raw Data Gathered. Presence of Component; Table C) Elaborated Data Gathered. Abacus of Signs*

CATALOGING AND FILING - graphic sources — historical cartography and maps

A. RAW DATA GATHERED - PRESENCE OF COMPONENTS (general scheme)

DATE	TITLE	AUTHOR	USE OF CARTOGRAPHY (reading / analysis or consultation)	ORIENTATION	VIEW	PRESENCE OF COMPONENTS THROUGH GRAPHIC CODES							
						NATURAL ASPECTS	NATURAL RESOURCES			CONSTRUCTED HERITAGE			
						OROGRAPHY	TRAVERTINE	WATER	RURAL LANDSCAPE	ARCHEOLOGY	OUTSTANDING BUILDINGS	URBAN CENTRES	VIABILITY

A. RAW DATA GATHERED - PRESENCE OF COMPONENTS (concrete exemple)

DATE	TITLE	AUTHOR	USE	ORIENTATION	VIEW	PRESENCE OF COMPONENTS THROUGH GRAPHIC CODES							
						NATURAL ASPECTS	NATURAL RESOURCES			CONSTRUCTED HERITAGE			
1547	*Mappa della Campagna Romana ai tempi di Paolo III*	Eufrosino Della Volpaia	reading graphic codes and analysis		perspective		lime ovens swamps						

B. ELABORATED DATA GATHERED - READING OF SIGNS (general scheme)

DATE	TITLE	AUTHOR	TECHNIQUE AND COLOR / LOCATION AND BIBLIOGRAPHY	DESCRIPTION				READING OF COMPONENTS							
								NATURAL RESOURCES			CONSTRUCTED HERITAGE				
				ORIENTATION	GRAPHIC SCALE	SYMBOLS	VIABILITY TRACES	OROGRAPHY	TRAVERTINE	WATER	RURAL LANDSCAPE	ARCHEOLOGY	OUTSTANDING BUILDINGS	URBAN CENTRES	VIABILITY

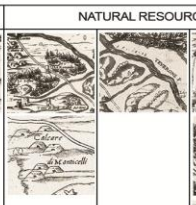
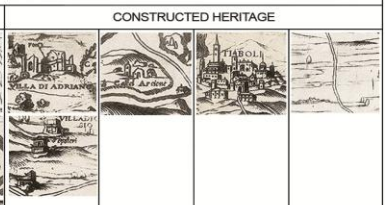
B. ELABORATED DATA GATHERED - READING OF SIGNS (concrete exemple)

DATE	TITLE	AUTHOR	TECHN. / COLOR	DESCRIPTION	READING OF COMPONENTS							
					NATURAL RESOURCES			CONSTRUCTED HERITAGE				
1547	*Mappa della Campagna Romana ai tempi di Paolo III*	Eufrosino Della Volpaia	Riproduzione: fototipia. Originale: inciso su rame. Assenza di colore. **LOCATION AND BIBLIOGRAPHY** Biblioteca Vaticana, Roma	ORIENTAMENTO: Nord-Est/Sud-Ovest SCALA GRAFICA : Miglia LEGENDA: non presente TRACCIATI VIARI : viabilità territoriale ad est di Roma che si dipartono dalle mura; la via Tiburtina, la Prenestina, la Labicana, la Latina. Non sembrano tenere conto dell'orografia OROGRAFIA: dettagliata	La palude de Le Sestine a Nord e de La Romandia a Sud occupano gli invasi delle antiche cave, ormai inutilizzate e colme di acqua. Ad Est de Le Sestine, andando verso Ponte Lucano, si collocano Le Calcare di Tigola, forni di calce che testimoniano un uso di verso della pietra calcarea.	Fiume Aniene, qui Teverone, é rappresentato qua e curve parallele e fitte. Un suo affluente, con andamento perpendicolare, costeggiando le peludi, giunge al Lago (Acque Albule).	Campi coltivati rappresentati con segni ordinati e paralleli che seguono le pendenze collinari. Ricca vegetaazione di canne e arbusti circonda i pantani, con qualche albero a Nord e sulle pendici del monte di Tiboli (Tivoli).	*Villa Adriana* *Villa di Cassio* *Sepolcri*	Nella piana: *Castel Arcione* *Torre de Sordi* *Torroni* *Torre S. Pietro* *Edificio a torre* *Ponte Lucano*	Tiboli	Due vie bianche percorrono il bacino non contrassegnate da toponimi: una va verso Nord Est, in direzione Montecelio, l'altra (la Via Tiburtina) arriva a Tivoli.

