

HERITAGE 2022 INTERNATIONAL CONFERENCE VERNACULAR HERITAGE: CULTURE, PEOPLE AND SUSTAINABILITY

Eds. C. Mileto, F. Vegas, V. Cristini, L. García-Soriano



edUPV

Universitat Politècnica de València

VERNACULAR HERITAGE: CULTURE, PEOPLE AND SUSTAINABILITY

Eds. C. Mileto, F. Vegas, V. Cristini, L. García-Soriano



Universitat Politècnica de València

Colección Congresos UPV

The contents of this publication have been approved by the Congress Scientific Committee and in accordance to the procedure set out in
<http://ocs.editorial.upv.es/index.php/HERITAGE/HERITAGE2022>

First edition, 2022

Scientific Editors

C. Mileto
F. Vegas
V. Cristini
L. García-Soriano

© of the contents: the authors

Publisher

Editorial Universitat Politècnica de València
www.lalibreria.upv.es / Ref.: 6117_01_01_01

DOI: <https://doi.org/10.4995/HERITAGE2022.2022.15942>

ISBN: 978-84-1396-020-3

Print on-demand

Printer

Byprint Percom, S.L.

Printed in Spain



HERITAGE 2022

International Conference on Vernacular Heritage: Culture, People and Sustainability

This book is licensed under a Creative Commons Attribution-NonCommercial-ShareAlike-4.0 International license. Editorial Universitat Politècnica de València
<http://ocs.editorial.upv.es/index.php/HERITAGE/HERITAGE2022>

Preface

C.Mileto, F. Vegas, V. Cristini, L. García-Soriano

Research Centre for Architecture, Heritage and Management for Sustainable Development (PEGASO),
Universitat Politècnica de València, Valencia, Spain

“HERITAGE2022, International Conference on Vernacular Heritage: Culture, People and Sustainability” is organized in the framework of the “VerSus+ | Heritage for PEOPLE” project, co-funded by the Creative Europe Program of the European Union (grant 607593-CREA-1-2019-1-ES-CULT-COOP1) and led by Universitat Politècnica de València (Spain) in partnership with Università degli Studi di Firenze and Università degli Studi di Cagliari (Italy), CRATERRE – ENSAG (France) and Universidade Portucalense - Departamento de Arquitetura e Multimédia Gallaecia (Portugal). The “VerSus+ | Heritage for PEOPLE” project focuses on the transmission of knowledge to communities and the general public. It pays special attention to the society of the future (children and young people), as well as local, regional and national authorities in charge of heritage management, and includes specialists and experts in the field of architecture (architects, engineers, cultural managers, historians, ethnographers, university students, etc.) together with craftsmen and companies in the construction and tourism sectors, cultural and social associations, and educational institutions.

Vernacular heritage is a tangible and intangible heritage of great importance to European and global culture. This architecture, born from the practical experience of local inhabitants, makes use of local materials to erect buildings taking into consideration the climate and geography, developing cultural, social and constructive traditions based on the conditions of the surrounding nature and habitat. Above all, it plays an essential role in contemporary society as it is able to teach us important principles and lessons for a respectful sustainable architecture. These lessons from vernacular heritage for contemporary architecture have been extensively studied in the “VerSus: Lessons from Vernacular Heritage in Sustainable Architecture (grant 2012-2792/001-001 CU7 COOP7)” project, co-funded by the European Union between 2012 and 2014, and the “VerSus+ | Heritage for PEOPLE” (2019-2023) project, which follows on from the previous project, focusing on the transmission of this knowledge to society, as seen earlier. The wisdom of vernacular architecture in the field of environmental, sociocultural and socioeconomic sustainability is increasing both in interest and significance in the world today. Climate change, depopulation and the pressure of tourism all pose major challenges, as do the increasingly rapid social changes and loss of traditional trades resulting from the industrialization of the construction process. These challenges alert us to the pressing and growing need for education and increased awareness in society and for the documentation and conservation of architecture within a framework of up-to-date integration into contemporary life, managing territory and heritage assets for the sustainable development of society in the future.

