XXI Convegno Internazionale Interdisciplinare
The 21st International Interdisciplinary Conference

Il Paradiso perduto del Mosaico paesistico-culturale. Attrattività, Armonia, Atarassia
Paradise Lost of the Landscape-cultural Mosaic. Attractiveness, Harmony, Atarassia

RELAZIONI BREVI SCRITTE/POSTERS

La visione è libera durante tutto il convegno

Clelia Cirillo 1, Barbara Bertoli 1, Giovanna Acampora 1, Marina Russo 1, Luigi Scarpa 2 (1 CNR Istituto di Biologia Agroambientale e Forestale U.O.S., Napoli, Italia; 2 Università Federico II - Scuola di Master di Pianificazione Urbana, Napoli, Italia)

Storia, arte e contemporaneità nel paesaggio vesuviano: il miglio d’oro

Davide Longato 1, Alessandro Pomes 1, Mattias Gaglio 2, Giulia Lucertini 1, Denis Maragno 1 (1 Dpt Design and Planning in Complex Environment, University Iuav of Venice; 2 Dpt Life Sciences and Biotechnology, Section of Evolutionary Biology, University of Ferrara)

Renewable Energy Supply and Landscape Value: an Achievable Harmonization

Maurizio Villata (Politecnico di Torino, Scuola di Specializzazione in Beni Architettonici e del Paesaggio)

Il «terzo occhio» sul paesaggio: lo sguardo sinestetico della poesia nella percezione delle langhe piemontesi

Per Informazioni
Segreteria organizzativa c/o Dipartimento di Progettazione e Pianificazione in Ambienti Complessi (DPPAC), Università IUAV di Venezia

SITO CONVEGNO
https://sites.google.com/site/landscapewonder/2017-conference
Ore 8.30 Aula Tafuri, Palazzo Badoer
Apertura Segreteria e Registrazione dei partecipanti / Registration

Ore 9.00
PLENARIE DI SINTESI P-Q/ SYNTHESIS PLENARY SESSIONS P-Q
ATTRAZIONE - ARMONIA / ATTRACTION - HARMONY

Chairperson Marina SCHENKEL
Università di Udine

Lorenza Gasparella (Fondazione Benetton Studi e Ricerche)
Mas a menor floresta será sempre maior que o mais alto castelo. Il bosco tra immaginazione e realtà
Donatella Di Gregorio, Alfonso Picone Chiodo, Agata Nicolosi
(Università Mediterranea di Reggio Calabria, Dip. Agraria)
Paesaggi culturali e sentieri della memoria: strumenti di sviluppo per territori e comunità
Teodoro Semeraro, Roberta Aretano (University of Salento, Lecce)
Rigenerazione paesaggistica nei sistemi socio ecologici: un processo senza tempo
Luigi Corniello, Giuseppe Morelli (Dip. Architettura e Disegno Industriale, Università di Firenze, Dipartimento di Architettura)

Ore 11.00
INDIRIZZI DI SALUTO

Chairperson Ting Fa Margherita CHANG
Coordinatore Dottorato di Ricerca in Ingegneria Civile, Architettura e Territorio, Università di Udine

Livio C. Piccinini Presidente Nazionale IPSAPA
Piercarlo Romagnoni Direttore Dipartimento di Progettazione e Pianificazione in Ambienti Complessi, IUAV
Matelda Reho Responsabile Organizzazione Convegno, IUAV
Luigi Cuttinì Presidente SOVAMM
Gilberto Marzano Presidente Ecosistema del FVG

Ore 11.30
RELAZIONE INTRODUTTIVA AI TEMI DEL CONVEGNO
INTRODUCTORY LECTURE

Livio C. Piccinini (Presidente Nazionale IPSAPA)

Ore 11.50
SESSIONE PLENARIA A-B/ PLENARY SECTION A-B
L’IMAGINARIOPAESISTICO-CULTURALE /

Chairperson Matelda REHO
IUAV

Valentina Rosa Laganà, Agata Nicolosi, Wilhelm Skoglund, Claudio Marciàno (Università Mediterranea di Reggio Calabria, Dipartimento di Agraria)
Cultura scenografica e immaginario paesistico: l’opinione dei consumatori in regioni del nord e del sud Europa
Andrea Oldani (DASIU, Politecnico di Milano)
Acqua umanizzata e paesaggi d’invenzione
Livio Clemente Piccinini, Maria Antonietta Lepellere (Università di Udine)
The mathematical teaching of Emnio De Giorgi and his project reality
Anita Calegari (Architetto, Pavia)
Caratteri del mosaico paesistico-culturale in Oltrepò Pavese
Luís Ochoa Sigüenza 1, Gilberto Marzano 2, Sabina Grzesiak 1 (1 Rezekne Academy of Technologies, Latvia; 2 Rezekne Academy of Technologies, Latvia)
A Mobile App to Disclose the Identity Values Associated to a Place