C. ELABORATED DATA GATHERED - ABACUS OF SIGNS (general scheme)

DATE	TITLE	AUTHOR	READING OF COMPONENTS							
			NATURAL ASPECTS	NATURAL RESOURCES			CONSTRUCTED HERITAGE			
			OROGRAPHY	TRAVERTINE	WATER	RURAL LANDSCAPE	ARCHEOLOGY	OUTSTANDING BUILDINGS	URBAN CENTRES	VIABILITY

C. ELABORATED DATA GATHERED - ABACUS OF SIGNS (concrete exemple)

DATE	TITLE	AUTHOR	READING OF COMPONENTS							
			NATURAL ASPECTS	NATURAL RESOURCES			CONSTRUCTED HERITAGE			
1547	*Mappa della Campagna Romana ai tempi di Paolo III*	Eufrosino Della Volpaia								

Source: Silvia Rinalduzzi.

The first "A" record shows the orientation, projection method, view used and the contents of the landscape elements, when present (raw data gathered). The “B” record contains an interpretation of the site in a descriptive text

through a specific analysis of the signs and graphic codes present in the cartography (elaborated data gathered). The "C" record presents in the form of an abacus the modality with which the elements were represented. In the canonical cataloging of graphical documents, which usually take into account the period, the author, the technique, scale of representation, the purpose and the content, the entries were integrated with items relating to the presence of natural elements, resources, and constructed heritage (Figure 7).

Figure 7. *Comparision betweem Canonical and New Filing Proposed for Historical Cartographies and Maps Cataloging*

N° CANONICAL FILING: **HISTORICAL CARTOGRAPHIES**	
GENERAL INFORMATION	-Date -Title -Author -Technique and color -Placement and bibliography -Description (graphic scale, orography)
ATTACHMENTS	- Full cartography

N° NEW FILING: **HISTORICAL CARTOGRAPHIES**		
GENERAL INFORMATION	-Date -Title -Author -Technique and color -Placement and bibliography -Description (graphic scale, orography, orientation, view, legend, routes)	
READING OF SIGNS	natural resouces	- travertine - water - rural landscape - spontaneous vegetation
	constructed heritage	- archeology - outstanding buildings - urban centers - viability
ATTACHMENTS	- full cartography - zoom of BDAA - list of signs	
ENVIRONMENTAL RISK ELEMENTS	water	- swamp - river deviations
KEYWORD		

Source: Silvia Rinalduzzi.

The environmental context, the existence of visual axes linked to the territory, and the descriptions of the individual artifacts depicted were obtained by analyzing and cataloging the engravings, drawings, views and photographs (Figure 8).

Figure 8. *Sperimental Cataloging and Filing of Graphic Sources Information: Table A) Historical Iconography, Table B) Historical Photographs*

CATALOGING AND FILING - graphic sources — Historical iconography and photographs

A. ICONOGRAPHY (general scheme)

DATE	TITLE	AUTHOR	TECHNIQUE AND COLOR / LOCATION AND BIBLIOGRAPHY	SUBJECT (toponyms)	NATURAL RESOURCES	CONSTRUCTED HERITAGE	IMAGE	POINT OF VIEW
					TRAVERTINE WATER RURAL LANDSCAPE	ARCHEOLOGY OUTSTANDING BUILDINGS URBAN CENTRES VIABILITY		