The second project involved in this conference is “RISK-Terra. Earthen architecture in the Iberian Peninsula: study of natural, social and anthropic risks and strategies to improve resilience” (RTI2018-095302-B-I00) (2019-2022), funded by MCIU (Ministerio de Ciencia, Innovación y Universidades), AEI (Agencia Estatal de Investigación), FEDER - UE (Fondo Europeo de Desarrollo Regional, Unión Europea). This project is geared towards the conservation of earthen architecture in the Iberian Peninsula, both monumental and vernacular, which continues to be undervalued and barely recognized. The RISK-Terra project aims to provide scientific coverage of the study of natural threats (floods, earthquakes, climate change), social threats (abandonment, social discredit, demographic pressure, tourist development), and anthropic threats (neglect, lack of protection and maintenance), as well as the mechanisms for deterioration

and dynamics and transformation (replacement, use of incompatible techniques and materials, etc.) to which architecture is exposed. The objective of the project is to establish strategies for conservation, intervention and rehabilitation which allow the prevention and mitigation of possible damage through compatible actions and/or actions to increase resilience.

As these two projects have major points of contact, particularly in relation to the challenges mentioned above, with potential for common reflection, their main themes have been combined in this Heritage2022 conference. The topics established for the conference are: 1. vernacular architecture: matter, culture and sustainability (study and cataloging of vernacular architecture; urban studies of vernacular architecture; studies of traditional techniques and materials; sustainability of vernacular architecture); 2. heritage education (research in heritage education; heritage education and social inclusion; heritage communities; creativity and heritage education); 3. artisans and crafts of traditional construction (intangible heritage: the management of know-how and local construction culture; training in traditional construction crafts; tradition and innovation in traditional construction crafts; plans and experiences for the recovery and maintenance of construction crafts); 4. conservation, restoration and enhancement of vernacular architecture (conservation and restoration projects of vernacular architecture; materials and intervention techniques for vernacular architecture; difficulties and possibilities of using traditional crafts in conservation; management and maintenance of vernacular architecture).

The scientific committee was made up of 102 outstanding researchers from 24 countries from the five continents, specialists in the subjects proposed. All the contributions to the conference, both the abstracts and the final texts, were subjected to a strict peer-review evaluation system by the members of the scientific committee. Out of the 200 proposals submitted, 134 papers by 254 authors from 25 countries from the four continents were chosen for publication. All the articles have been published in print and online in the two-volume book “Vernacular Heritage: Culture, People and Sustainability”.

“HERITAGE2022 (Versus+ | RISK-Terra), International Conference on Vernacular Heritage: Culture, People and Sustainability” was held from 15 to 17 September 2022 in in-person and online modality at the Universitat Politècnica de València. The conference was under the aegis of: ICOMOS-CIAV (International Scientific Committee of Vernacular Architecture); ICOMOS-ICICH (International Scientific Committee on Intangible Cultural Heritage); IEB (Instituto Español de la Baubiologie). The organization, publication and implementation of the conference have been made possible thanks to co-funding of the Creative Europe Programme of the European Union for the project “VerSus+ | Heritage for PEOPLE” (grant 607593-CREA-1-2019-1-ES-CULT-COOP1); and the MCIU, AEI and FEDER - UE for the research project “Risk-Terra. Earthen architecture in the Iberian Peninsula: study of natural, social and anthropic risks and strategies to improve resilience” (ref.: RTI2018-095302-B-I00). Furthermore, Escuela Técnica Superior de Arquitectura and PEGASO - Research Centre for Architecture, Heritage and Management for Sustainable Development of Universitat Politècnica de València have also contributed to the whole project.