Ore 13.05
Discussione / Discussion

Ore 13.30
Pranzo di lavoro / Lunch

Ore 14.40
Assemblea dell’Associazione Interregionale Partecipazione e Studi in Agribusiness Paesaggio e Ambiente (IPSAPA)

Chairperson Livio C. PICCININI
Presidente dell’Associazione Interregionale Partecipazione e Studi in Agribusiness Paesaggio e Ambiente (IPSAPA)

Ore 15.40
SESSIONE PLENARIA C/ PLENARY SECTION C
I LUOGHI DELL’ARTE

Chairperson Piero PEDROCCO
Università di Udine

Marianeresa Gianmetti (Università di Napoli Federico II, Diarc)
DOOR_A. The DOORs of Archeology
Antonella Versaci 1, Alessio Cardaci 2 (1 Università di Enna KORE; 2 Università di Bergamo)
Il porto di Messina, cuore produttivo della città, tra evoluzione e involuzione
Marina Schenkel (Università di Udine)
The defence of the landscape: the case of Venice Regulatory Plan (PRG)
Anna Pellegrino 1, Gilberto Marzano 2 (1 University of Udine, Italy; 2 Rezekne Academy of Technologies, Latvia)
L’arte del paesaggio dall’estetica all’etica: la trasformazione territoriale sostenibile tra bellezza e terapeuticità
Daniela Cinti (Università di Firenze, Dipartimento di Architettura)
Paesaggi culturali nel parco agricolo della piana Firenze-Prato. Il sogno produttivo di Lorenzo il Magnifico alle Cascine di Tavola

Ore 17.05
Discussione / Discussion
**SESSIONE PLENARIA D / PLENARY SECTION D**
La cultura materiale / The material culture

Chairperson  Livio C. PICCININI
Presidente IPSAPA

Ginevra Balotto, Stefano Naitza, Giulia Desogus (Università di Ca-gliari)

Stone in the City. Extraction Sites and Spilliation of Stone Materi-als in the City of Nora (South -West Sardinia)

Margherita Chang Ting Fa, Luca Iseppi (Dipartimento di Scienze Agro-Alimentari, Ambientali e Animali, Università di Udine)

The rural world: a lost paradise between technology and intensive exploitation

Nadia Fabris (Dipartimento DAD, Politecnico di Torino, Italia)

Il paesaggio ritrovato la rappresentazione artistica delle Grange Elisabetta Maino, Daniele Torreggiani, Giulia Gatta, Patrizia Tassinari (Dipartimento di Scienze Agrarie, Università di Bologna)

Strategie per migliorare l’armonia del paesaggio urbano: il caso degli spazi aperti dell’Alma Mater Studiorum (Emilia Romagna, Italia)

Gina Busceni 1, Valeria Scavone 2 (1 Architetto; 2 Università di Pa-lermo, Dipartimento Architettura)

La rinascita di un paesaggio

Francesco Bortot (Studio in Formazione, Sviluppo, CSR e Partecipa-zione, Milano)

Il paradiso perduto dei molteplici distretti: apprendimento resi-lente tra armonia locale sociale e attrattività globale virtuale

Ore 12.35  Discussion / Discussion

Ore 13.00  Chiusura dei lavori

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**PLENARIE SCRITTE**

Giuseppe Abbate (D’Arch, Università di Palermo)
La riscoperta dei territori della Sicilia sud-orientale
Filippo Angelucci (Università G. d’Annunzio’ì Chieti-Pescara)
Orizzonti di innovazione tecnologica tra salute e qualità per una nuova armonia dei borghi minori italiani
Roberta Aretano, Teodoro Semeraro, Luca Parlagreco, Irene Petrosillo, Giovanni Zarfimi (University of Salento, Lecce)
Landscape Dynamic Vs People Perception for an Effective Conservation and Protection of the Coastal Landscape
Zaira Barone (D’Arch, Università di Palermo)
Il palazzo Abatellis di Palermo, dalle ricostruzioni post-belliche all’allestimento di Carlo Scarpa
Claudia Battaino, Luca Zecchin (DICAM, Università di Trento)
Intersezioni fra visibile e invisibile
Daniele Cacace (Dip. Architettura e Disegno Industriale, Università della Campania “Luigi Vanvitelli”, Aversa, CE)
Il disegno come strumento di conoscenza. Modificazioni antropiche e naturali nella Valle del Sarno tra XIX e XXI secolo
Assunta Campi, Lester Lonardo (Dip. Architettura e Disegno Industriale, Università della Campania “Luigi Vanvitelli”, Aversa, CE)
Medioevo riscoperto, Medioevo dimenticato: insediamenti e paesaggi dell’alto Casertano alla luce dell’archeologia
Francesca Castanò, Giangaspere Mingione (Dip. Architettura e Disegno Industriale, Università della Campania “Luigi Vanvitelli”, Aversa, CE)
Il paradiso perduto dei molteplici distretti: apprendimento residuente tra armonia locale sociale e attrattività globale virtuale
Carlo Dal Cortivo (Dip. Cultura e civiltà, Università di Verona)
La soggettività del bello: arte come cura dell’atarassia
Giorgio D’Anna (D’Arch, Dip. Architettura, Università di Palermo)
Oltre il racconto letterario, La Sicilia e i paesaggi del grano e dello zolfo