A. ICONOGRAPHY (concrete exemple)

DATE	TITLE	AUTHOR	TECHN./COLOR / LOCATION AND BIBLIOGRAPHY	SUBJECT	NATURAL RESOURCES	CONSTRUCTED HERITAGE	IMAGE	POINT OF VIEW
1796	*Tivoli. Ponte Lucano, bella veduta complesso architettonico con il ponte e il mausoleo. Il fiume in primo piano.*	Smith, J.	inc. in rame Smith J., Select views in Italy with topographical and historical descriprionts in English and Franch, London Chapman, 1792-96	Ponte Lucano Mausole dei Plauzi	TRAVERTINE / WATER fiume Aniene RURAL LANDSCAPE Vegetazione arbustiva e spontanea nei pressi del letto del fiume. Alberi vicino al Mausoleo e alla Locanda	ARCHEOLOGY / OUTSTANDING BUILDINGS Ponte Lucano Mausoleo dei Plautii Locanda Medioevale URBAN CENTRES / VIABILITY Snodo della viabilità tiburtina		

B. PHOTOGRAPHS (concrete exemple)

DATE	TITLE	AUTHOR	TECHN./COLOR / LOCATION AND BIBLIOGRAPHY	SUBJECT	NATURAL RESOURCES	CONSTRUCTED HERITAGE	IMAGE	POINT OF VIEW
1879 - 1895	*Tivoli. Veduta di ponte Lucano sul fiume Aniene. Sullo sfondo la struttura circolare della tomba della famiglia dei Plauti*	/	albumina/carta Iccd, Istituto Centrale per il Catalogo e la Documentazione Nr. inventario FB004799_31	Ponte Lucano Mausole dei Plauzi	TRAVERTINE / WATER Fiume Aniene. Situazione di innalzamento del livello dell'acqua causa periodo di piena. RURAL LANDSCAPE Vegetazione arbustiva e spontanea nei pressi del letto del fiume. Alberi vicino al Mausoleo e alla Locanda	ARCHEOLOGY / OUTSTANDING BUILDINGS Ponte Lucano Mausoleo dei Plautii Locanda Medioevale URBAN CENTRES / VIABILITY Snodo della viabilità tiburtina		

LOCATION OF TOPONYMS

Source: Silvia Rinalduzzi.

Here also, the iconographic documentation integrated the usual cataloging of archives (title, author, technique, date, subject, location) with items concerning the presence of natural and anthropic-cultural components. Furthermore, information on the point of view and the field of view was associated with the reference IGM map, thus establishing the possible location of the subject represented and the observer (Figure 9).

Figure 9. *Comparision betweem Canonical and New Filing Proposed for Historical Iconographies and Photographs Cataloging*

N° CANONICAL FILING: **ICONOGRAPHY AND PHOTOGRAPHS**	
GENERAL INFORMATION	-Date -Title -Author -Technique and color -Placement and bibliography -Description
ATTACHMENTS	- full iconography - full photographs

N° NEW FILING: **ICONOGRAPHY AND PHOTOGRAPHS**		
GENERAL INFORMATION	-Date -Title -Author -Technique and color -Placement and bibliography -Description (angle of observation,framing, proportions; point of view)	
READING OF SIGNS	natural resouces	- travertine - water - rural landscape - spontaneous vegetation
	constructed heritage	- archeology - outstanding buildings - urban centers - viability
ATTACHMENTS	- full iconography - full photographs	
ENVIRONMENTAL RISK ELEMENTS	water	- swamp - river deviations
KEYWORD		