Finally, we would like to thank all the authors who contributed to the quality, range, diversity and richness of these publications with their articles. We give special thanks to all the partners of the European project “VerSus+ | Heritage for PEOPLE” and the national research project “Risk-Terra” for participating in the conference and helping to spreading the word about it worldwide. We are grateful for the aid of all the members of the advisory committee and the scientific committee for their work throughout the process of revising the abstracts and papers. And, above all, we thank the organizing committee for the complex setting up of the whole conference, the style and language reviewers for their corrections, and all the collaborators for their invaluable work in the management and organization of all stages of the process.

Organization and Committees

ORGANIZING COMMITTEE

Camilla Mileto (Chair) – *Universitat Politècnica de València, Spain*
Fernando Vegas López-M. (Chair) – *Universitat Politècnica de València, Spain*
Lidia García Soriano – *Universitat Politècnica de València, Spain*
Valentina Cristini – *Universitat Politècnica de València, Spain*
María Lidón De Miguel – *Universitat Politècnica de València, Spain*
Alicia Huetos Escobar – *Universitat Politècnica de València, Spain*
Vincenzina La Spina – *Universidad Politécnica de Cartagena, Spain*
Sergio Manzano – *Universitat Politècnica de València, Spain*
Francesca Trizio – *Universitat Politècnica de València, Spain*
Matilde Caruso – *Universitat Politècnica de València, Spain*
Marina Elia – *Universitat Politècnica de València, Spain*
Stefania Farina – *Universitat Politècnica de València, Spain*
David Eduardo Morocho-Jaramillo – *Universitat Politècnica de València, Spain*
Eva Tortajada Montalva – *Universitat Politècnica de València, Spain*

ORGANIZED BY

UPV – *Universitat Politècnica de València*
UPT-DAMG – *Universidade Portucalense, Departamento de Arquitetura e Multimédia Gallaecia*
UNIFI – *Università degli Studi di Firenze*
UNICA – *Università degli Studi di Cagliari*
CRATERRE-ENSAG – *École Nationale Supérieure d'Architecture de Grenoble*
PEGASO – *Research Center Architecture, Heritage and Management for Sustainable Development, UPV, Spain*
Departamento de Composición Arquitectónica, Spain

CO-FUNDED BY

VERSUS+/Heritage for PEOPLE Project
Creative Europe – *Creative Europe Programme of European Union*
RISK – *terra Project*
MICIU – *Ministerio de Ciencia, Innovación y Universidades*
AEI – *Agencia Estatal de Investigación*
FEDER, UE – *Fondo Europeo de Desarrollo Regional, Unión Europea*



UNDER THE AEGIS OF

ICOMOS-CIAV – International Scientific Committee for Vernacular Architecture –

International Council on Monuments and Sites

ICICH – International Committee on Intangible Cultural Heritage

ICOMOS-ISCEAH – International Scientific Committee on Earthen Architectural Heritage