Irina-Virginia Dragulianescu 1, Armenia Andronicanu 2, Daniela Simona Nenciu 1 (1 Dimitrie Cantemir’Christian University Constan-ta; 2 Bucharest University of Economic Studies)
Cultural Tourism Attractiveness and Harmony of the Territory

Mariantonietta Fiore, Francesco Comtò (University of Foggia, Dip. Economics)
An Intelligence Artificial model for investigating epicurean at-arassia-apone in emotional landscape mosaic of social-health farms
STONE IN THE CITY. EXTRACTION SITES AND SPOLIATION OF STONE MATERIALE IN THE CITY OF NORA (South-West Sardinia)

GINEVRA BALLETTO (1), STEFANO NAITZA (2), GIULIA DESOGUS (3)

UNICA – Cagliari University – DICCAR
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2. Ricercatore DSCG – Dipartimento di Scienze Chimiche e Geologiche (Università di Cagliari, Via Trentino snaitza@unicas.it – tel. 0706755544 - fax 0706755523)
3. Assegnista di ricerca Dipartimento di ingegneria ambientale e architettura (Università di Cagliari, Via Marengo, 2 – giulia.desogus@gmail.com - tel 0706755559, fax 0706755523

Abstract
In this study we intend to read the "backstage" of the urban scene in the archaeological city of Nora, in the southwestern coasts of Sardinia, with the aim of identifying main urban processes that take into account the ancient supply and circulation of building materials essential for the urban formation.

The intention is to create a different point of view in order to get a comprehensive picture of the urban form and characteristics, and also to define the social, cultural and economic context which led to the birth and development of the local building language, and to understand the relationship between the city and geo-resources in the surrounding region.

In particular, the work intends to focus to the historical extraction sites and to the movement of construction materials, without neglecting the spoliation of monuments, to identify the plots between geology and urban structure, also in order to evidence as the historic cities possessed an unconscious smart approach.

The choice of the city of Nora is not accidental; in fact, different kinds of local stones are undoubtedly the most widely used building materials within the city. The choice, optimization and use in buildings and urban infrastructures was masteredly performed, without interruptions, from the late sixth century B.C. until at least the fourth or fifth century A.D.

Already during his trip to Sardinia (1857) Alberto Ferrero La Marmora recognized in the peninsula of Is Fradis Minoris, close to the city ruins, traces of quarrying recorded in "quaternary grès" stone, widely used in buildings of Nora. It will then Gennaro Pesce, who through his works (1957-1971) showed great interest in the main building materials and construction techniques used in Nora.

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3 Alberto Ferrero La Marmora (1789-1863) was an Italian soldier and cartographer geography
4 La Marmora 1857, pp. 287-288
5 Gennaro Pesce (1902-1984) (1902-1984) was an archaeologist his main studies were carried out in Sardinia and Libya.
providing insights on the architectural aspects, and then making a specific focus on building materials, wall structures and architectural taste in the city during Roman imperial age (IVth period of Nora). In particular, G. Pesce (1957) provided an essential list of stone materials most frequently used in Nora for buildings, which are: 1) carbonatic sandstone (Quaternary), 2) fine-grained sandstone (Tertiary), 3) andesite (Tertiary), 4) limestone (Miocene); 5) pyroclastite (Miocene). The contribution wants to investigate the correlations between urban building and the aforesaid stone materials, whose extraction was proximal, and whose masterful use has allowed the construction of the city of Nora.

1.0 Introduction: the territory of Nora

The aim of this study is to explore the choices of building stone materials, in relation with stone extraction, use in construction, spoliation and reuse, in the ancient city of Nora (southwestern coast of Sardinia: Fig 1).

Fig. 1 - Location of Nora Peninsula in Sardinia (Google Earth image).

The archaeological site of Nora plays a multiplicity of significances, being the crossroad among the vestiges of several ancient Mediterranean civilizations, the beautiful natural environment of a lagoon, the home of an environmental education center and a refuge for cetaceans and sea turtles, and the place of a major center of popular religious belief in the Cagliari area, the church of S. Efisio.

The morphology of this stretch of Sardinian coast is like many areas of western Mediterranean, marked by an alternation of promontories, beaches and backshore lagoons. The archaeological site of Nora lies on one of these promontories, whose peculiar shape, originated by three small creeks, has probably influenced the colonization of the site in ancient times (Fig.2).

Fig. 2 - General overview of the Nora area. (Google Earth image).