Source: Silvia Rinalduzzi

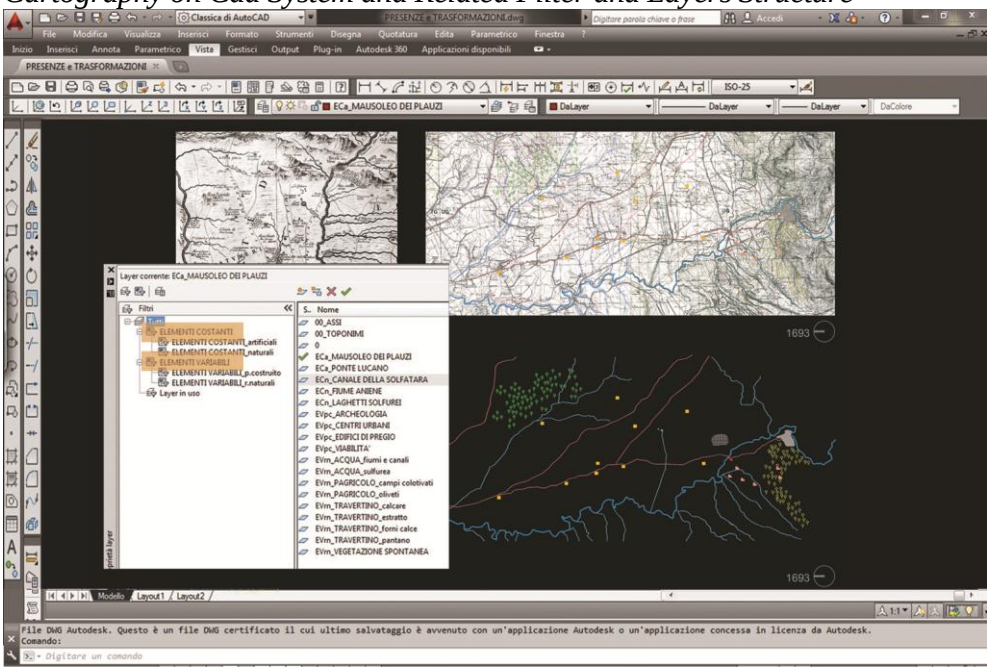
Notes on Interpreting the Documents

When identifying in the historical maps *eco-facts* and *artifacts*, the cultural background of the author, the intentions that guided the work, and the cultural milieu in which it was realized were taken into account. It is possible in fact that we do not find the same elements in drawings of the same period. The hydrographic system, for example, though present in all the maps, varies depending on the representation. The tributaries of the Aniene river and the sulphur springs were either present or not depending on the scale or purpose of the drawing or the orographic or anthropic elements. The archaeological area near the Agrippa thermal baths is at times characterized by the small lakes of the Acque Albule or the Tenute Storiche (Historical Estates), and at other times by the presence of the systems of ditches to the west of the Basin. The signs relative to the cultivated areas on the hills, on the other hand, persist and are evident even in the oldest cartographies used [8]. The signs of travertine quarrying, on the other hand, change either according to the mode of exploitation of the deposits (travertine quarry [9], lime quarry [10]) or to the type of cutting performed (as the extractive technology refined and went deeper, cutting became more regular [11]). The interpretation of natural hazards that affected this territory in the past was obtained by comparing historical drawings and identifying in the landscape representation those differences that could be due to the occurrence of natural events. By cross referencing these data with those derived from written sources, it was possible to identify the period of the transformations. Floods, for example, were a commonly identified transformation. In fact, some parts of the territory are represented as active quarry zones surrounded by settlements and, in subsequent maps, as uninhabited wetlands, thus demonstrating the varying settling or use of the territory.

Vectorialization of Historical Systems

Each landscape setting, identified in each cartography, was obtained from the vector drawing of the components on the basis of the IGM cartographic basis, retracing the relative forms and then geo-referencing them. The typology of artifacts and eco-facts indicated the structure of the key. As mentioned, the analysis shows that some elements may be found in all representations, while others are not. To distinguish these, two filters were adopted and labeled *constant elements* and *variable elements*. The constant elements could be both artificial (such as Ponte Lucano and Mausoleo dei Plautii) and natural (such as Aniene River and Canale della Solfatara). The variable elements follow the structure of the filing system and are divided into elements of *constructed heritage*: archaeological remains, outstanding buildings, urban centers, viability and *natural resources*: *travertine* (in all its temporal changes, pond, limestone, limestone furnaces, quarried material), *water*, (channels and rivers and hydrothermal springs), *agricultural landscape* (olive groves, cultivated fields) and *spontaneous vegetation*. Thus we have *defined the historical systems*, which constitute thematic vector maps, referenced by year and geo-referenced (Figure 10) to enable the spatial comprehension of objects, concepts and human processes.

Figure 10. *Work Screenshot about Vectorialization Process of 1963 Historical Cartography on Cad System and Related Filter and Layers Structure*



Source: Silvia Rinalduzzi.

Relationship between Historical and Present Systems

GIS Setting: Structure and Originality

The information contained in the WebGIS available today comes from associations, regional or ministerial entities and, as stated, concern the territory, the environment, risks and cultural assets. However, the intersection of information across different layers and the interpretation (for example, architectural resources and risk areas) is entrusted to the user's expert reading, thus requiring a significant amount of time. The purpose of the database proposed here is to relate the various elements that make up the BDAA landscape by providing a reading that links information among natural, anthropic and cultural domains.