SCIENTIFIC COMMITTEE

Adolfo Alonso Durá – *Universitat Politècnica de València, Spain*; Ahmed Alaidarous – *King Saud University, Riyadh, Saudi Arabia*; Alejandro García Hermida – *Universidad Alfonso X el Sabio, INTBAU-España, Spain*; Alessandro Merlo – *Università di Firenze, Italy*; Alessio Cardaci – *Università di Bergamo, Italy*; Alicia Hueto Escobar – *Universitat Politècnica de Valencia, Spain*; Amparo Graciani García – *Universidad de Sevilla, Spain*; Ana González Serrano – *Universidad de Sevilla, Spain*; Ana Yañez Vega – *Universidad Complutense de Madrid, Spain*; Andrea Pane – *Università Federico II di Napoli, Italy*; Angela Squassina – *Istituto Universitario di Architettura di Venezia, Italy*; Antonella Versaci – *Università Kore di Enna, Italy*; Apolonia Begoña Serrano Lanzarote – *Universitat Politècnica de Valencia, Spain*; Arianna Guardiola Villora – *Universitat Politècnica de Valencia, Spain*; Arturo Zaragoza Catalán, Generalitat Valenciana, **Spain**; Bakonirina Rakotomamonjy – *CRATERRE-ENSAG, France*; Borut Juvanec – *University of Lubiana, Slovenia*; Camilla Mileto – *Universitat Politècnica de València, Spain*; Chiho Ohiai – *Kyoto National University, Japan*; Claudia Cancino – *The Getty Conservation Institute, USA*; Cristina Vidal Lorenzo – *Universitat de València, Spain*; Daniela Esposito – *Università La Sapienza Roma, Italy*; David Eduardo Morocho-Jaramillo – *Universitat Politècnica de València, Spain*; Donatella Fiorani – *Università La Sapienza Roma, Italy*; Eva Tortajada Montalva – *Universitat Politècnica de València, Spain*; Fabio Fatiguso – *Università di Bari, Italy*; Fabio Fratini – *CNR-ICVBC, Sesto Fiorentino (FI), Italy*; Faissal Cherradi – *Ministerio de Cultura, Morocco*; Félix Jové Sandoval – *Universidad de Valladolid, Spain*; Fernando Vegas López-M. – *Universitat Politècnica de València, Spain*; Fernando Vela Cossío – *Universidad Politècnica de Madrid, Spain*; Francisco Javier López Martínez – *Universidad Católica de Murcia, Spain*; Francisco Javier Torrijo Echarri – *Universitat Politècnica de València, Spain*; Francesca Trizio – *Universitat Politècnica de València, Spain*; Francesco Trovó – *Istituto Universitario di Architettura di Venezia, Italy*; Frank Matero, *University of Pennsylvania, USA*; Gaspar Muñoz Cosme – *Universitat Politècnica de València, Spain*; Gilberto Carlos – *Escola Superior Gallaecia, Vila Nova Cerveira, Portugal*; Gisle Jakhelln – *ICOMOS-CIAV, Norway*; Guillermo Guimaraens Igual, *Universitat Politècnica de València, Spain*; Hirohide Kobayashi – *Kyoto National University, Japan*; Hossam Mahdy – *ICOMOS-CIAV, Great Britain*; Hubert Guillaud – *CRATERRE-ENSAG, ISCEAH, France*; Humberto Varum – *Universidade de Porto, Portugal*; Isabel Kanan – *ICOMOS-ISCEAH, PROTERRA, Brazil*; Ivan Enev – *Arquitecto, ICOMOS-CIAV, Bulgaria*; Javier Ors Ausin – *World Monument Fund, United States*; Jorge Luis García

