

DANIELA PITTALUGA

FABIO FRATINI

(édité par/by)

CONSERVATION ET MISE EN VALEUR DU PATRIMOINE ARCHITECTURAL ET PAYSAGÉ DES SITES CÔTIERS MÉDITERRANÉENS

CONSERVATION AND PROMOTION OF ARCHITECTURAL AND
LANDSCAPE HERITAGE OF THE MEDITERRANEAN COASTAL SITES

ripam 7

Gênes, 20-22 Septembre 2017

Genoa, September 20th-22nd 2017

FrancoAngeli

OPEN  ACCESS



Il presente volume è pubblicato in open access, ossia il file dell'intero lavoro è liberamente scaricabile dalla piattaforma **FrancoAngeli Open Access** (<http://bit.ly/francoangeli-oa>).

FrancoAngeli Open Access è la piattaforma per pubblicare articoli e monografie, rispettando gli standard etici e qualitativi e la messa a disposizione dei contenuti ad accesso aperto. Oltre a garantire il deposito nei maggiori archivi e repository internazionali OA, la sua integrazione con tutto il ricco catalogo di riviste e collane FrancoAngeli massimizza la visibilità, favorisce facilità di ricerca per l'utente e possibilità di impatto per l'autore.

Per saperne di più:

http://www.francoangeli.it/come_pubblicare/pubblicare_19.asp

I lettori che desiderano informarsi sui libri e le riviste da noi pubblicati possono consultare il nostro sito Internet: www.francoangeli.it e iscriversi nella home page al servizio "Informatemi" per ricevere via e-mail le segnalazioni delle novità.

DANIELA PITTALUGA

FABIO FRATINI

(édité par/by)

**CONSERVATION ET MISE EN VALEUR
DU PATRIMOINE ARCHITECTURAL ET PAYSAGÉ
DES SITES CÔTIERS MÉDITERRANÉENS**

CONSERVATION AND PROMOTION OF ARCHITECTURAL AND
LANDSCAPE HERITAGE OF THE MEDITERRANEAN COASTAL SITES

FrancoAngeli

OPEN  ACCESS

Les textes ont été fournis par les auteurs, qui en sont responsables.
La source des images, sauf indication contraire, est celle des auteurs.

The texts were provided by the authors who are responsible for them.
The source of the images, unless otherwise specified, is of each author.

Couverture: profil de Gênes, graphiques de / Cover page: profile of Genoa, graphics by
Lorenzo Poli, Linda Bruzzone, Stefania Pantarotto

Ce livre est un ouvrage collectif, dont les contributions ont été élaborées à partir de la conférence RIPAM 7, organisée à Gênes du 20 au 22 septembre 2017 par le DAD - Département d'architecture et de design (Université de Gênes) en partenariat avec le CNR-ICVBC Institut national de recherche, Institut pour la conservation et la mise en valeur du patrimoine culturel de Florence).

This book is a collective work, with contributions developed starting from RIPAM 7 conference, organized in Genoa, 20 to 22 September 2017 by the DAD - Department of Architecture and Design (University of Genoa) in collaboration with the CNR-ICVBC (National Research Council, Institute for Cultural Heritage Conservation and Valorization, Florence).

Comité Scientifique / Scientific Committee: José Alberto ALEGRIA, Taoufik BELHARETH, Roberto BOBBIO, Philippe BROMBLET, Roberto BUGINI, Younes EL RHAFARI, Giovanna FRANCO, Filipe GONZÁLEZ, Mustapha HADDAD, Mounsif IBNOUSSINA, Saïd KAMEL, Boudjemaa KHALFALLAH, Manuela MATTONE, Roland MAY, Saverio MECCA, Camilla MILETO, Mohamed MILI, Stefano F. MUSSO, Juan Antonio QUIROS CASTILLO, Luisa ROVERO, Abderrahim SAMAOUALI, Abid SEBAI, Vincenzo TINÉ, Fernando VEGAS

Daniela Pittaluga et Fabio Fratini ont travaillé ensemble sur les textes initiaux (comprenant les sections “Qu’est-ce que le RIPAM?” et “Conférence RIPAM 7”, les remerciements et les index) et sur les descriptions des thèmes et sous-thèmes (sections A et B et sous-parties). Cependant, Daniela Pittaluga a écrit les parties en français et Fabio Fratini a écrit les parties en anglais, ils sont auteurs de certains articles et les éditeurs de la partie restante.

Daniela Pittaluga and Fabio Fratini worked together on the initial texts (including sections “What is RIPAM?” and “RIPAM 7 Conference”, acknowledgements and indexes) and on the descriptions of the themes et subthemes (section A and B and subparties). However, Daniela Pittaluga wrote the parts in French, and Fabio Fratini wrote the parts in English. They are authors of some articles and editors of the remaining part.

Copyright © 2019 by FrancoAngeli s.r.l., Milano, Italy.

This work, and each part thereof, is protected by copyright law and is published in this digital version under the license *Creative Commons Attribution-NoDerivatives 4.0 International* (CC-BY-ND 4.0)

By downloading this work, the User accepts all the conditions of the license agreement for the work as stated and set out on the website

<https://creativecommons.org/licenses/by-nd/4.0/>

a Anna Maria e a Luca

Support à ce livre / Support to this book





Società
Italiana
per il
Restauro
dell'
Architettura.



Comune di Genova



Centre Interdisciplinaire
de Conservation et Restauration
du Patrimoine



Table des matières / Table of contents

VOLUME 1

SUPPORT À CE LIVRE / SUPPORT TO THIS BOOK	6
TABLE DES MATIERES / TABLE OF CONTENTS	9
REMERCIEMENTS / ACKNOWLEDGEMENTS	27
CONTRIBUTIONS DES AUTORITES / CONTRIBUTIONS FROM THE AUTHORITIES.....	35
Marco BUCCI	
Niccolò CASIDDU	
Giulia PELLEGRINI	
Giovanna FRANCO	
Manuela SALVITTI	
Paolo RAFFETTO, Clelia TUSCANO	
QU'EST-CE QUE C'EST RIPAM / WHAT IS RIPAM	49
COMITÉ PERMANENT RIPAM / RIPAM STEERING COMMITTEE	54
SECRÉTAIRE GÉNÉRAL RIPAM / RIPAM GENERAL SECRETARY	55
DE RIPAM1 À RIPAM8 : L'ÉVOLUTION D'UN CHEMIN DE CONSERVATION / FROM RIPAM1 TO RIPAM8: THE EVOLUTION OF A CONSERVATION PATH.....	56
HERITAGE DE RIPAM7 / THE LEGACY OF RIPAM7	62
CHARTER RIPAM	68
LA CONFÉRENCE RIPAM 7 / RIPAM 7 CONFERENCE	75
LES RAISONS SCIENTIFIQUES DE LA CONFERENCE / SCIENTIFIC REASONS FOR THE CONFERENCE	77
COMITE SCIENTIFIQUE / SCIENTIFIC COMMITTEE	83
REFEREES	86
COMITE D'ORGANISATION / ORGANIZATION COMMITTEE	92
THEMES ET SOUS-THEMES DE LA CONFERENCE / CONFERENCE THEMES AND SUB-THEMES	94
PARTICIPANTS	96

PROGRAMME DE LA CONFERENCE / CONFERENCE PROGRAM	103
LEÇONS PRELIMINAIRES SUR POINTS CLES / PRELIMINARY KEY NOTE LECTURES	
.....	105
Gênes : une ville stratifiée à travers le temps et l'espace.....	107
Anna BOATO	
Italy and overseas reflections: the "Tyrrhenian space", diffusion and reception of Mediterranean architectural models in the Middle Ages. Some methodological considerations	121
Alireza NASER ESLAMI	
The new requests for protection, conservation and valorisation of Cultural Heritage	139
Stefano Francesco MUSSO	
La récupération du Système Fortifié Génois.....	155
Roberto TEDESCHI	
Graffiti removal from historical buildings	171
Barbara SALVADORI	
Palmaria Island a wild, botanical, terrestrial and marine Garden.....	173
Rita MICARELLI, Giorgio PIZZIOLO	
A - CONSERVATION ET VALORISATION DE L'ARCHITECTURE, DES SITES ET PAYSAGES COTIERS / CONSERVATION AND PROMOTION OF ARCHITECTURE AND LANDSCAPES OF THE COASTAL SITES	175
HISTOIRE ET EVOLUTION DU PAYSAGE COTIER / HISTORY AND EVOLUTION OF THE COASTAL LANDSCAPE	179
Territoires côtiers et stratégies de conservation en Turquie.....	193
Emanuele ROMEO	
The coast of Altavilla Milicia east of Palermo. History of a forgotten coastal landscape between illegal buildings, architectural-landscape emergencies and the need for protection	207
Rosario SCADUTO, Zaira BARONE	
La place romaine de Cherchell: évolution de l'interface ville-mer d'une cité méditerranéenne multimillénaire	219
Abdelkader BEHIRI	
The injured coast: the degradation of the Italian coastal landscape between unauthorized development, eco-mafia and regulations.....	233
Emilia GARDA, Marika MANGOSIO, Giuseppe MUDANÒ	
Le Fahs d'El-Djezaïr (Alger), un paysage côtier à redécouvrir	245
Ouassila MENOUEUR, Mohamed Salah ZEROUALA	