The system developed considers on the basis of a critical selection only some of the layers relating to present systems, and is characterized by the introduction of *vectors* constituting historical systems and arranged tables of *attributes* with interdisciplinary entries. The experimentation was carried out based on three scales of detail: 1:25000 for the reconnaissance of the macro components (historical and present systems); 1:5000 for reconnaissance of precise eco-factors and artifacts; 1:500 for detailed information. The structure of the system is subdivided into four sections: *present systems*, *historical systems*, *historical remainsin existing systems*, *environmental risks* (Figure 11).

Figure 11. *Structure of GIS Layers*

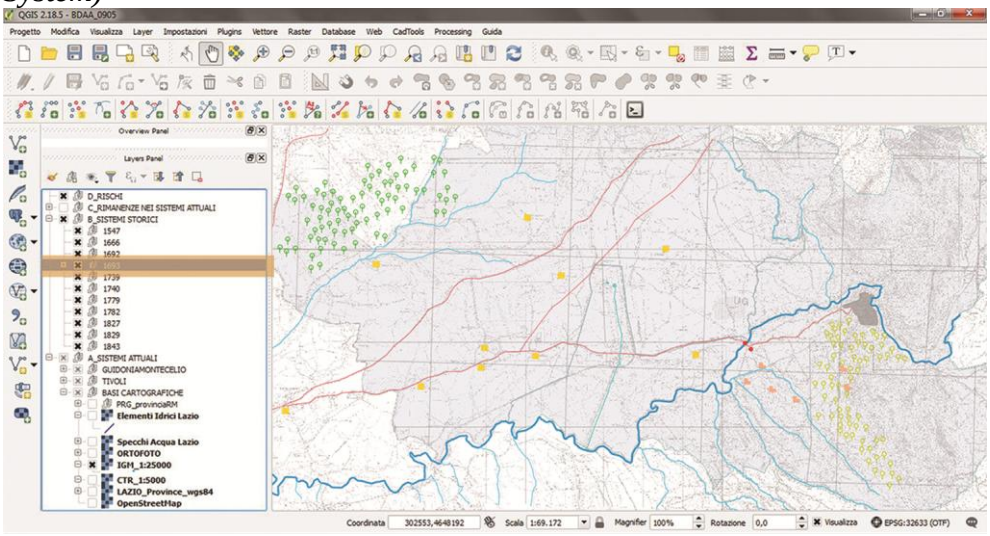
SECTION	SUB - SECTION	CONTENT	TIPOLOGY	GRAPHIC SCALE
ENVIRONMENTAL RISKS	Seismic risk	(to define)		
	Hydro-geological risk	*Flood risk* *Flood hazard*	vector	1:25000
		(zoning carried out by the PAI)		
REMAINS IN PRESENT SYSTEMS	Archifact	*Puntual and linear assets*	vector	1:5000 1:500
	Eco - fact	*(selection of the levels in Table B of Landscape Assets Regional Landscape Territorial Plan, 2006)*		1:5000
HISTORICAL SYSTEMS	1547 1666 1692 1693 1739 1740 1779 1782 1827 1829 1845	*Vector maps of the historical systems*	vector	1:25000
PRESENT SYSTEMS	Municipality of Guidonia Municipality of Tivoli	*Administrative limits* *Road access* *Altimetry* *Hydrography* *Construction*	vector	1:5000
	Cartographic bases	*Open Street Map (2016)* *Boundaries of the provinces in Lazio* *CTR - Regional Technical Map (2002-2006)* *Orthophoto (2007)* *IGM map (1872-49)* *Mosaic of the General Regulatory Plan*	vector/raster vector raster raster raster vector	/ 1:75000 1:5000 / 1:25000 1:10000

Source: Silvia Rinalduzzi.