Valldecabres – *Universitat Politècnica de València, Spain*; Jorge Tomasi – *CONICET, Instituto Interdisciplinario Tilcara, Argentina*; José Luis Baró Zarzo – *Universitat Politècnica de València, Spain*; José Manuel López Osorio – *Universidad de Málaga, Spain*; Juan Bravo Bravo – *Universitat Politècnica de València, Spain*; Juan María Songel González – *Universitat Politècnica de València, Spain*; Juana Font Arellano – *Fundación Antonio Font de Bedoya, PROTERRA, Spain*; Julieta Barada – *CONICET, Instituto Interdisciplinario Tilcara, Argentina*; Letizia Dipasquale – *Università di Firenze, Italy*; Lidia García Soriano – *Universitat Politècnica de València, Spain*; Luis Fernando Guerrero Baca – *Universidad Metropolitana Autónoma, Mexico*; Luisa Basset Salóm – *Universitat Politècnica de València, Spain*; Maddalena Achenza – *Università di Cagliari, ICOMOS-ISCEAH, Italy*; Marcel Vellinga – *Oxford Brookes University, ICOMOS-CIAV, United Kingdom*; María Concepción López González – *Universitat Politècnica de València, Spain*; Maria Ines Subercaseaux – *Metropolitana de Santiago, ICOMOS-CIAV, Chile*; María José Viñals Blasco – *Universitat Politècnica de València, Spain*; María Lidón de Miguel – *Universitat Politècnica de València, Spain*; Mariana Correia – *Escola Superior Gallaecia, Vila Nova Cerveira, Portugal*; Marina Elia – *Universitat Politècnica de València, Spain*; Marwa Dabaieh – *Lund University, Lund, ICOMOS-CIAV, Sweden*; Matilde Caruso – *Universitat Politècnica de València, Spain*; Mikel Landa Esparza – *Arquitecto, ICOMOS-IIWC, Spain*; Min Hall – *architect, Unitec Institute of Technology, Auckland, Nueva Zelanda*; Mónica Luengo Añón – *Arquitecto paisajista, ICOMOS-IFLA, Spain*; Naima Benkari – *Sultan Qaboos University, Omán*; Natalia Jorquera – *Universidad de Chile, Santiago, Chile*; Ona Vileikis Tamayo – *University Collage London, Reino Unido*; Pamela Jerome – *Columbia University, ICOMOS-ISCEAH, United States*; Pablo Rodríguez Navarro – *Universitat Politècnica de València, Spain*; Paolo Vitti – *University of Notre Dame, United States*; Pasquale De Dato – *Universitat Politècnica de València, Spain*; Paulo B. Lourenço – *Universidade do Minho, ICOMOS-ISCARSAH, Portugal*; Pere Roca Fabregat – *Universitat Politècnica de Catalunya, ICOMOS-ISCARSAH, Spain*; Plácido González Martínez – *Tongji University Shanghai, China*; Rawiwan Oranratmanee – *Chiang Mai University, Thailand*; Renata Picone – *Università Federico II di Napoli, Italy*; Saverio Mecca – *Università di Firenze, Italy*; Sébastien Moriset – *CRATERRE-ENSAG, France*; Sergio Manzano – *Universitat Politècnica de València, Spain*; Sergio Ortín Molina – *Universitat Politècnica de València, Spain*; Shao Yong – *Tongji University Shanghai, China*; Simone Ricca – *WHITRAP, Shanghai, China*; Stefan Balici – *Ion Mincu Universty, Romania*; Stefania Farina – *Universitat Politècnica de València, Spain*; Teresa Gil Piqueras – *Universitat Politècnica de València, Spain*; Thierry Joffroy – *CRATERRE-ENSAG, France*; Valentina Cristini – *Universitat Politècnica de València, Spain*; Valentina Russo – *Università Federico II di Napoli, Italy*; Valeria Prieto – *Arquitecta, ICOMOS-CIAV, Mexico*; Vincenzina La Spina – *Universidad Politècnica de Cartagena, Spain*; Yolanda Hernández Navarro – *Universitat Politècnica de València, Spain*; Wenhao Ji – *China Academy of Art, Hangzhou*; Youcef Chennaoui – *École Polytechnique d'Architecture et d'Urbanisme d'Alger, Algeria*; Zuzana Syrová – *National Heritage Institute, Czech Republic*.

COLLABORATION IN THE PUBLICATION

Marina Elia (coordinator)

Stefania Farina

Lidia García Soriano

María Lidón De Miguel

Alicia Hueto Escobar

Sergio Manzano Fernández

Francesca Trizio

Matilde Caruso

David Eduardo Morocho-Jaramillo

Eva Tortajada Montalva

Conference support

ORGANIZED BY



UNIVERSITAT
POLITÈCNICA
DE VALÈNCIA



UNIVERSIDADE PORTUCALENSE
DEPARTAMENTO ARQUITETURA E MULTIMÉDIA GALLECIA



UNIVERSITÀ
DEGLI STUDI
FIRENZE



UNIVERSITÀ
DEGLI STUDI
DI CAGLIARI



CRAterre



E
NS/
AG



Centro de Investigación
Arquitectura, Patrimonio y Gestión
para el desarrollo Sostenible