West of the archaeological site opens the lagoon, whose origin is related to the emergence of a quaternary beach berm (Fradis Minoris) and to the sandy accumulation of the Agumu beach. The lagoon was partly closed and isolated from the sea by a long jetty during 1950’s. The outcrop of Fradis Minoris is made up of alternations of carbonate sandstones

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(cemented beach and backshore dunes), and represents a physical link between the archaeological site and the lagoon itself. Nora is an ancient site: the earliest evidences, few and not well archaeologically documented, of human presence in the site date back to the Nuragic age. Afterwards, the Phoenician sailors used the promontory as a port facility on their routes to Spain. The morphology of the site was favorable and similar to those found in other Phoenician colonization sites, characterized by promontories bordered by lagoons and small islands. Excavations performed in recent years confirmed that Phoenician frequentation probably begun in the VIIIth century BC. From the Punic and Roman times then, the site has progressively taken the appearance of a true city, included in the main commercial trade routes of the ancient western Mediterranean. Archaeological data allow us to establish that the city of Nora was already flourishing in Vth and IVth centuries B.C. In the archaeological area, visible buildings attributable to this Punic period are few, while the funerary kits found in the tombs of this age are very rich. Roman colonization began around 238 B.C., after the first Punic war: most of the currently visible buildings relate to this phase of Nora's history. Excavation data combined with the epigraphic documents show that the city assumed from now on its greatest expansion and its greatest wealth: documents of restoration of public works or gifts made to the city by some of its rich inhabitants. The Punic and Roman times also coincide with an expansion in the surrounding area (Fig. 3); in Roman times the territory was populated by villas and small settlements, with several necropolis. This situation lasted until the fifth century A.D. From that time on, the city began its disintegration phase, due to Vandal incursions; the promontory remained, however, still inhabited until at least the 7th century A.D., to be abandoned, as well as the rest of the coastal area, up to the eighteenth century, with the exception of some religious buildings, such as the church of S.Efisio, built in the 11th century A.D.

Fig. 3 - Main chronological phases of Nora city

1.1 The geological elements: between natural landscapes and city building materials.
Before addressing the subject, it seems appropriate to make a substantial premise: without the masterful use of the stone, the Mediterranean civilizations would not have developed. In fact, at each stone construction corresponds a quarry. Each artifact and, more generally, the urban complex that contemplates the use of stone finds correspondence in one or more quarries, whose proximity is

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8 Tronchetti C., Nora, Delfino editore, 2001
10 Gisotti, M. Coli (Università Firenze)
directly proportional to the dating to which the works can be traced back. In this sense, the historic quarries themselves are of cultural value. Indeed, they are the result of many coordinated, finalized, and non-casual actions, not developable without first having attained a wise knowledge of the territory, its materials and their workability, mode of transportation and implementation potentials. It is no coincidence that this extensive knowledge of is called by the experts "mining art" \(^\text{12}\). Based on these premises, our research has been specifically intended to cover not only the urban history of the city of Nora, but to locate the most hidden traces, more neglected in the approach of classical urban readings, to make room for the "short chain", that of ancient building materials, and favor a multidisciplinary approach \(^\text{13}\). In other words, we intended to read the "backstage" of the urban scene, that is, all that cannot be seen, to give space to a new approach to urban analysis in favor of an assessment of urban processes that will take account of supply and circulation of materials in antiquity, without which the same formation of the city would have failed. Building stone materials are here considered in an extensive way, as in addition to the construction stones, we also considered different materials, like the sands required for making mortars, both of river and marine origin (yellow, plio-pleistocene sands). A further element to consider, and certainly not of lesser importance, are the geological and hydrogeological risks that, since antiquity, have been among the main drivers of urban abandonment. In other words, in the correlations between urban settlement and geo-resources of the territory, in addition to the geological availability of building materials (positive externality) there are also the geological risks (negative externalities); they, respectively, may represent the alpha (geological elements) and the omega (geological hazards) of the city \(^\text{14}\). The intention is to create another point of view in order to obtain an exhaustive picture of the "technical" characteristics of urban buildings and to define the social, cultural and economic context that led to the birth and development of constructive language, as well as to understand the existing relationships between the city and the geo-resources in its territory \(^\text{15}\). It is intended to draw attention to the extraction sites and the circulation of building materials, without neglecting the spoliation of the monuments, to locate the weaves between geology and urban structure \(^\text{16}\), and to represent how the historic cities possessed an unconscious smartness approach \(^\text{17}\), the forerunner of the recent smart city paradigm \(^\text{18}\).

\(^\text{16}\) CAVE E MATERIALI UTILIZZATI IN ALCUNI MONUMENTI DI SIRACUSA Congresso internazionale "Le cave nel mondo antico. Sistemi di sfruttamento e processi produttivi" Arquelogía de la Construcción IV, Maria Mastelloni
2.0 The building materials in Nora City as an opportunity for active cultural tourism
In the city of Nora, stone is undoubtedly the preferred and most spread construction material. The choice of stones to be used in urban buildings and infrastructures of the city was masterful (Fig 4); the optimization and use of these materials is seamlessly testified since the late VI\textsuperscript{th} century B.C. until at least the IV\textsuperscript{th}-V\textsuperscript{th} century A.D.