Syracuse Sicily Mediterranean. Transformations and design of coastal landscape	257
Valerio TOLVE	
The Troublesome Future of the Archaeological Sites of Caprazoppa, on the Western Coast of Finale Ligure (SV).....	271
Gianfranco PERTOT	
Pour une patrimonialisation de l'urbain. Cas du Cours de la Révolution d'Annaba – (Algérie)	285
Marwa MENAIFI	
Sacrée nature, paysage du sacré des fronts de mer au Maghreb.....	291
Abir MESSAOUDI	
Construction of coastal landscape in Italy, between the 19 th and 20 th century. The case study of the Ligurian seaside colonie.....	303
Francesca SEGANTIN	
The Nymphaeum of Massa Lubrense: conservation issues of an archaeological palimpsest in the coastal landscape	315
Federica MARULO	
Paysages côtiers de l'Algérie entre enjeux et perspectives	329
Zoulikha AIT-LHADJ, Pr. Messaoud AICHE	
Le paysage urbain en Ligurie et sa sauvegarde.....	343
Caterina GARDELLA, Silvana VERNAZZA	
The “Sanatorium” of Salerno. Knowledge, restoration and enhancement of a forgotten coastal heritage	355
Luigi VERONESE, Mariarosaria VILLANI	
The promontory of the “Arma di Taggia”, Sanremo: a conservation and enhancement project	367
Paola GALELIO, Tiziana MIGNOGNA, Benedetta ROCCON	
Salento's coast: safeguard and tourism, a possible pair	377
Giovanna CACUDI, Michela CATALANO	
Evolution of Friulian coastal structures from the Serenissima to modern times: synchronic extracts for a study	389
Federico BULFONE GRANSINIGH	
L'évolution de la ville méditerranéenne, et son impact sur le paysage côtier – Cas de la ville de Béjaïa	399
Kaouther TEBBANE, Djamel ALKAMA	
La revalorisation d'un paysage côtier emblématique en péril-hier, aujourd'hui et demain-cas de la ville d'Annaba	411
Imene Khoulood KADER, Kawther ZOUITEN, Boudjemâa AICHOIR	
Salerno restarts from the sea	423
Annarita TEODOSIO	

Patrimoine urbain comme levier de développement économique : entre stratégies de conservation et attractivité	435
Amina CHEBLI	

TÉMOIGNAGES / TESTIMONIALS

The impact of stone quarrying on Porto Venere's coastal landscape (La Spezia, Italy).....	454
Enrica MAGGIANI	
Dynamics of fragmentation of settlements in coastal areas. From land take to abandonment. The case of Liguria.....	455
Giampiero LOMBARDINI	
Genoa in the Middle Ages: architecture, urbanism and society.....	456
Aurora CAGNANA, Antonella TRAVERSO	
Coastal Transformation: the Landscape and the New Scenarios of Land Consumption	457
Lorenza COMINO	
De La Coquille à L'Inconnu_Entre Deux Cultures.....	458
Ana TOMÁS	
Le patrimoine bâti entre : réhabilitation, reconversion et préservation ; quels compromis ?	459
Karima BOUANDES	
Les paysages d'eau : un parcours historique et une singularité culturelle et paysagère. Cas des lacs du parc national El Kala « Tarf »	460
Nassira NOUI	
Alger colonial et ses rapports à la mer. Paysages et panoramas : cas de l'Hôtel des Postes d'Alger	462
Nadia HAMZAOU, BALAMANE, Samira DEBACHE BENZAGOUTA	

ARCHITECTURES ET INFRASTRUCTURES PORTUAIRES / PORTS

INFRASTRUCTURES AND ARCHITECTURE463

Modernisation de la zone portuaire de Bejaia et son impact sur le patrimoine architectural	475
Walid HAMMA	
Quai G. B. Cuneo à Oneglia : une infrastructure portuaire du XIX ^{ème} siècle	487
Francesca Luisa BUCCAFURRI	
Etude de l'Impact du risque géologique sur le patrimoine urbain par les méthodes géomatiques : cas du port de la ville d'Oran	499
Ibrahim ZEROUAL , Hakim KADDOUR, Djelloul ZENATI, Mansour HAMIDI	
La valorisation de l'architecture portuaire de la ville de Cherchell.....	513
Rym MERZELKAD, Yamina NECISSA	

Preservation et mise en valeur des ports antiques a Venaria Russicade (Skikda), Algerie.....	523
Amira GHENNAI, Said MADANI	
The role of the port cities in the definition of the coastal and architectural landscape of Gallia Narbonensis	537
Alessandro VIVA	
Porto Flavia: an “iconic” engineering work in the mine machine-landscape.....	549
Antonello SANNA, Giuseppina MONNI, Adriano DESSI	
The coastal-mining landscape of Sulcis in Sardinia. The ruins of the landing and of the laveria Lamarmora de Nébida, perspectives of preservation and reuse	567
Pier Francesco CHERCHI	
The seaport of San Benedetto del Tronto (Le Marche). The recovery of its history and possible development.....	581
Enrica PETRUCCI, Francesco DI LORENZO, Carla PANCALDI	
Identity architectures and port landscape in Naples. The case of Immacolatella from a local Ellis Island to a part of a new urban hub.....	593
Renata PICONE	

TEMOIGNAGES / TESTIMONIALS

La revalorisation du patrimoine architecturale et des paysages maritimes : une contribution à la promotion de l’image et l’attractivité de la ville. Cas de la ville– port d’Annaba	608
Lina ADJAILIA	

ARCHITECTURES INDUSTRIELLES, ARCHITECTURES DES TRANSPORTS / INDUSTRIAL AND TRANSPORTS ARCHITECTURE611

Quelle stratégie de reconversion des friches industrielles en milieu urbain, cas de la ville de Mostaganem (Nord-Ouest algérien).....	619
Elbatoul BENYAGHOB, Hayet MEBIROUK	
Gares ferroviaires d’Alger : un héritage colonial en déperdition.....	635
Souaad FANIT, Nadia CHABI	
Cartography and military heritage. Methodological and design lines for Naval Arsenal of La Spezia	649
Carlo Alberto GEMIGNANI	
The Arsenals of Venice, La Spezia and Taranto between history and industrial heritage. Conservation and enhancement of sites and architectures	661
Sara DE MAESTRI, Claudio MENICHELLI, Antonio MONTE	

TEMOIGNAGES / TESTIMONIALS

Les halles de marchés en Algérie : entre l’architecture industrielle et une tendance à l’éclectisme	676
Safia MEKLATI, Samia CHERGUI	

Etude comparative des typologies Architecturales et constructives des gares ferroviaires datant de la période française en Algérie (Ligne Est : Alger, Constantine, Annaba/ Ligne du Tell : Alger, Blida, Oran)	678
Abderrhaim MAHINDAD, Nabila MOUHOUS	
L'architecture des gares à travers l'œuvre de Denis Marius Toudoire	679
Mohamed Abdelaziz METALLAOUI	
LE FRONT DE MER / THE WATERFRONT	681
At the EDGE: between the natural and the artificial.....	685
Victor NEVES	
Collo - Algeria: natural and architectural qualifications for the classification in the World Heritage of the UNESCO	695
Abdelhalim ASSASSI, Samir Merouane GUEDOUH	
Le front de mer de Messine : hypothèses de sauvegarde et valorisation	705
Antonella VERSACI, Alessio CARDACI	
New scenarios for the Palmaria island (Porto Venere-Ligurian Sea)	719
Patrizia BURLANDO	
The waterfront of Genoa: surveys and critical considerations	731
Giulia PELLEGRINI	
La réalité du paysage côtier à Ain Benian (Algérie).....	743
Ferial BOUSTIL	
Alger se réconcilie avec son front de mer : la valorisation paysagère des sites côtiers à travers le parc «Sablettes»	753
Manel SOUIDI, Siham BESTANDJI	
La lecture du processus de formation et de transformation de la ville de Ténès en Algérie.....	763
Yamina NECISSA, Rym MERZELKAD, Sara SABET	
Conservation et valorisation du paysage côtier : Un patrimoine de l'inventaire à l'action. Cas de projet d'aménagement du site de la lagune de Marchica à la ville de Nador	773
Lamya MAGHNAOUI	
TEMOIGNAGES / TESTIMONIALS	
L'interface ville-port de la ville de Annaba d'une ville industrialo-portuaire à une ville qui retourne vers la mer	786
Nawel BOULAHROUZ	
La promenade Fibonacci à Béjaia ; un paysage côtier unique à la rencontre de ses défis	787
Kenza MAMERI	