DEPARTAMENTO DE
COMPOSICIÓN ARQUITECTÓNICA

CO-FUNDED BY



versus
plus



Co-funded by the
Creative Europe Programme
of the European Union



RISK_Terra



Gobierno
de España

Ministerio
de Ciencia, Innovación
y Universidades



UNIÓN EUROPEA

UNDER THE AEGIS OF



ICOMOS CIAV
International Committee
on Vernacular Architecture



ICICH
International Committee on Intangible Cultural Heritage



ICOMOS - ISCEAH
International Scientific Committee
on Earthen Architectural Heritage

Table of contents

Preface.....	I
Organization and Committees.....	IV
Conference Support.....	VIII

PLENARY LECTURES

A Vision for CIAV. Addressing the challenges facing the ICOMOS International Scientific Committee on Vernacular Architecture.....	3
<i>H. Mahdy</i>	
The National Plan for Traditional Architecture as a safeguarding tool. Action programmes and projects.....	11
<i>M. P. Timón Tiemblo, E. Agromayor Navarrete</i>	

VERNACULAR ARCHITECTURE: MATTER, CULTURE AND SUSTAINABILITY

STUDY AND CATALOGING OF VERNACULAR ARCHITECTURE

The standardisation of vernacular architecture. Wine buildings in Andalusia.....	23
<i>J. Aladro-Prieto, F. J. Ostos-Prieto, M. Murillo-Romero</i>	
Vernacular architecture in Brazilian semiarid region: survey and memory in the state of Sergipe.....	31
<i>D. Felix Andrade, M. A. Penido de Rezende, S. Araújo Lima Bessa</i>	
Knowledge and conservation of Mediterranean spontaneous architecture: some of the villages of the northern Tyrrhenian coast of Calabria.....	39
<i>B. Canonaco, F. Bilotta</i>	
Architectural and constructive characteristics of vernacular settlements in southern Italy: the Esaro's valley and the popular identity of some exemplary cases.....	47
<i>B. Canonaco, F. Castiglione</i>	
Spanish traditional architecture abandonment and destruction: an initial analysis of social risks, phenomena, and effects in earthen architecture.....	55
<i>M. Caruso, C. Mileto, F. Vegas, V. Cristini</i>	
A taxonomy of vernacular heritage in the mid-Adriatic: Landscape relations and architectural characteristics of the farmhouses in Tronto Valley (Italy).....	63
<i>S. Cipolletti</i>	
Traditional houses in the South-Western Iberian Peninsula: Themes for a cross-border comparative typological study.....	71
<i>A. Costa Rosado, V. Gómez Martínez, M. Reimão Costa, M. T. Pérez Cano</i>	