Fig.4 – Planimetry of the city. (http://nora.beniculturali.unipd.it/)

It was during his trip in Sardinia (1857), that Alberto Ferrero La Marmora recognized in the peninsula of Is Fradis Minoris, traces of quarrying engraved in the "quaternary gres", a sandstone widely used in the buildings of the city.\textsuperscript{19} Then Gennaro Pesce, who through his guidebook (1957), showed a lively interest in building materials and building techniques in use at Nora, providing indication on architectural aspects and then dedicating a specific insight into "building materials, wall structures and architectural taste in the area of Nora IV ", in Roman imperial age.\textsuperscript{20}

According to G. Pesce (1957), the stone use in buildings would have appeared in Nora in the late-Punic period (III\textsuperscript{rd}-II\textsuperscript{nd} century B.C.) and until the first century B.C., when in the wall structures are inserted "large rectangular parallelepiped blocks, made as pillars, set at more or less regular intervals, and operating as ligaments of intermediate wall structures ", in turn formed by "blocks more or less similar to the first type, but placed horizontally ".

\textsuperscript{19} Della Marmora 1857, pp. 287-288
However, the stone use was widely spread in the imperial age (IInd-IIIrd century A.D.), when the city was characterized by a strong urban and architectural renewal, and the urban streets were paved with "andesite blocks". Likewise, G. Pesce (1957) provided a list of the stone materials "most frequently used in Nora for building". Based on recent studies and geological surveys, the list may be updated as follows, in order of abundance of rock types:
1) carbonate sandstones (Quaternary: commonly known as the “Panchina tirreniana Auct.”);
2) siliciclastic, red-violet sandstones (Eocene-Oligocene: part of the terrigenous continental “Cixerri Fm.”);
3) grey-violet andesitic lavas, often with brecciated textures (Oligocene-Miocene: “Andesiti di Monte Arrubiu” Fm.);
4) white-yellow limestones (Miocene: mostly of the “Tramezzario” and “Pietra cantone” members of the “Calcari di Cagliari” Fm.);
5) pyroclastic, grey tuffaceous rocks (Oligocene-Miocene: popularly known as “trachytic” tuffs).

To these rock types must be added various kinds of Paleozoic schists, which are however of less extensive and structural use (e.g. as small wedges in walls), and different varieties of grey-white marbles, used as a parietal lining or in columns.

About the origin of the identified stone materials, recent geological maps and literature show that the first three types of stone (the "Panchina" sandstones, the gray-violet “Cixerri Fm.” sandstone and the andesitic lavas) are clearly "native" materials whose outcrops are located very close to the Nora city center. The other two kinds of stones were transported from the outside: the “Tramezzario” and “Pietra cantone” limestones surely came from the quarries in Cagliari, while the “trachytic” tuff could have been quarried from some pyroclastic layer north of Nora, as in Monte Arrubiu volcanic dome (Sarroch), or have been transported from an unknown Sulcis area. This may be an evidence that a better workability of the material increases the range of its use and destination, as also confirmed by the wide use of the “Tramezzario” and the “trachitic” tuff in other historical periods.

The careful reading of the history of the city, not only through its urban form and the sequence of its prevalences, but also through the materials that allowed its realization, allows to identify the real urban processes and the main informational layers of the building. They always occurred with obvious objectives of optimization, performance and low entropy, similarly as that recently is contemplated in the smart city paradigm. In fact, for “Smart Cities” are intended “the territories in which the Communities use resources in an efficient and sustainable manner [...] are attractive in terms of quality of life and services to citizens [...]", and are capable of enhancing its own cultural and economic peculiarities to increase the competitiveness of the territory”. This definition seems to be the most suitable to open a chronologically backward confrontation.

In particular, if in the past the prerequisite for foundation and urban development was the combination of geomorphologic elements and geological resources, including water, in the contemporary world the prerequisite of smart city is a dense and complex network of sensors able to monitor the city in real-time and possibly to increase it.

The compact urban weave of the city of Nora originates precisely from the interaction between the geomorphological features typical of the coastal area (the promontory, bordered by the lagoon and sand bars), favorable to defense and port activities, and the availability of natural and geological

22 IESE – Cities in Motion 2017 ww.iese.edu/research/pdfs/ST-0442-E.pdf?_ga=2.86421848.1792964978.1496677288-573355761.1496677288
23 M. Carta, Planning the Augmented City, published in Urbanistica, n.156, december 2016
resources including food (the lagoon was a good fishing area), water and, of course building materials. It was the combination of these elements which have allowed the birth and urban development, and the preservation of a large archaeological city heritage. Specifically, the “short chain” of materials and resources, also by the repeated practice of monument spoiling, conferred to the city of Nora, like all ancient cities a significant value of objective environmental sustainability.