**B - CONNAISSANCE ET STRATEGIE DE CONSERVATION DU PATRIMOINE
ARCHITECTURAL MEDITERRANEEN / KNOWLEDGE AND CONSERVATION
STRATEGY OF MEDITERRANEAN ARCHITECTURAL HERITAGE789**

**ETUDES ET ANALYSES DES ARCHITECTURES : CARACTERISATION,
INSTRUMENTATIONS / ARCHITECTURES STUDIES AND ANALYSES :
CHARACTERIZATION, INSTRUMENTS792**

**ETUDES ET ANALYSES : ANALYSES DE LABORATOIRE SUR MATERIAUX
HISTORIQUES / STUDIES AND ANALYSES: LABORATORY ANALYSES ON
HISTORICAL MATERIALS794**

The stone materials in the historical architecture of Levanto and their durability
(Liguria, Italy) 807

Fabio FRATINI, Manuela MATTONI, Silvia RESCIC

The building "stone materials" of the Genoese fortification system from the XIIIth
to the XXth century 821

Daniela PITTALUGA, Gianfranco CARUSO, Fabio FRATINI, Elena PECCHIONI ,
Emma CANTISANI, Silvia VETTORI

L'ancien bâtiment des douanes : analyse des matériaux et des dégradations d'un
bâtiment témoin de l'activité portuaire et industrielle de Marseille au 19^e siècle
..... 833

Philippe BROMBLET, Myriam BOUICHOU, Fanny BAUCHAU, Claire VALAGEAS ,
Pierre-Yves POSTIC, Elisabeth MARIE-VICTOIRE, Philippe BERTONE

Caractérisation des mortiers de réparation et l'influence de l'ajout de la brique
pillée sur leurs caractéristiques physiques et mécaniques..... 845

Naima ABDERRAHIM MAHINDAD

Analyses non-destructives d'enduits peints issus de fouilles archéologiques de la
mosquée al-Qarawiyyin à Fès (Maroc) 857

Imane FIKRI, Mohamed EL AMRAOUI, Mustapha HADDAD, Christophe
FALGUERES, Ludovic BELLOT-GURLET, Ahmed Saleh ETTAHIRI, Roland
NESPOULET, Saadia AIT LYAZIDI, Lahcen BEJJIT

Caractérisation spectrométrique de marbres du Maroc : étude de provenance 865

Salam KHRISSI, Mustapha HADDAD, Lahcen BEJJIT, Saadia AIT LYAZIDI,
Mohamed EL AMRAOUI, Christophe FALGUERES

Caractérisation de la Céramique Architecturale Provenant de la Citadelle
Hamadide - M'sila 873

Abla BRAHMI, Messaoud HAMIANE

**ETUDES ET ANALYSES : ANALYSES HISTORIQUES, ARCHEOLOGIQUES,
TYPOLOGIQUES, D'ARCHIVE / STUDIES AND ANALYSES : HISTORICAL,
ARCHAEOLOGICAL, TYPOLOGICAL ARCHIVAL ANALYSES.....889**

Le patrimoine domestique rural du Honda: des spécificités spatiales et des logiques constructives en voie de déclin. Cas du modèle de la maison à cour centrale.....	891
Hynda BOUTABBA, Mohamed MILI, Samir-Djemoui BOUTABBA	
Analyse d'un monument néoclassique de la rive sud de la méditerranée : l'hôtel de ville de Ghazaouet	903
Halima Saadia OUADAH, Nadir BOUMECHRA	
The church of the former psychiatric hospital of Cogoleto (Genoa).....	915
Maria Francesca BERTA	
The nineteenth-century batteries of Genoa: a forgotten heritage	927
Anna BOATO, Anna DECRI, Stefano FINAURI	
The "round tower" of Monterosso (Cinque Terre): historical-archaeological investigations and renovation project	941
Anna BOATO, Mauro MORICONI	
L'ornement ferronnier: une approche par le détail du paysage Méditerranéen Algérois	953
Wahiba BELOUCHRANI	
Medieval Sardinian castles. Transdisciplinary approach for the definition of typologies, masonries and materials	959
Carla BARTOLOMUCCI, Donatella Rita FIORINO, Caterina GIANNATTASIO, Silvana Maria GRILLO, Valentina PINTUS, Maria Serena PIRISINO	
Renovation of the Palazzata della Ripa in Genoa (1865-1903): between neoRenaissance project and restoration of Middle Age.....	973
Lucina NAPOLEONE	
The fortifications of Vernazza in Cinque Terre	987
Anna DECRI	
Building technologies in the XIXth century in Mediterranean coastal sites: the case study of Cagliari	1001
Leonardo G.F. CANNAS, Laura BRANDINU, Fausto CUBONI	
Techniques, nature et origine des pierres de construction de l'époque romaine du site antique de Rirha (Maroc)	1013
Rachida MAHJOUBI, Mohamed KBIRI ALAOUI, Saïd KAMEL, Charifa KHALKI	
Ruins by the sea. Spanish towers in northern Puglia, between knowledge and risk of loss.....	1029
Michele COPPOLA, Cristina TEDESCHI	

Historical buildings with timber frame in the Ligurian coast. Knowledge and conservation	1041
Anna BRUZZONE, Silvia GELVI, Giorgio MOR, Nicola RUGGIERI, Linda SECONDINI, Gerolamo STAGNO, Daniela PITTALUGA	
Contribution of photogrammetry for mensiochronology of industrial fired bricks structures. The bridges in the Arquata-Busalla-Genoa section of the Turin-Genoa railroad	1053
Simonetta ACACIA, Marta CASANOVA, Elena MACCHIONI, Pietro PAPA	
Reconstitution du système décoratif en faïence dans les palais de l'époque ottomane à Alger	1065
Rachida HADJI-ZEKAGH	
Analyse morphométrique du patrimoine architectural tunisois «L'habitation traditionnelle de la Médina de Tunis»	1075
Bilel SOUISSI	
Vers une caractérisation stylistique de l'architecture institutionnelle coloniale en Algérie. Etude comparative des édifices publics au nord et au sud du pays	1085
Nassiba BENGHIDA, Leila SRITI	
The castle of Gallipoli in the defensive system of the Ionian coast in the kingdom of Naples	1099
Aurora QUARTA	
Gaetano Cima's innovative architectural design in the 1800s: case study of the Palazzo Lostia in Cagliari	1107
Laura BRANDINU, Leonardo G.F. CANNAS, Fausto CUBONI	
The Church of Madonna del Carmine in Melpignano (Lecce): From Diagnostics to the Restoration Project.....	1121
Marta FERSINI, Maria Lidia GUGLIELMINETTI, Enrica CAPELLI	
TEMOIGNAGES / TESTIMONIALS	
La perception des constructions en terre en Kabylie : Mâatkas	1136
Dahbia ABBOU, Nasr-eddine BOUHAMOU	
Les madrsas de la vallée du M'za. Etude architecturale de deux cas	1137
Baelhadj MAROUF	
Connaissance et reconnaissance du noyau historique de la ville de Mostaganem	1138
Fatima Zohra MAHREZ, Dahbia ABBOU	
L'architecture vernaculaire en terre en Algérie. Des ksour aux villages ruraux en Kabylie	1139
Dahbia ABBOU	
La restitution des savoir-faire traditionnels et sa contribution dans la conservation du patrimoine ; cas d'étude : la vallée du Mzab (Algérie)	1140
Imane KECHACHA ep BERDI	

Giving value to the Ancient Stone Quarries in the Mediterranean. True example of industrial Archaeology	1141
Marco ACRI, Alessandra BIASI	

VOLUME 2

ETUDES ET ANALYSES : ANALYSES URBAINES, OUTILS ET STRATEGIES / STUDIES AND ANALYSES : URBAN ANALYSES, TOOLS AND STRATEGIES.....1147

L'utilisation de la brique silico-calcaire a connu un échec en Algérie. Cas de la ville de M'sila.	1149
Allaoua AMMICHE, Hynda BOUTABBA, Mohamed MILI, Djamel DAHDOUH	
Dar el Djezair: son langage codifié, notre quête	1159
Mounjia ABDELTIF	
La patrimonialisation des médinas en Algérie, discours et réalités : le cas de la médina de Constantine et d'Annaba	1173
Hana SALAH-SALAH, Hania MEDDOUR, Sassia SPIGA	
Relecture de l'architecture vernaculaire kabyle: village Djebba (Algérie) un écomusée, un écotourisme.....	1183
Izza Fatiha GUIRI, Hamza ZEGHLACHE	
Protection activities and integrated development for the urban archaeological park of San Vincenzino in Cecina (LI)	1191
Roberto SABELLI	
Structuration de l'information du patrimoine par la Méthode HBDS : cas de la ville de Tindouf.....	1205
Ibrahim ZEROUAL, Khelifa HAMI, Djelloul ZENATI, Hamza HACINI, Abdelkrim TALHI, Abdelhamid TOUHAMI	
De la nécessité d'une planification stratégique dans la conservation du patrimoine	1219
Nadia ASSAM-BALOUL	
Quand la restauration entrave la durabilité : Cas du site archéologique de Chellah à Rabat	1229
Meriem BENHARBIT, Rabia HAJILA	
L'évolution urbaine de la ville de Bejaïa. Bejaïa la ville diluée.....	1239
Fatma Zohra ZENATI-BOUICHE, Djamel ALKAMA	