The Hameau de la Reine at Versailles and the reproduction of vernacular architecture.....	79
<i>D. Crispino</i>	
Vernacular architecture of the Amalfi coast: a medieval domus in Villa Rufolo in Ravello (Italy)	87
<i>E. De Feo</i>	
Architectural survey, realized with integrated methodology, of the complex of Walser houses in Alagna Valsesia, Italy	95
<i>A. Di Paola, S. Vecchio, G. Frosini, B. Verona, S. Garuglieri</i>	
Modern attitudes towards vernacular architecture. Works by the Italians Luigi Angelini, Alberto Alpago Novello, Ottavio Cabiati, Alessandro Minali	103
<i>M. M. Grisoni</i>	
Wind and the villages in Rincón de Ademuz, Spain	111
<i>W. Ji, C. Mileto, F. Vegas</i>	
Vernacular features in eclectic architecture from the tropics. An analysis by means of architectural survey	119
<i>M. Leserri, G. Rossi, M. Chaverra Suarez, S. Gómez Mejía</i>	
Configuring, building and inhabiting the house from a gender perspective	125
<i>M. Lidón de Miguel, C. Mileto, F. Vegas, A. Hueto-Escobar</i>	
Rediscovering tradition through representation: the vaulted house of the Amalfi Coast.....	133
<i>B. Messina, S. Morena, C. Ferreyra</i>	
Traditional dwellings and techniques of the First Indigenous Peoples of South Africa in the Eastern Cape.....	141
<i>M. Minguzzi, Y. Hernández Navarro, L. Vosloo</i>	
Rediscovered earth heritage becomes motor for local change The Guérande Peninsula (France)	149
<i>M. Miranda Santos, A. Hilton, P. Poullain, E. Hamard, C. Mouraud</i>	
Tradition and semantics: the case of Aeolian architecture.....	157
<i>S. Mollica</i>	
The Italian case of Leopoldine in Tuscany: methods and issues for the cataloguing of rural building heritage	165
<i>I. Nocerino</i>	
Highlighting the Heritage of Meseta Ibérica.....	173
<i>J. Pinto, A. Paiva, D. Almeida, S. Pereira, A. Antunes, R. Bento</i>	
A heritage to reveal and protect. Historical water-based paper mills and ironworks in Campania (Italy)	181
<i>S. Pollone</i>	
Architecture and Proto Industry. Watermills in the historic peri-urban landscape of Benevento (Italy).....	189
<i>L. Romano</i>	

An architectural catalogue for the study of traditional building features from their seismic behaviour in the 2016 Central Italy earthquake	197
<i>L. Sbrogiò, Y. Saretta, M. R. Valluzzi</i>	
Earthen vernacular architecture in flood-prone areas: characteristics and typologies in the Ebro basin.....	205
<i>F. Trizio, F.J. Torrijo Echarri, C. Mileto, F. Vegas</i>	
New studies for the knowledge of the vernacular characters of the ancient water mills in central Sicily	213
<i>A. Versaci, A. Cardaci, L. R. Fauzià, M. Russo</i>	
Identification and safeguarding of Central Sicily's forgotten vernacular heritage: elements of identity and memory	221
<i>A. Versaci, A. Cardaci</i>	
The particular ensemble of Mas d'en Segures: Functional and constructive analysis of a house and a barn in Tinença de Benifassà (Castellón, Spain).....	229
<i>J. Villasante Claramonte</i>	
In the shadow of Vesuvius. Sustainable and bioclimatic lessons from a vernacular heritage	237
<i>E. Vitagliano</i>	
URBAN STUDIES OF VERNACULAR ARCHITECTURE	
The rural founding villages of the Italian Agrarian Reform in Basilicata (1950-1970): urban planning and 'modern' vernacular architecture to the test of contemporaneity. The case of Borgo Taccone (MT)	247
<i>C. Achille, S. Bortolotto, E. Ciocchini, M. C. Palo</i>	
Vernacular architecture and written sources: the case study of the Tronto Valley	255
<i>E. Facchi, A. Grimoldi, A. G. Landi</i>	
Urban vernacular architecture in the Middle Ages in Galicia, Spain.....	263
<i>A. Fernández Palicio</i>	
Binibeca Vell. Interpreting tradition	271
<i>J. J. Ferrer Forés</i>	
Mapping spatial social aspects of urban recovery in contested cities: a case of the historic commercial center of the ancient city of Aleppo	279
<i>S. Ibrahim</i>	
Contributions of the vernacular heritage in the current city. Case study: Santo Domingo Neighborhood, Tuxtla Gutiérrez, Chiapas, Mexico	287
<i>A. Parra Zebadúa, M. Genís Vinyals, L. Ocampo García, R. Villers Aispuro, M. A. Zenteno Hernández, L. F. Escamiroso Montalvo, S. N. Zebadúa Velasco</i>	
The town of Collodi: the vernacular heritage.....	293
<i>F. Pisani</i>	

Between landscape and fortified architecture: traces and memory of rural civilization
in the territory of Pesche in Molise 301
M. P. Testa