Unlike historical systems developed directly ex-novo by the authors of this text, *present systems* inserted in the GIS are the result of a targeted selection of data already present in the national and regional databases, linked to the system via WMS links (Web Map Service) and suitably geo-

referenced. In Italy, many administrations are updating cartographic production to facilitate sharing information via Topographic Databases, also accessible to external users. For the Lazio Region this service is only available as of March 2017. The section of *present systems* is therefore composed of three subgroups of layers from the aforementioned sources: the vectors concerning the Municipality of Guidonia Montecelio, vectors concerning the Municipality of Tivoli and the raster layers selected as cartographic bases. These latter are the web layer of Open Street Map (selected as the most recent base), the boundaries of the provinces in Lazio, the raster assembly of the Carta Tecnica Regionale (CTR - Regional Technical Map) at 1:5000 scale for 2002-2006, a 2007 orthophoto, the IGM 1872- 1949 map and the Mosaico del Piano Regolatore Generale (Mosaic of the General Regulatory Plan) with unified caption. For the Municipality of Guidonia and the Municipality of Tivoli, some CTR shape files were selected on a scale of 1:5000 for the year 2002-2003: *administrative limits*, *altimetry*, *hydrography*, *construction* and *road access*. The first two are considered constant and invariable over time, while the latter are being updated using the observation of satellite imagery. Vector maps of the *historical systems* are imported as DXF files in the GIS system through the geo-referencing process and are superimposed over present systems. This allows for an immediate thematic and chronological comparison of all reported data in historical or current cartography (Figure 12), taking into account the monitoring of transformations and the concatenation of cause and effect of phenomena.

Figure 12. *Work Screenshot of GIS. Comparison between IGM 1872-1949 Map (Black and White Base) and 1963 Historical System (Colored Vector System)*



Source: Silvia Rinalduzzi.

The section of *remains in existing systems* is also subdivided into two subgroups, artifacts and eco-facts. The contents of these two categories is obtained from a selection of the levels in Table B, Beni Paesaggistici, del Piano Territoriale Paesistico Regionale del 2006 (Landscape Assets of the 2006 Regional Landscape Territorial Plan). From an operative perspective,

we have been importing in our new database shape files from the Lazio Region's database. Since WebGIS constitutes a descriptive, prescriptive and propositional control tool aimed at landscape conservation, the record provided is linked to a file referring to the legal article that describes the tutelage procedure (conservation, preservation, use or enhancement).

In this section the information elaborated in MiBACT, Carta del Rischio and Vincoli in rete (Risk Paper and Constraints Network), was consulted as well. Both classify Cultural Property (cataloged by authors as artifacts) in relation to risk factors and hazards. The relationship seems to be included in a scalar interval far too large since the territorial indicator is related directly to the building record, omitting the map of local hazards and possible responses of the construction itself.

The section on *environmental risks* is divided into two subgroups of risk types found in the area: *seismic risk* and *hydro-geological risk*. This information had already been systematized in other databases, with national or regional scale of representation, and then imported as shape files or WMS links. Other data, however, are the result of studies conducted by geologists from Roma Tre and CNR, who have investigated the BDAA area on a more detailed scale.

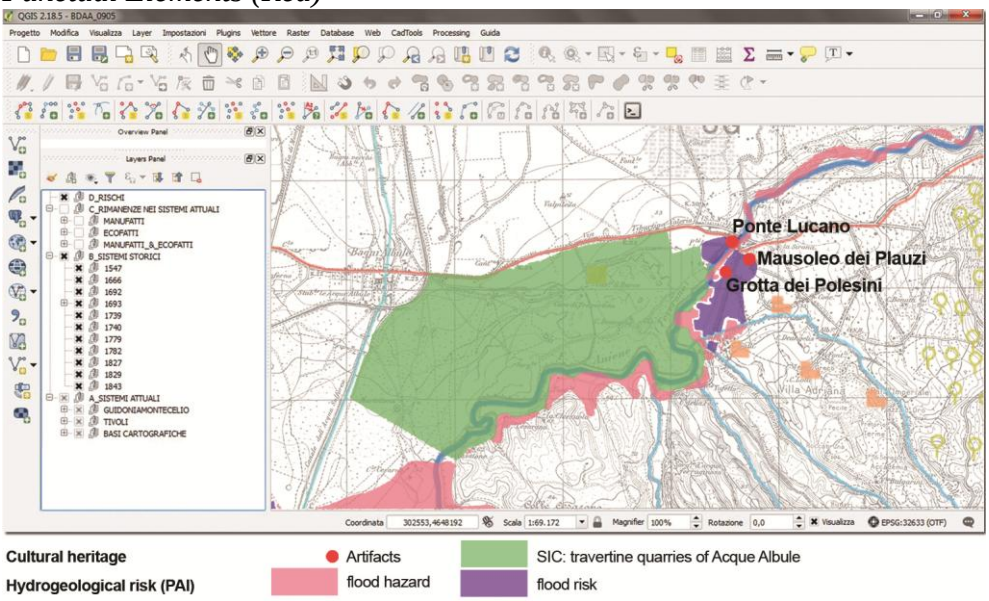
At present, the BDAA GIS is updated on information for environmental issues regarding water resources. The hydrogeological risk layers are due to a zoning carried out by the PAI (Piano d'Assetto Idrogeologico - Hydrogeological Condition Plan), covering the hydrogeological hazards and the hydrogeological risks. With regard to the first, in particular, the surface area was obtained around the flood hazards, much of which adjacent to Aniene is affected, and the one indicating the risks of landslides occurring at the border of the quarries due to the rise of the groundwater, but also on a macro-level the historical center of Tivoli.