TEMOIGNAGES / TESTIMONIALS

La Formation : une stratégie pour la sauvegarde du patrimoine en péril.....	1252
Yamina NASRI	

The transformation of the Mediterranean coastal landscapes. A comparison among best practices in the Italian peninsula	1253
Susanna CURIONI	
Vers l'élaboration d'un mortier originel à base de chaux pour la restauration d'un patrimoine architectural. Cas du théâtre régional de Skikda	1254
Amira AYAT, Karima MESSAOUDI, Hamoudi BOUZERD	
La médina : un fondateur de savoir et un modèle pour la ville durable	1255
Malek MEROUANI, Lina MEROUANI, Yamina NASRI	
Influence of temperature and humidity on the state of conservation of building and decorative stones (Case of the Kasbah of Algiers)	1256
Messaoud HAMIANE, Zineb CHELBI, Andrzej KIELSKI, Krystyna WODNICKA, Abdelwahab ZEKAGH	
La mise en tourisme du patrimoine architectural et paysager de la ville côtière Collo-Skikda	1257
Sihem FERAH, Kaddour BOUKHEMIS	

SPÉCIFICITÉS ET STYLES ARCHITECTURAUX DU PATRIMOINE MÉDITERRANÉEN / SPECIFIC FEATURES AND STYLES OF THE MEDITERRANEAN ARCHITECTURAL HERITAGE1259

Identification des typologies architecturales du noyau historique colonial de la ville de Annaba	1265
Ouafa BOUMAZA	
L'architecture romano-bizantine " <i>all stone</i> " dans la Syrie et la Jordanie	1281
Massimo COLI, Luigi MARINO	
Influence de la lithologie locale sur l'architecture vernaculaire : approche de base par référence aux bâtiments de l'Italie	1293
Roberto BUGINI, Luisa FOLLI	
Inventaire des monuments construits par les européens dans la ville de Sousse (Tunisie). Les constructions de style néo-mauresque	1309
Nadia BOUKADIDA	
The defensive architecture of Ischia: the towers-houses and the stone-houses	1323
Florian CASTIGLIONE	
Les spécificités stylistiques des mosquées ottomanes en Algérie	1333
Meriem REDJEM	
Style architectural des monuments de l'époque coloniale: cas de l'Hôtel du Sahara à Biskra, Algérie	1343
Amdjed Islam DALI, Azeddine BELAKEHAL	

L'église du Sacré Cœur d'Alger : une œuvre religieuse à l'épreuve de la modernité architecturale des années 50.....	1355
Nabila CHERIF, Toufik NEBBAD	
L'architecture hôtelière côtière de Fernand Pouillon en Algérie: Création d'une architecture méditerranéenne contemporaine en symbiose avec son contexte historique.....	1371
Sara ZINEDDINE, Azeddine BELAKEHAL	
Vieux bâti de l'Algérois: un patrimoine architectural d'une remarquable richesse	1383
Naïma TOULOUM, Sid AIT SAID, Ahmed BRARA	
La persistance de l'architecture néo mauresque dans les édifices chrétiens à Alger dans les années trente.....	1395
Chima AZIL, Dalila HIMEUR DJALAL	
Paysage et patrimoine rural. La culture humaine laisse des traces sur le territoire. Reconnaître et valoriser le patrimoine rural en tant que ressource.....	1407
Daniela PITTALUGA, Marco REBORA, Stefania PANTAROTTO, Valentina FATTA	
La maison algérienne durant la colonisation française, Une étude typologique. Cas des maisons –Biskra Titolo.....	1423
Fatima Zohra LEBBAL, Said MAZOUZ	
La typologie architecturale et constructive des phares côtiers du 19 ^e et 20 ^e siècles en Algérie.....	1435
Karima AMARI, Amina Abdessemed FOUFA, Karima AMARI	
Could the Pierre Loti's vision be useful today? For remembering the past and reflecting on the future of the Mediterranean cultural environment	1447
Fabrizio EVA	
Knowledge, diagnosis, conservation, restoration of historical buildings. Cornices and ceiling hang of Genoese's historical buildings. An experimental methodology aimed to knowledge and conservation. Studies and application doing fieldwork	1459
Giulia GARIBBO, Linda SECONDINI, Gerolamo STAGNO, Asmara TESFAY, Giovanni VARESE, Daniela PITTALUGA	
The Portuguese tradition of thatched roofs: The case of the inside of the Caldeirão Mountain	1473
Filipe GONZALEZ, Sofia PINTO	
Rationalisme colonial et héritage méditerranéen. La "ville nouvelle" de Portolago dans l'île grecque de Léros (1933-1938).....	1485
Riccardo FORTE	
Revalorisation de Site archéologique Kalâa de Beni Hammed et de sa zone de protection	1497
Salima SAOUCHI, Boudjemaa KHALFA ALLAH	

Les fermes agricoles européennes de la plaine littorale de Bejaia (ex bougie, Algérie) comme élément de connaissance et de compréhension de l'architecture rurale de l'époque coloniale française (XIX-XXe siècles).....	1509
Idir BENAIDJA, Belkacem LABII	
Identity and dis-identity of the sea villages: colours as an architectural identity	1519
Enrico BASCHERINI	
Le bourg muré de Taggia (IM): sur la trace de l'avenir	1527
Francesca Luisa BUCCAFURRI, Angela Cristina DE HUGO SILVA, Mirko PASQUINI	
La fenêtre habitée, un art de l'architecture domestique à la Casbah d'Alger ...	1539
Rania MECHICHE	
The Sea pebble mosaic floors of the Aegean Basin. Rhode's Case study.....	1547
Maria TZANETI	
De la particularité de la sauvegarde de deux lieux cultuels – La Basilique Saint augustin et Le Mausolée de Sidi Brahim à Annaba (Algérie)	1555
Amina CHOUAHDA, Sassia SPIGA	
From the crypt to the altar – SaintAndrew's Church in Akko, Israel.....	1567
Alessandra VEZZI	
La décomposition spatiale du patio Constantinien : un art « introverti »	1579
Rahma SARAoui	
Archaeology and Mediterranean landscapes. The Vesuvian coast from Herculaneum to the Sorrento Peninsula	1587
Roberto VANACORE, Manuela ANTONICIELLO, Felice DE SILVA	
Spécificités et styles architecturaux et urbains du patrimoine du vieux Rocher de Constantine.....	1597
Roukia BOUADAM GHIAI	

TEMOIGNAGES / TESTIMONIALS

Les lieux du pouvoir civil du XIX ^{ème} siècle en Algérie au prisme d'une approche monographique. Cas de l'hôtel de ville d'Annaba	1610
Sihem ROUAISSIA, Heddy BOULKROUNE	
La pureté du patrimoine urbain et architectural et son impact sur le site et le paysage. Le cas de la ville de Ghoufi en Algérie.....	1612
Khiredine DOUNIA, Nedjai FAITHA	
Les leçons de la Casbah d'Alger dans l'œuvre moderniste de l'architecte Paul Guion	1613
Nabila CHERIF, Yasmine BELATTAR	
Stratégies de valorisation du patrimoine architecturale et urbain méditerranéen : Cas de souk el acer Constantine, Algérie	1615
Chahrazad BOUCIF, Said MADANI	

RECONVERSION DU PATRIMOINE ARCHITECTURAL / RECONVERSION OF ARCHITECTURAL HERITAGE.....1617

La mosquée Sîdî BûMarwân: d'une authenticité controversée à un patrimoine
réconcilié 1619
Samia CHERGUI, Samira HAOUI

Patrimoine Architectural et Culturel Méditerranéen : entre mise en valeur et
Reconversion. Cas de l'Algérie 1631
Yasmine HOCINE

Résurrection d'un patrimoine architectural en péril en Tunisie post
révolutionnaire: Études de cas 1639
Imen REGAYA, Said MAZOUZ

New strategies for Mediterranean architectural heritage. The case of Calabria's
historical centres repopulated by refugees 1651
Annunziata Maria OTERI, Nino SULFARO

Les tours costières entre degré et désuétude. Réflexions sous les stratégies
possibles d'intervention. Le cas de la Torre Muzza à Carini (PA) 1663
Carmen GENOVESE