In fact, in the past, without having an awareness of environmental implications, people operated with greater respect; this was mainly related to the lesser mobility of people, products and information. In the contemporaneity known as “information”, the identification of building materials and stone extraction sites gives completeness to historical events by expanding the perspective to the neighboring territory, also in accordance with the recent directive on cultural goods and activities and of tourism (2016) – Anno dei Cammini d’Italia, open its doors to cultural tourism and to active tourism. In fact, in the light of what has just been highlighted, the city of Nora has an ecological footprint referable to building materials much wider than its urban area. The deepening and dissemination of ecological footprints in the field of archaeological cultural fruition therefore provides a more complete picture of the city system in the past and offers interesting insights for the contemporary city.

3.0 Proposal for cultural enhancement and valorization of Fradis Minoris extraction site

A territorial analysis that includes the study of the building materials, from extraction sites to the skillful use in the urban context, may originate a new methodological approach of valorization of these sites at both ends of the productive chain, favored by their proximity that well agrees with an unitary fruition. (Fig 5)

Our attention was particularly focused on the most spread rock-type used in the Nora’s buildings, the Quaternary carbonate sandstones extracted in the ancient quarries of Fradis Minoris.

25 De Seta C (2017) La città. Da Babilonia a smart city, Rizzoli
29 http://www.ont.it/opencms/opencms/ont/it/focus/focus/2016_turismo_citta_arte
30 http://www.regione.sardegna.it/documenti/1_292_20101220103210.pdf
34 Naturali, riciclati, riciclabili, innovativi: 100 materiali per una nuova edilizia (2016) Rapporto dell’Osservatorio Recycle Legambiente: https://www.legambiente.it/sites/default/files/docs/cento_materiali_rapporto_osservatorio_recycle.pdf
35 Colletta, T., & Niglio, O. (Eds.). (2016). Per un turismo culturale qualificato nelle città storiche/For a qualified cultural tourism in the historical cities. La segnaletica urbana e l’innovazione tecnologica/The urban signage and the technological innovation: La segnaletica urbana e l’innovazione tecnologica/The urban signage and the technological innovation. FrancoAngeli.
contextualize them within the archaeological landscape to which they belong: the archaeological area of Nora\textsuperscript{36} and the archaeological museum "Giovanni Patroni" in Pula.\textsuperscript{37}

Fig.5 - The quarry of Is Fradis Minoris with respect to the archaeological area of Nora (Google Earth)

In fact, the aim is to reduce the negative perception of the extraction sites, to instead confer on it the active role of "productive archeology"\textsuperscript{38}, through territorial contextualization and narration of the extraction and processing of building materials.

This peculiarity allowed us to study the various stages of use of the stone and to propose a valorization based on the idea of highlighting the still existing links between the urban places of the city, by means of an itinerary following the path of the materials in time.

3.1 Metodological approach

The research allowed to acquire a set of data finalized to develop a spatial analysis of the movement of the stone from extraction sites to the places of final destination and use. Research activities included: 1) recognition and survey of the Fradis Minoris extraction sites, finalized to a reconstruction of the quarry landscapes as a whole, including identification of the geological, stratigraphical, and geomorphological features of the deposit and its geometry; 2) reconstruction of the extension, layout and structure of the quarries, with the individuation of the extraction fronts, the spoil heaps, the working areas, and the related ways of transport of the materials; 3) individuation of traces of quarrying and stone working tools, and of the remnants of loading and harboring facilities for the ships; 4) characterization of the stone materials from rock outcrops, in particular as regards their mineralogy and petrography, both by optical microscopy and XRPD (X-Ray Powder Diffraction) analyses, essential for future reconstructions of the final destinations and the diffusion of the stones at local and, eventually, at regional scales; 5) recognition in the city of buildings, monuments and artefacts built with stone materials macroscopically comparable with those extracted in Fradis

\textsuperscript{36} http://www.sardegnacultura.it/j/v/253?s=19469&v=2&c=2489&c1=2123&t=1

\textsuperscript{37} http://www.sardegnacultura.it/j/v/253?s=19469&v=2&c=2489&c1=2123&t=1

\textsuperscript{38} T. Mannoni, E. Giannichedda, \textit{Archeologia della produzione} Einaudi, 2003
Minoris. A further issue regards the vulnerability of the ancient quarries. Ancient coastal quarry landscapes are very vulnerable environments, and the Fradis Minoris quarries make no exception, being now in a clear state of degrade. For this reason, performed surveys comprise the assessment of site degradation that mostly derive from natural factors (coastal erosion, sea level rise, quality of rock masses and potential rock collapses, weathering of rocks and alteration of quarry fronts, etc.).