Notes on the GIS Structure

The diversity of information being collected and systematized is justified by the fact that the BDAA GIS deals with information relative to the phenomena found in sites evidencing the collision between *environmental-setting* and *human-setting* on local, detailed and territorial scale. Though the research has carried out the study of eco-facts and artifacts simultaneously, the first phase of the preparation of the GIS focused on implementing a census and a catalog relative to detailed and linear immovable heritage. A table of attributes is assigned to them to identify the asset in the *system-geo-cultural landscape* and *environmental risk* of which it is part. This combines the various items relating the general aspects of the artifact and the environmental risk in the landscape context in which it is inserted. The authors are also expanding the section of attachments, including, where possible, records of the surveys undertaken and the resulting 3D models (as in the case of Casale Nuovo) and, in general, enriching the section with cartographic views, iconography, photographs (past and present) in which the artifact is present. To understand the importance of simultaneous readings of information, one may refer to the case of the Ponte Lucano (Lucano Bridge) area analyzing the *site* and *artifacts*. The analysis of

historical cartography and iconography (*historical systems*) shows that: a) historically the area is a crucial section of the Basin as hub of the Tiburtina roadways since ancient Rome; the Ponte, also located near the oldest travertine quarries in the Barco area, was where those traveling along Via Tiburtina crossed the river, traveling between Rome and Tivoli; b) the area is characterized by the presence of various remains (artifacts), such as the Lucano Bridge, the Mausoleodei Plauzi (Mausoleum) adjacent to it, and the prehistoric Grotto dei Polesini; c) the area historically falls within territory subject to periods of overflow of the River Aniene, as evidenced from historical documents. The 1826 flood was the most devastating and most recent, after which hydraulic defenses were constructed (Villa Gregoriana) and environmental reclamation undertaken; d) the industrial interventions along the river banks have narrowed the width of the bed, resulting in an increase in the river's height; and e) hydraulic defense works were undertaken, consisting of the construction of reinforced concrete embankments on the left side. The analysis of present systems reveals that: a) the area is subject to hydro-geological risks, specifically flood risks (PAI); b) the area is adjacent to SIC (systems of interest to the community) area of the travertine quarries of Acque Albule; and c) the area is not connected to the tourist system of the adjacent archaeological parks of Villa Gregoriana, Acquoria area and Villa Adriana (Figure 13).

Figure 13. *Work Screenshot of GIS. Comparison between IGM 1872-1949 Map (Black and White Base, 1963 Historical System (Colored Vector System), Hydrogeological Risk, PAI (Colored Shape Areas) and Cultural Heritage Punctual Elements (Red)*



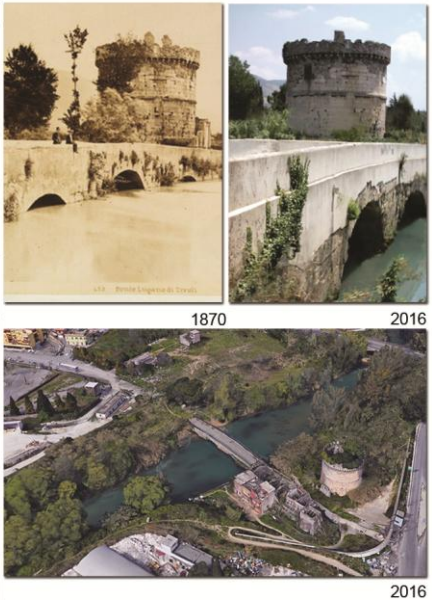
Source: Silvia Rinalduzzi.