Les églises d'Alger ; un patrimoine architectural reconverti 1677
Naouel NESSARK, Mohamed DAHLI, Dominique JARRASSE

Restoration project of the Punta of Guardia Lighthouse on the Ponza Island, Italy
..... 1689
Cristiana BAROLOMEI, Gianluigi DE MARTINO, Chiara FRONTA

The Goro Lighthouse and the connected landscape. Reuse, valorization and
management project 1699
Francesco AUGELLI, Alberta CAZZANI, Claudia COLOMBO, Carlotta M. ZERBI,
Matteo RIGAMONTI

La reconversion des fermes agricoles coloniales en Algérie une tentative
prometteuse pour valoriser le patrimoine et développer l'attractivité des
territoires ruraux 1711
Fouzia FAREH, Djamel ALKAMA

Park of Portofino: landscape, environment and energy. Scenario planning for the
Acqua Viva Valley 1721
Matteo GATTUSO, Deborah OMBRA

TEMOIGNAGES / TESTIMONIALS

La conservation du patrimoine Aurassien en peril. Cas de la maison Ben Chaiba,
Batna 1734
Houda BOURAYOU, Imene Khouloud KADER, Boudjemaa AICHOUR

La reconversion des palais ottomans en Algérie, diagnostic et bilan 1736
Abdelkhalik MEBARKI, Akila BELABBAS, Souria SALEM ZINAI

Réhabilitation d'un ancien bordj beylical à Dar Bel-Ouar	1737
Nadia BOUKADIDA	
La reconversion du patrimoine architectural d'Alger : Cas des ex-Galeries de France	1738
Mohamed Abdelaziz METALLAOUI	
Le patrimoine hospitalier : entre reconversion, préservation et humanisation. Quelles réalités ?!	1739
Karima BOUANDES, Said MAZOUZ	
GIS as a mechanism to conserve the urban Heritage and activation the tourism. Case Study: Urban Heritage of Casbah of Beni-Ilmane in M'sila city	1740
Hacene REGUIG, Imeddine SALAMANI, Mohamed MILI	
La revalorisation et la réutilisation des fortifications militaires côtière en Algérie. Cas de la citadelle médiévale d'Annaba, Algérie	1741
Abelkrim LARGUECHE, Hedya BOULKROUNE	
Quel avenir pour la gare ferroviaire de Guelma ?	1742
Myriam GHEDJATI	
La mosquée Abou Marwan de Annaba Algérie : genèse d'une opération de restauration	1743
Ahmed NAHAL, Ilham BOURAFA	

PATRIMOINE DISPARU : RESTAURATION, RECONSTITUTION,... / LOST HERITAGE: RECOVERY THROUGH KNOWLEDGE, RECONSTRUCTION,...1745

Patrimonialisation de l'héritage culturel en Algérie. Quelle perspective de gestion pour le paysage culturel d'Ath El Kaid ?.....	1749
Karima FRENDI, Zoulikha AIT-LHADJ	
La nouvelle muséologie active appliquée à la présentation des sites archéologiques. Cas d'étude : site archéologique de la Pointe-Noire à Jijel (Algérie)	1765
Ammar KORICHI, Imane KECHACHA ep BERDI	
Le château de la Comtesse, un édifice a patrimonialiser	1777
Sonia AMZAL, Tsouria KASSAB	
Akko's waterfront	1787
Federica TRUDU	
Material evidences and memorial values in coastal ruins in urban landscapes. Sardinian and Scottish case studies	1801
Donatella Rita FIORINO, Silvana Maria GRILLO, Elisa PILIA	
La connaissance, la sauvegarde et la gestion des villes historiques du nord de l'Algérie.....	1813
Malika BOUSSERAK, Mohamed Salah ZEROUALA	

Bâtiments militaires de paysages côtiers de l'Italie à l'époque de la première guerre mondiale. Aspects typologiques et constructifs des forts «umbertini» et du bastion Peloritan..... 1825
Sara ISGRÒ

Les ouvrages défensifs du Vallo Ligure: protection des témoignages de la seconde guerre mondiale 1839
Andrea CANZIANI, Lorenza COMINO

La perte de l'identité nationale dans l'urbanisme Algérien - Cause et défis -.... 1851
Wassila OUAAR, Saliha ACHI

Sauver le patrimoine urbain et architectural ancestral par des actions de restructuration. Cas du quartier d'El Argoub de Msila en Algérie 1861
Mohamed MILI, Hynda BOUTABBA, Samir-Djemoui BOUTABBA

Revaloriser et réhabiliter l'habitat traditionnel méditerranéen. Un facteur de développement durable: Habitat traditionnel de la vallée du M'zab en Algérie..... 1875
Nawal BENMICIAL, Nora CHEBLI

TEMOIGNAGES / TESTIMONIALS

Les nouvelles technologies pour la reconstitution d'un patrimoine altéré, l'église de Bordj Bou Arreridj Algérie..... 1888
Hamza ZEGHLACHE, Monia BOUSNINA, Nadir ALIKHODJA

Iconic applications of reinforced concrete on the Genoese coast at the beginning of XX century 1890
Federica STELLA

Le patrimoine ambiantal des medersas du Maghreb (XIII^{ème} – XVIII^{ème} siècles) 1891
Abdelouhab ZIANI, Azeddine BELAKEHAL

The transfer of "anastylosis" from Europe to Egypt, 1900-1980 1893
Adham FAHMY

La restauration des monuments historiques entre theorie et application en Algérie. Cas d'étude : Bordj el tork (Fort de l'Est) de Mostaganem 1895
Akila BELABBAS, Abdelkhalik MEBARKI, Souria SALEM ZINAI

PROJETS ET INTERVENTIONS SUR L'ARCHITECTURE EXISTANTE : GESTION PARTAGEE AVEC LA POPULATION / PROJECTS AND INTERVENTIONS ON EXISTING ARCHITECTURE : MANAGEMENT SHARED WITH POPULATION1897

Pays d'Annaba. Proximité entre dégradation d'un rivage et beauté d'une façade maritime 1907
Fatma-Zohra HARIDI

Algérie, Bilan et Analyse des Expériences de Réhabilitation locaux 1921
Ahlem KAOUACHE, Salim KOULOUGHLI

La Casbah de Constantine un patrimoine architectural à conserver ou à raser 1933
Boudjemâa AICHOUR, Soraya BAKHOUCHE

The Old Tower at Gorgona. An hypothesis for a long-term conservation plan involving convicts.....	1949
Francesca DE VITA, Alessandra DE VITA, Angiolo NALDI, Enzo PERSICO, Stefano PULGA	
Coastal towers: project of conservation and development of the "Saracen tower" in Arenzano (Genoa)	1959
Rita VECCHIATTINI, Arianna CALCAGNO	
Villa Zanelli: a shared project with the population for its rehabilitation	1973
Marco DELLA ROCCA	
Public participation: a possible way to manage and maintain the existing cultural heritage? The case study of the archaeological site of the Ex- Convento di Santa Maria in Passione in Genova.....	1983
Matteo ROCCA	
Stone architecture in the stone landscape of middle Apulia and local people role	1993
Giacomo MARTINES	
The safeguard of the Italian vernacular built heritage: the importance of education and participation	2007
Valentina CINIERI, Emanuele ZAMPERINI	
The "Cultural Heritage and Urban Development Project - C.H.U.D." in Lebanon and the participation of ARS Progetti S.P.A.	2019
Daniele FANCIULLACCI, Patrizia BARUCCO	
Projects and interventions on cultural heritage: management sharing with the community.....	2031
Andrea UGOLINI	
Projects and interventions on existing architecture: management shared with population	2043
Rossella MASPOLI	

TÉMOIGNAGES / TESTIMONIALS

The Sardinian coast, an uninhabited place of historical transformations.....	2058
Caterina GIANNATTASIO, Silvana Maria GRILLO, Stefania MURRU, Andrea PINNA	
Projet d'aménagement du territoire à l'embouchure du Tiber	2059
Giuliano FAUSTI, Sonia GALLICO	
La mise en valeur des immeubles coloniaux en Algérie. Cas de l'immeuble Âali Chouchena à Guelma.....	2060
Mounira MIHOUBI, Kaddour BOUKHEMIS	
La mise en valeur du patrimoine d'Ath El Kaid : Conjuguer mémoire des lieux et participation habitante pour une bonne gouvernance.....	2061
Kahina SAID AISSA, Meriem CHABOU-OTHMANI	

CHEMIN ET CHOIX EDITORIAUX / EXPLICATION OF EDITORIAL CHOICES.....	2063
INDEX DES AUTEURS / AUTHORS INDEX	2065

Medieval Sardinian castles. Transdisciplinary approach for the definition of typologies, masonries and materials