3.2 The ancient quarry of Fradis Minoris

The quarries of Fradis Minoris, located to the west of the Nora promontory (38°59'10.55''N, 9°00'19.77''E), represents a unique example of stone material extraction. From cuts and block negatives in quarry faces and from rocky elements at sea (rocky septa left to protect the working places from waves and wind), it is possible to recognize a well-structured working chain of stone extraction and subsequent transport by sea. The total extension of the site can be evaluated of about 1.2 ha. The general layout of the quarries is linear, with E-W oriented extraction fronts, corresponding to the different working areas, which run for over 300 m along both sides of the narrow peninsula (Fig. 6); the seaside fronts are still well-exposed, while fronts overlooking the lagoon are in part under the vegetal cover. According to Auriemma and Solinas\(^39\) the lagoon side of the quarries was probably used in prevalence for handling and loading the blocks in small ships that would take advantage of a more sheltered port.

The fronts on the seaside are fairly preserved, despite the erosional action of sea; all the lowermost working areas are currently submerged \(^41\). This is related to a sea level rise that in this area has been


evaluated in the extent of +1.40 / +1.60 m from Roman times to today, resulting in important changes in the trend of the coast line\textsuperscript{42}. The quarry fronts and the basal bedrock surfaces are, as usual, marked by negatives of blocks, with a prevalence of the 90x50x50 cm type. These dimensions are comparable with those observed in the buildings of the ancient city. Marks of ancient working tools (chisels, pickaxes, heavy picks) are widespread on quarry faces. The average height of the fronts is of about 2 m. No true spoil heaps are currently visible in the site above the fronts, but much of the sandstone pebbles that are found along the intertidal zone on the seashore are probably original rock fragments derived from quarrying and block reduction. The fact that a large part of the ancient working yards now is under the sea level makes it difficult to assess the quantities of materials extracted in the quarries, although volumes of several thousands of m\textsuperscript{3} may be reasonably inferred\textsuperscript{43}.

The Pleistocene sequences of this area are among the best known in Sardinia\textsuperscript{44} \textsuperscript{45}; they rest on a substratum made of tertiary andesites, and colluvial sediments and paleosols of uncertain age. From the main reference sections (Nora and Fradis Minoris), two main overlapped sequences have been distinguished (Fig. 7): 1) a basal sequence, 1.5 m thick, well exposed in the eastern Nora peninsula, prevalently made of medium-coarse grained sandstones with high-angle cross-stratification and other sedimentary features indicating an high-energy depositional environment, interpreted as subtidal (Kindler et al., 1997) an upper sequence 2.5-3 m thick that crops out for the most part in Fradis Minoris, including a basal coarse conglomerate, covered by cross-bedded, coarse to medium-fine grained carbonatic sandstones, showing the sedimentary features of a shallowing upward depositional environment, from shoreface to foreshore (Kindler et al., 1997).

Fig.7 Carbonatic sandstones of the Fradis Minoris’s quarry


The Fradis Minoris basal conglomerate is characterized by fragments of sequence 1) sandstones, abundant volcanite cobbles, and a carbonatic sandstone matrix. The sandstone sequence is marked by several *Lithotamnium* rodholits (red algae) levels, and reworked rodholits are also present in the uppermost part, above a distinctly bioturbated level. A carbonate crust (calcrete) that covers the sandstone outcrop is interpreted as a paleosurface of erosion covered by a paleosoil (Ulzega and Hearty, 1986). From the integration of amino-acid racemization dating (Belluomini et al., 1986) with the above described stratigraphy, the sequence 1) has been considered as pre-Thyrrenian, while the sequence 2) has been entirely attributed to the isotope substage 5e (Kindler et al., 1997).

### 3.3 Relations with the built environment in the city.

The Fradis Minoris quarry was identified during one of the archaeological prospecting campaigns carried out by Nora's archaeological mission; the comparison of stones both from the quarry and in the built environment in the city, highlighted the compatibility of the materials. Comparison is facilitated by macroscopic lithological characters of the stone, as the occurrence of layers with *Lithotamnium* rhodoliths, which are typical of the quaternary sequences in Fradis Minoris. In particular, observations in the Nora city theater (Fig. 8), marked by wide use of the Quaternary sandstone, lead to the fact that in Roman times the outcrop of Fradis Minoris was extensively quarried for the extraction of building materials used for this building, thus identifying its mother quarry.

Fig. 8 - The Nora theatre and its 3D reconstruction

Evidences of the use of Fradis minoris sandstones in the previous era are still under study, although macroscopic material analysis suggests their exploitation for the construction of some Punic Age buildings. (Fig. 9). Further observations made in medieval religious building in Nora and its surrounding area (e.g. San Efisio church in Nora; San Pietro church in Villa San Pietro, Santa Barbara de Montes church in Capoterra), testify of a systematic and prolonged activity of spoiling of ancient buildings in the abandoned city.