Regarding the Ponte Lucano artifacts, the records with historical, landscape and risk information were prepared as shown in the Table of Figure 14. From the implementation of the system of information of the artifacts and their location it appears that the site has always been at risk of flooding, but that interventions on the banks (cfr. item d) have done nothing

but increase that risk. The area is furthermore isolated from the surrounding urban fabric and has, paradoxically, become the site where water from the Aniene floods flow. These phenomena have expanded due to partial and inopportune recovery operations that have led to the current situation of degrade (Figure 14).

Figure 14. *New Filing Proposed for Punctual or Linear Artifact (Left) and Comparision between Ponte Lucano Situation in 1870 and 2016 (Right)*

N° NEW FILING FOR ARTIFACT (ex.PONTE LUCANO)		
GENERAL INFORMATION	location	- municipality - historical toponymy - cadastral sheet
	building and pertinence	- class - tipology
	chronology	- hystorical period - date - motivation for date
	description	- plant - state of preservation - coverage - original function - actual use
ARTIFACT IN CONTEXT	natural resouces	- travertine - water - rural landscape - spontaneous veg.
	constructed heritage	- archeology - outstanding b. - urban centers - viability
ATTACHMENTS	- historical cartography (cutted part) - iconography - historical photograph - actual photograph	
ARTIFACT AND ENVIRONMENTAL RISK	water	- swamp - river deviations - flood hazard
	sejsmic risk	- faults - sinkholes
PROTECTION AND CONSERVATION LEGISLATIVE REFERENCE		



Source: Silvia Rinalduzzi.

The purpose of GIS is therefore to reconstruct the long-term reasons for the state of affairs, and to make it possible to identify possible courses for environmental recovery.

Conclusions

The work presented here is only part of a broader research on the Acque Albule, or BDAA. The complexity of the transformations of this territory in past millennia and in recent centuries makes it necessary to monitor the state of all its components, both natural and anthropic. This has prompted the authors to undertake an interdisciplinary and interscalar study that would allow a global vision of the territory under examination. This led to the need to standardize different languages and to consider time as a variable. This is fundamental to understanding not only the present phenomena, but also the stratifications that have occurred, of which memory is often lost. The existing maps of risks are on a territorial scale, and absent is the response to risks, part of the history of the site and of its composing elements. Those activities structure the ongoing experiment towards the creation of a cognitive framework and may induce reflections on possible sustainable reprogramming of the territory. The urban fabric and its structures can be listed as follows:

- Read, interpret and graph the transformations that have taken place over time to enable the identification of the characteristic elements of a territory and understand how they can result from the relationship between resources and human activity over time.
- Conduct a survey of landscapes that have consolidated or changed over time to understand the existing risks and potentials of a territory.
- Expand the census methods of cultural assets in historical or environmental settings, enabling identification of characteristic objects subject to environmental risk.
- Predispose the cross check of information among the different layers and their interpretation (for example, architectural heritage and the risk area) towards a direct reading, which also takes into account the time necessary for data recognition.

Furthermore, the multidisciplinary approach taken with the GIS system aims at responding to cross-interrogations, beyond the usual *queries* relative to criteria such as spatial, superposition, inclusion and proximity.

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sue stampe in Roma alla Pace con privilegio del Sommo Pontefice e Licenza de Sup. Anno 1693, Parte prima Terrestre del Lazio [...] [Lazio with its most prominent ancient streets, and modern and main houses, and kept of it. Described by Giacomo Filippo Ameti Romano and given to light by Domenico Rossi heir of Gio.Giac.de Rossi from his prints in Rome to Peace with the privilege of the Supreme Pontiff and License of Sup. Year 1693, Part One Terrestrial of Lazio [...]]. 1693.

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