Carla BARTOLOMUCCI¹, Donatella Rita FIORINO²,
Caterina GIANNATTASIO², Silvana Maria GRILLO³,
Valentina PINTUS², Maria Serena PIRISINO²

¹Dipartimento di Ingegneria Civile, Edile-Architettura e Ambientale - DICEAA, Università degli Studi dell'Aquila

²Dipartimento di Ingegneria Civile, Ambientale e Architettura - DICAAR, Università di Cagliari

³Dipartimento di Scienze chimiche e geologiche, Università di Cagliari
e-mail: carla.bartolomucci@univaq; donatella.fiorino@unica.it;
cgiannatt@unica.it; grillo@unica.it; valentinapintus@unica.it;
mariaserenapirisino@gmail.com

Abstract. The present study stems from the awareness that researches on traditional masonry techniques in Sardinia, and particularly those aimed at dating historical architectures, are insufficient when compared to the studies on other Italian cultural areas started at the end of the 20th century. Over the last decade, the Chair of Restoration of the University of Cagliari has carried out a research project focused on the archaeometric investigation of traditional masonries (12th -19th centuries). This paper refers to the medieval Sardinian fortified systems (12th -15th centuries). The purpose is to define chrono-typological references, in order to date and preserve the so-called minor buildings, which are not philologically dated unlike the examined ones. The investigation protocol, specific for the local peculiarities and based on a transdisciplinary approach, started with the indirect analysis. A direct survey of the structures was further carried out through photographic, architectural and material assessments, with non-destructive diagnostic techniques. The creation of a Geo-Topographic Database and a WebGIS has been essential to archive and manage the collected information. The archival and archaeometric data have been cross-referenced, facilitating the definition of chronotypes. So, this method allowed to gain knowledge of local historical masonries and to identify important references in dating buildings. Architectures of ancient Sardinian villages often undergo improper interventions regardless their historical and cultural values. Consequently, dating becomes a tool to protect and preserve them. Also, this study offers a better understanding of the entire system, whose current fragmentation - as a result of the absence of conservation actions, abandonment, demolition, improper reuse and reconstructions - proves the need of identifying its values and critical issues, essential for a project aimed at the successful protection and enhancement of its components.

Keywords: medieval fortified system, archaeometry, masonry techniques, chronotypes, dating.

Introduction

The research is included in the studies on historical constructive techniques, that even if widely carried out in different national areas, dealt with the Sardinian context only recently. Therefore, for over a decade, the Chair of Restoration of the University of Cagliari has carried out a research on the masonry techniques employed in Sardinia between the 12th and the 19th century, in order to define chronotypes in order to date other historical architectures. Due to the absence of specific studies related to it, the investigation started with the analysis of the historical and architectural philologically dated heritage, consisting in religious, civil, residential, productive, military and defensive complexes.

The heterogeneity and the singularity of the Sardinian historical and architectural heritage, often abandoned and degraded, have led to define an investigating protocol, supported by specialised analyses for a deeper and wider knowledge of the heritage itself. The investigating protocol is based on a transdisciplinary approach, aimed to underline the dimensional technical-constructive, mensiochronological and material characteristics, as well as the physical-mechanical and energetic ones, necessary for the definition of the peculiarity, the structural behaviour and the performance levels of the investigated architectures. This allowed us to recognise chronological evidences as a function of type, formal and material variables able to define the chronological succession of masonry structures and the finishing of historical artefacts, arranged in homogeneous areas, thus facilitating the recognition and dating of the structures. This aspect has a fundamental importance. As it is well known, dating often implies expressing a historical and cultural value, very likely to be followed by protective actions. Therefore, the main aim of this research is to outline exploratory and operational guidelines supporting the interventions for the protection and the enhancement of the regional architectural heritage. This contribution, for synthesis sake, focuses on the results of applied research to medieval fortifications, investigated on the basis of a general operational protocol, but organised according to the peculiarities of any single case study¹.

¹ This study is forms part of the Basic Research project "Traditional building techniques: knowledge for conservation and enhancement", 2013 edition, lead scientist C. Giannattasio, financed by the Autonomous Region of Sardinia (L.R.7/2007 - Promotion of scientific research and technological innovation in

1. Transdisciplinary approach for the fortified heritage (CB, DRF, CG, SMG)

The study of the medieval fortified system has been carried out starting from the recognition of indirect sources through which the exploratory scenario could be reconstructed. This stage has allowed to identify 31 defensive structures representing the investigated contexts. Every case study has been further involved in a photographic, metric, geometric and material survey. Based on the first historical-architectural observations, studies in depth have been carried out on the constructive techniques and on the performance characteristics. As for the survey phase, traditional techniques have been integrated with innovative instruments and methods, such as *photomodelling* and *laserscanning* 3D², analysing settings and results case after case, according to the specificity of the site. During a subsequent investigation campaign, masonries have been sampled aiming to the physical-mechanical and thermo-hygrometric characterisation of the materials and to understand the related constructive systems³.

More precisely, the material characterisation has been conducted with a mineral-petrographic approach through *in situ* investigations and archaeometric analyses, aiming to gain a systematic census of natural and artificial stone materials. This exploratory phase has been divided into two parts: the first one related to the macroscopic analysis of the stone

Sardinia). In particular, it is the synthesis of two PhD researches carried out by Valentina Pintus (PhD in Technologies for the conservation of Architectural and Environmental Heritage - 28th cycle) and Maria Serena Pirisino (PhD in Civil Engineering and Architecture - 29th cycle) at the University of Cagliari. Specifically, V. Pintus analyzed the masonry chrono-typologies of the fortified architectures of South Sardinia and M.S. Pirisino studied those referred to North Sardinia, this last one carried out with the support of a scholarship financed with the resources allocated by INPS - Management of Public Employees, as part of the initiatives of *Homo Sapiens Sapiens*.

² Surveys have been processed with the support of the Mediterranean Laboratory for the Knowledge and Development of Historical-Traditional Materials and Architecture, Unit Survey, Restitution and Modelling (LabMAST-URRM), University of Cagliari, Scientific Manager A.M. Cazzani, Administrative Manager S. De Montis, Operating Manager V. Pintus.

³ These surveys have been carried out with the support of the Engineering Architectural Centre laboratories (Polilab) connected to the University of Cagliari, in cooperation with the National Council of Researches (CNR).

materials, and the second one consisting in the lab analysis⁴. Some assessments have been carried out on the residual resistance of the loading capacity increment, gained through improvements. Similarly, the knowledge of thermic and hygrometric performances has proved fundamental to improve and adapt historical buildings to the current requirements of energetic performance. The information gained in the three exploratory phases have been archived on an IT relational support, through the use of reproduction, archiving and divulgation technologies. The collected data are implementing a WebGIS, still under experimentation and development. These data have been analysed, systematised and compared through specific scientific data sheets and graphical theme tables, which have led to identify the discretisation and extrapolation parameters of effective chrono-typological models. Further in-depth studies on the identified chronotypes, have been arranged through BIM applications, by which a three-dimensional parametric library is being realised, to support sustainable conservation and restoration of historical architectures. The transdisciplinary approach has therefore allowed building exploratory and operational tools, defining materials and technology according to the principles of compatibility and reversibility, as well as new guidelines supporting the conservation and protection of the historical architectural heritage and, in particular, of common buildings⁵.

2. Historical background (VP)

The birth and the evolution of medieval Sardinian defensive systems have been strongly influenced by the complex historical events characterising Sardinia in the long span between the 11th and the 15th centuries. In this period the island was actually divided into four kingdoms, called *Giudicati*, those of Cagliari, Torres (or Logudoro), Arborea and Gallura, and different powers alternated on the territory: first of all, the kings, then the maritime republics of Pisa and Genova - with the Donoratico, Massa, Visconti, Malaspina and Doria families - and finally the Crown of Aragon.

In this context, defensive structures were realised and transformed both for the control of the territory and for the success and consolidation of the different

⁴ Analyses have been carried out at the LabMast (Historical Materials Lab) and the DICAAR lab.

⁵ In this sense, efficacy is recognised to the synergy with the local productive structure represented, in this research context, by the Buccellato s.r.l. company.

powers established in the island. At the end of the 13th century, with the infeudation of the *Regnum Sardiniae et Corsica* to James II of Aragon, castles became the object of a dispute among the different authorities fighting to unify Sardinia under a single kingdom. Starting from the 15th century, with the final conquest of the island by the Crown of Aragon, the political reorganisation led to a transformation of the defensive system. As a matter of fact, many sites lost their defensive function being destroyed and/or abandoned while other structures were built *ex-novo*. In particular, the Aragonese-Catalan government enhanced strongholds close to villages and cities, and, in the second half of the 16th century, started building towers to protect the coast.