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49 http://nora.beniculturali.unipd.it/gli-edifici/edifici-pubblici/teatro/
Fig. 9 - Use of materials from Fradis Minoris in the construction of the Theater

4. A proposal for valorization

At present, Nora and the lagoon site receive a large flow of visitors throughout the year (ranked third in 2016 among state museum complexes in Sardinia for a total of 68,235 visitors), but the quarry of Is Fradis Minoris and, in general, the correlations with the origin of the building materials, are not included in the current circuits of visit, both in the archaeological site and in the environmental education center where the quarries are located. As underlined in previous paragraphs, an analysis of the urban fabric of the city, located in the context of the material resources of the territory, evidence the tight link between the extraction sites of stones and the built environment where stones were used. This is supported by observations and lithological analyses both in the rock outcrops in the quarries and surrounding area, in the quarry fronts (e.g negatives of blocks) and in the archaeological site (e.g. block dimensions in major buildings). Based on these results, the proposal for valorization provides a tour itinerary that allows the visitor to follow the path of the stone from the quarry to the monument, until its reuse in other artifacts (Fig.10 - 11).

50 P Mistretta, Teatro romano di Nora, in “Dionisio” XXXV, 3-4, pag 28-37
The proposed itinerary include a “traditional” part, structured in paths equipped with descriptive panels of stone circulation and use over time, and a 3D virtual tour\textsuperscript{51}, to allow an immediate comparison between archaeological remains and the original state of the sites. Within the quarries, the layout can be more articulated, to highlight both the anthropic aspects (stone extraction and processing), as well as geological and naturalistic aspects.

\textsuperscript{51} http://nora.beniculturali.unipd.it/virtual-tour/ricostruzioni-3d/video-3d/
Exploiting the concept of open-air museums, in the ancient working areas there could be placed reconstructions of tools and machines, while in the summer special diving trips will allow to visit the lower, currently submerged quarry areas and fronts.

To preserve the site from degradation and, at the same time, allow its fruition, it will be provided a partial coverage, with a transparent structure, of better preserved quarry fronts and other features of greater interest, also providing wooden walkways for visitors.

The itinerary, spatial and temporal, can be traveled in both directions, either from the quarries, by observing the material in its place and following its movement in time towards the use in Roman times within the Nora site, and then to move to the XI sec A.D., when the dismantling of pre-existing Roman sites provided the material for building the church of Sant'Efisio.

The quarries, in addition to representing a departure (or arrival) point in the pathway that joins it with the archaeological site and the church of Sant'Efisio, offer a further opportunity for touristic fruition, by the realization of itineraries of environmental interest.

Again, this is the case of the latest and extended open-air museum concept. In which the most significant geological sections will be an object of immediate tactile perception, highlighted by panels and other visual devices that will give rise to awareness of the evolution of the site as a temporal record of a number of phenomena related to coastal dynamics. At present, the lagoon hosts an environmental education center that deals with studying, preserving and divulging all the aspects of the local flora and fauna; the presence of sedimentary rocks with fossil evidences of different habitats, compared to the present, allows to create parallels between past and present marine environments.

5. Conclusions

The multidisciplinary study of the archaeological site and the main quarries of Nora has led to the delineation of the "archaeological landscape" of the analyzed area. This is the "archaeological landscape" where archaeological factors fit into environmental factors and vice versa, creating a series of elements that can be considered a multi-thematic itinerary.

In addition, by exploiting the time factor on different scales, it is possible to create a multiplicity of concepts, apparently unconnected, where the quarries occupy a prominent role, as they represent both the starting point and the union of various elements of the itinerary.

The proposed noninvasive approach relates both archeometric aspects related to the quarry / monument relationship and the paleogeographic links to the lagoon. Fradis Minoris has the prerequisite to contain important paleo-environmental and archaeological information, similar to that of other historic quarry sites set on quaternary sandstones in western Mediterranean. What makes this site so unique is to be an exceptional showcase for contemporary observation of anthropic and naturalistic data. Overall, the study carried out is a further proof of how a site of historical quarry is not to be understood as a negative element of the landscape, but as a place rich in elements that can be valorized, in which the interaction between natural and artificial features has created unusual scenarios and great suggestions.

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Terzo Premio VII Ed. (Pan Paesaggio Architettura Natura) – Ardito Desio a Ginevra Balletto¹, Stefano Naitza², Giulia Desogus¹ (¹Dip. di ingegneria ambientale e architettura, Università di Cagliari; ²Dip. di Scienze Chimiche e Geologiche, Università di Cagliari) per: Stone in the City. Extraction Sites and Spoliation of Stone Materials in the City of Nora (South-West Sardinia) “Lo studio della circolazione dei materiali costruttivi e i rischi ad essa connessi, di spoliazione dei patrimoni ambientali e dei monumenti, costituisce una strategia di analisi importante e originale per comprendere le problematiche della sintesi tra tradizione e innovazione e tra patrimonio ambientale e patrimonio culturale.” Furio Ponsell, Sindaco di Udine.

Il Presidente del Premio – Università di Udine
Ting Fa Margherita Chang

Il Presidente IPSAPA/ISPALECM
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