3. The places (MSP)

The rich lithology of the island, resulting from a long and complex geological history, characterised architectures in different historical periods, determining not only the distribution of the investigated buildings, but also the choice of the construction materials. From a geological point of view, Sardinia consists in two main components: a Palaeozoic base and volcanic and sedimentary covering dating back to an age included between the late Palaeozoic and the Quaternary periods. The basement, of magmatic and metamorphic nature, emerges in a wide eastern belt extending from north to south and, at a lower level, in the southwest sector. It is made up of acid plutonic rocks-granites (granodiorites, monzogranites and leucogranites) and of metamorphic rocks (gneiss, micaschists, schists and meta sandstones). The western part of the island, starting from the upper Oligo-Miocene up to the lower Miocene, is involved in two volcanic cycles, the first calco-alkaline showing the emplacement of a powerful succession consisting in andesites, rhyodacites and rhyolites with a texture from aphanitic to porphyritic; the second alkaline, with the extrusion of basalts. Sedimentary rocks, of a different age are distributed on the whole island with sediments of a continental environment, mainly represented by alluvial pebbles and marine deposits: conglomerates, sandstones, organogenic limestones.

Furthermore, the different lithologies give the Sardinian territory rather diversified morphologies. As a matter of fact, irregular mountainous systems and inaccessible coasts are present in the granitic and metamorphic areas, alternated with regular and hilly morphologies in the central areas characterised by sedimentary rocks. Finally, in the western

part of the island, where highly different volcanic outcrops for composition and texture prevail, wide morphological variations can be observed.



MASONRY CHRONOTIPOLOGIES | 12th - 13th centuries

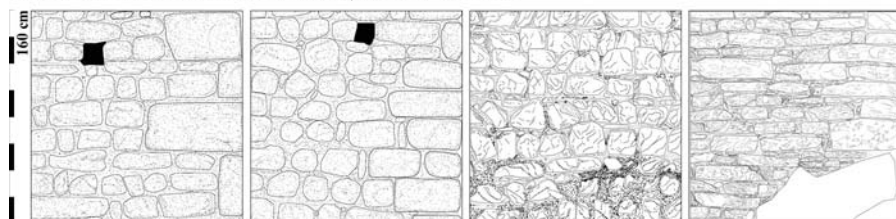


Fig.01: The image shows the mapping of the Sardinian fortified system (12th - 15th centuries), the fortified palace of Re Baldo (Luogosanto, Sassari), the fort-house of San Michele (Cagliari), the donjon of Ghilarza (Ghilarza, Oristano), the fortress of Del Goceano (Burgos, Sassari) and a synthesis of the chrono-types of masonries referred in the 12th-13th centuries, realised with ashlars, arranged according to sub-horizontal courses (survey and graphic elaboration by V. Pintus and M.S. Pirisino)

4. Fortified architectures (VP, MSP)

The medieval fortified system, object of this study, consists in about 105 sites, among which 59 localised in the northern sub-region and other 46 are positioned in the southern one, characterised by a fairly advanced state of damage or decay. They are uniformly distributed in the territories historically belonging to the *Giudicati* of Arborea, Cagliari and Torres, and along their respective borders. On the contrary, in the north eastern sector, historically coinciding with the *Giudicato* of Gallura, given the complex morphology of the territory, structures are mostly concentrated along the coast belt and next to important harbours.

4.1 Typologies (VP)

The survey has highlighted a rather complex and heterogeneous defensive panorama, resulting from the different historical-political events and from the several cultural influences occurred between the 12th and the 15th centuries. On the one hand, these features emerge from the structure models of the social-settlement context; on the other hand, they derive from the characteristics of the specific structures, especially with peculiar type models as well as formal and stylistic expressions. In particular, the study of defensive architectures allowed to identify two categories: walled systems and so-called castles. With reference to the latter, four sub-categories have been distinguished: the fortified palace (01), the fort-house (02), the donjon (03) and the fortress (04). As for fortresses, the observation of recurring formal, structural and morphologic characters have allowed defining four types, according to parameters related to the location, the planimetric configuration, the characterising elements and the prevailing function. Every type can be associated to a chronology and to the phases of *incastellamento* characterising the fortified Sardinian landscape. The type 04/01, related to the 12th century fortifications, shows wide sizes and is realised on an inaccessible relief, directly on the rocky outcrop. It has a strictly strategic-defensive function, emphasised by the lack of decorative elements. The defensive site usually consists in a main tower, around which service spaces are built, such as cisterns, storehouses, etc.

The type 04/02 consists in military-residential fortresses of the late 12th century. These fortresses are located on an inaccessible relief controlling the territory, and have reduced size, with a regular elongated shape,

along a NE/SW direction. Only the openings usually overlook the inner courtyard. Instead, the stronghold is characterised by a high-fortified tower and protected by a wall located at a lower level. A refined fortress, dated to the first half of the 13th century, represents the type 04/03. Realised on a relief, inaccessible on different sides, it presents large sizes and is arranged in a double wall: a more external one at a lower level supporting the soil morphology, and a more inner one, positioned near the top of the relief. The latter, in a regular shape, presents spaces in its inner side with a supposed defensive or residential function. The characterising elements are the fortified tower and the system of cisterns for the water supply. The type 04/04 is the residential fortress, ascribable to the period included between the end of the 13th and the beginning of the 14th century. This fortress has an emblematic power role. This led to choose a particularly visible site dominating the surrounding territory, as well as a more refined formal expression compared to the previous types. The complex has a double function: residential and defensive; it shows a wide planimetric development and is structured supporting the soil morphology, although a precise building plan is evident. More specifically, built on an easily accessible relief, this stronghold generally consists in a fortified wall provided with towers, quadrangular and circular ones, and a door allowing access to the inside, where there are several spaces, among which the palace and the palatine church.

4.2 Masonry techniques (VP, MSP)

Through a deep survey of the medieval fortified system, 31 case studies, as already mentioned, have been selected, representing the examined cultural environments. Thus, on these architectures, an analysis of the masonry structures and of their technological peculiarities was performed. Having identified more than a hundred masonries, significant for the building phases, they have been investigated with an archaeological approach, aimed to highlight the constructive, dimensional, material and structural specificities, through which the most relevant characteristics can be identified, and valid chronological local keys defined.

The classification of masonries has led to the definition of three macro-categories, according to the function of the placing (in rows; in sub-horizontal courses; "*a cantieri*"- arranged periodic horizontal levels). Furthermore, according to the shape and the processing type of the

stone elements (blocks, ashlar and rustic stones), any of them has been divided into two sub-categories. In the case of the “*a cantieri*” type, they have been defined according to the arrangement of the elements (horizontal; sub-horizontal; fishbone). In the following, the chrono-typologies are described. The masonry type 1 is realised with blocks (1a) and ashlar (1b) arranged in rows. It is characterised by misaligned joints, often not as thin as the bases and only some show a recessed finishing. The use of wedges is common in the type 1.2. In some masonries, it is possible to observe the presence of ashlar characterised by bossage stone. This type is commonly employed for the realisation of bases and cantonal blocks of representative buildings such as the palace and the fortified tower, the towers of the wall systems and the palatine chapels, between the 12th and the 15th century, with different trends in the different parts of the island. The masonry type 2 consists of ashlar (2.1) or sometimes it is associated to rustic stones, arranged according to sub-horizontal courses. A common feature in the investigated textures is the concurrence of cantonal blocks in squared stone. Joints and bases are realised with abundant mortar. The use of wedges in stone or brick fragments is common, either to fill the interstitial voids or to allow more regularity to the masonry. This texture is used for the construction of the main walls in fortified towers and, in some cases, for the bases and the inner spaces of fortified palaces. It was adopted in a period circumscribed to the 12th and 13th centuries in the northern area and in Gallura. However, in the 14th century it can be also found for the construction of inner walls in some fortified complexes of Logudoro, strictly connected to the Ligurian culture. Moreover, this typology is present in structures dating back to the 13th century, with a plant deriving from the first phase of the *Giudicati*, but with a successive Pisan frequentation, and in the 14th and 15th centuries, in relation to the first phases of the Aragonese conquest of the island, especially in the southern area. The masonry type 3 consists of rustic stones of several shapes and sizes, arranged according to periodic horizontal levels, known as “*a cantieri*”. This texture is generally used for the realisation of cisterns and for the curtain walls of castles, as well as the walls of boroughs and fortified cities, with continuity between the 12th and the 15th century. The “*a cantieri*” masonries with bosses and scales arranged in fishbone pattern (masonry type 3.2) are usually employed to realise the highest portion of the walls, in the internal facings of the structures realised in the 12th-13th centuries in the southern area.

4.3 Materials (MSP)

The macroscopic characterisation *in situ* of the investigated structures allowed to underline the lithological, morphological and chromatic characteristics of the stone elements, of the lodging mortars and the plasters, as well as of the bricks. Besides, by comparing the lithological nature of the masonries with the geological and lithological peculiarities of the area where the examined architectures are placed, the study has made important historical and material relationships between the case studies and their context⁶. More precisely, in the north-eastern part, historically corresponding to the *Giudicato* of Gallura, masonry structures are realised with ashlar, bosses and rustic stones of lithotypes characteristic of the granitic and metamorphic area: granite in a grey to pink colour; metamorphites in light and dark colours; and material related to rhyolitic veins in a porphyric structure of a dark colour. In addition, some defensive structures situated in southern Gallura - an area marked also by the presence of calcareous and volcanic outcrops -, are present masonries characterised by limestone bosses, in a white, grey and yellow colour, and dark basalt ones. On the contrary, defensive structures in the north west of Sardinia, corresponding to the historical region of Logudoro, are marked by very diversified stone materials in relation to the variety of lithotypes, of volcanic and sedimentary nature, characteristic of this area. Specifically, near Gallura, masonry structures are realised with ashlar, bosses and rustic stones of pink granite, granites and metamorphites of a grey colour, ignimbrites of a pink colour, as well as trachyandesites of a grey-green colour and quartz phyllades in a red hue. In the central-northern area of Logudoro, masonries are realised with ashlar, bosses and rustic stones of carbonate lithologies, characterised by a yellow-mustard colour or by a grey-white colour, and of dark basalt. In southern Logudoro, instead, masonries are usually realised with ashlar, bosses and rustic stones of sandstones, tuffaceous and volcanic conglomerates, of a yellow-grey colour, and sandstones, andesites, ignimbrites and basalts with colours from grey-green to pink-violet. The same diversification of lithologies, of volcanic and sedimentary nature, are present in the fortified architectures of the area historically corresponding to the *Giudicato* of

⁶ The high variety of regional lithotypes, in general characterised also by a wide chromatic variation, has been solved in this specific case with reference to the geological maps drawn up by ISPRA, on a scale 1:100.000, for the whole regional territory, and on a scale 1:50.000, whose publication is still partial.

Arborea. More precisely, masonries of the castles situated in the northern part are characterised by ashlar, bosses and rustic stones of calcareous and volcanic lithologies (material with a phonolitic component; basalts and rhyolites with chromatisms varying from dark black to purplish-blue and dark pink). By contrast, in the central area, masonries are realised with limestones and calcarenites of a light grey colour, sandstones with marly components, of a grey-green colour, and only in some cases with basalt, in a colour varying from grey to pink. As far as the southern area is concerned, corresponding to the *Giudicato*-of Cagliari, it can be noticed that the episodes affecting the southeast area are characterised by masonries built with ashlar, bosses and rustic stones of granites and metamorphites in a colour tending to pink. However, it is interesting to highlight the presence of a defensive structure realised with bosses and scales of *bardiglio* marble, characterised by a grey colour and the presence of white streaks. The masonries of the fortifications situated in the central part are mostly realised, instead, with lithologies corresponding to limestones - more commonly the Cagliari ones, used in two variations locally called *pietra Cantone* and *pietra Forte*-, meta-limestones and sandstones; as well as calco-alkaline volcanite of a grey-green colour - locally called greenstone of Sanluri -, andesites and basalts. Finally, masonries of defensive strongholds located in the southwestern area consist in lithologies of a volcanic nature, in particular basalts, limestones, and sandstones from San Vito, in a grey-greenish colour, reddish meta-sandstones, schists and argillaceous schists. Later, in a second phase of investigation, a reasoned sampling has been carried out of the artificial stone material, according to what provided for by the standard rules (UNI 11176/2006). Several samples of mortar beds and plasters have been taken, on which a petrographic investigation has been performed on thin sections integrated by X-ray diffractometry analyses on powder samples. The interpretation of images in thin petrographic section with the polarising light optical microscope has allowed distinguishing mortars according to the type of binder, to the nature of the aggregate, the relationship between binder and aggregate, the origin of the aggregate and its composition, as well as the textural and granulometric characteristics. The examined samples are characterised by a binder made of air-hardening lime with a structure from micritic to micro-sparitic. The mineralogical composition, determined through the analyses in X-ray diffractometry (XRD), is strictly connected to the lithological context of the site. These petrographic analyses have highlighted mortars characterised

by aggregates prevalently of a siliciclastic nature, or by aggregates of a volcanic and sedimentary nature, according to the emerging lithological formations. The presence of *cocciopesto* (fragments of earthenware mixed with lime and sand) can be noticed in some mortars coming from specific structures of the fortified complexes, such as cisterns. The quality of mortar beds and plasters depends not only on the mineralogical composition of the binder and of the aggregates, but also on the workers. The slurry shows the presence of unburned and lime lumps, of shrinkage fractures and reaction rims.

Conclusions

The in-depth investigation of the fortified system built during the 12th -15th centuries in Sardinia allowed us to underline technologies and processing procedures belonging to different constructive cultures in order to recognize different chrono-typologies. In summary:

- the typological classification for the defensive structures is closely related to the phases of Sardinian *incastellamento*, and the analysis highlights the relationship between Sardinian fortifications and those found in other European countries, although the dating of the Sardinian ones is later;
- masonries 01 and 03.1 have been widely used with continuity from the 12th to the 15th century. In particular, the first one has been employed for the construction of towers and *mastio*, the towers of fortified cities, palaces and palatine chapels, and the second one for cisterns and urban walls. On the contrary, masonries 02 and 03.2 was less widespread: the 02 has been used only during the 12th-13th centuries, mainly in Gallura, and during the 14th century for the construction of inner walls in some fortified complexes of Logudoro, whilst in the southern area this typology is present in structures dating back to the 13th century and to the 14th and 15th centuries, in relation to the first phases of the Aragonese conquest. The masonry 03.2 is usually employed to realise the highest portions of walls, in the internal facings of the structures realised in the 12th-13th centuries in the southern area;
- regarding the material aspect, the fortifications were generally built with materials corresponding to those available on site.

Bibliography

- BRIGAGLIA M., MASTINO A., ORTU G.G. edited by (2002) - *Storia della Sardegna*, vol. 2, Editore Laterza, Roma-Bari.
- FIORINO D. R., PINTUS V., VACCA G. (2017) - Un webGIS per conoscenza e tutela delle tecniche murarie tradizionali in Sardegna, in "ANANKE - Numero Speciale GeoRES", pp.129-134.
- GIANNATTASIO C., GRILLO S. M., MURRU S. (2017) - *Il sistema di torri costiere in Sardegna (XVI-XVII sec.). Forma, materia, tecniche murarie - The Sardinian coastal tower system (XVI-XVII century) Form, material and masonry techniques*, L'Erma di Bretschneider, Roma.
- GIANNATTASIO C., GRILLO S. M., PINTUS V., PIRISINO M.S., *Protocolli di conoscenza per la conservazione dei paesaggi militari medievali della Sardegna. I casi dei castelli di Gioiosa Guardia e Della Fava | Protocols of knowledge for the conservation of Sardinian medieval military landscapes. The cases of Gioiosa Guardia and Della Fava castles*, in Donatella Rita Fiorino (by), *Military Landscapes. Scenari per il futuro del patrimonio militare. Atti del Convegno internazionale | Military Landscapes. A future for military heritage. Proceedings of the International conference* (EBOOK), Skira, pp. 1-17.
- GIANNATTASIO C., PINTUS V. (2015) - *Sistemi fortificati nel Sud Sardegna. Tipi architettonici e crono-tipi murari (XII-XV secolo)*, in "Palladio", 55, pp. 45-64.
- GRILLO S. M. (2009) - *Notizie geologiche, petrografiche e storiche*, in Ulrico Sanna, Cirillo Atzeni (by), *Il manuale tematico della pietra*, Coll. Manuali del Recupero dei centri storici della Sardegna, DEI, Roma, pp. 1-22.
- MILANESE M. (2015) - *Incastellamento e archeologia della Signoria in Sardegna*, in Donatella Rita Fiorino, Michele Pintus (by), *Verso un Atlante dei sistemi difensivi della Sardegna*, Coll. Castella 100, Giannini Editore, Napoli, pp. 117-127.
- PINTUS V. (2017) - *Architettura fortificata nella Sardegna meridionale. Cronotipologia delle strutture murarie (XII-XV sec.)*, in "ArchHistoR", 8, pp.132-173, accessed July 19, 2017, doi: 10.14633/AHR060.
- PIRISINO M. S. (2017) - *Percorsi di conoscenza per il patrimonio fortificato della Sardegna settentrionale (XII-XV secolo). Architettura, materiali e tecniche murarie*, in "ArchHistoR", 7, pp. 154-189, accessed July 19, 2017, doi: 10.14633/AHR056.
- SODDU A. (2015) - *Castelli signorili nella Sardegna medievale (XIII-XIV sec.)*, in Donatella Rita Fiorino, Michele Pintus (by), *Verso un Atlante dei sistemi difensivi della Sardegna*, Coll. Castella 100, Giannini Editore, Napoli, pp. 265- 271.