Light Touch on the land – continued conversations about architectural change,
informality and sustainability..... 309
D. Whelan

STUDIES OF TRADITIONAL TECHNIQUES AND MATERIALS

The stone as constant presence: vernacular structure of the cultural heritage of Porcuna
(Andalusia, Spain)..... 319
S. Belmondo, P. Millán Millán

From natural to artificial: vernacular housing in the Spanish Caribbean 327
B. del Cueto

Designing with water for climate change adaptation and cultural heritage preservation..... 335
A. Elnokaly, W. Pittungnapoo

La Vera's vernacular architecture. Structural design and climate protection in timber
frame wall houses using constructive systems and local materials..... 341
E. Franco Rodríguez, M. Bujalance

Traditional buildings for tobacco processing in Val Tiberina (Tuscany-Italy) 349
F. Fratini, S. Rescic, M. Camaiti, M. Mattone

The parish church of San Michele Arcangelo in Metelliano: the path of knowledge of
a vernacular architecture 357
G. Ghelfi

Indoor air quality for sustainability, occupational health and classroom environments
through the application of earth plaster 363
M. I. Gomes, T. Miranda

The importance of water in traditional gypsum works..... 369
B. González-Sánchez, W. Salazar Chuquimarca, J. R. Rosell Amigó, A. Navarro Ezquerra

State of conservation of half-timbered walls in Burgos (Spain): Quantitative analysis
of material and structural degradation..... 377
A. Hueto-Escobar, F. Vegas, C. Mileto, M. Lidón de Miguel

Adobe Constructions – Colonial Chilean House..... 385
M. G. Jofré Troncoso

Favignana bio-calcarene: technological culture, knowledge and recovery..... 393
A. Mamì, E. Caleca, E. Nicolini

Examination of earthen construction in archaeological sites of the Iberian Peninsula
for risk analysis 401
S. Manzano Fernández, C. Mileto, F. Vegas, V. Cristini

Traditional mortars with chucum in Yucatan, Mexico, as biocultural heritage	409
<i>M. M. Martínez-Barreiro, L. F. Guerrero-Baca</i>	
Dry Stone Wall Relics as a Part of Cultural Landscapes: A Case Study from the Foot of Mt. Hira Region in Japan	417
<i>C. Ochiai, J. Wang</i>	
The paving of ancient paths, testimony of an ancient culture: recovery of a traditional route in Genoa (Liguria, Italy)	425
<i>D. Pittaluga, S. Rescic, F. Fratini</i>	
Constructive and earthquake-resistant aspects of modelled-earth, a technique in ancient Peru	433
<i>H. E. Torres Peceros</i>	
Research on technique “Banzhu” used in traditional dwellings in China from the perspective of formwork	441
<i>Q. Zhou</i>	
<i>SUSTAINABILITY OF VERNACULAR ARCHITECTURE</i>	
Traditional Bukharian Houses and Mahallas: a shared vernacular heritage at risk.....	451
<i>N. Aituganova, O. Vileikis, S. Babaev, J. Ors Ausín</i>	
A look on the intrinsic sustainability of Aeolian vernacular architecture	459
<i>R. Caponetto, G. Giuffrida</i>	
The Z Free Home – inspired by vernacular architecture	467
<i>M. Dabaieh</i>	
Proposals for the sustainable recovery of dry stone buildings in Puglia, Italy.....	475
<i>S. Farina</i>	
Casa Nautilus Solar – Organic contemporary Architecture based on Vernacular Heritage	483
<i>P. Jebens-Zirkel Imm, A. J. Zirkel Zirkel</i>	
Making our Rural Landscape visible. A way to defend Anonymous Cultural Heritage.....	491
<i>A. Martínez Duran, M. Villaverde Rey</i>	
Shuar architecture as a model of sustainability	499
<i>D. E. Morocho-Jaramillo</i>	
Dry stone architecture: the survey as a tool to safeguard the risk of morphological or formal homologation.....	507
<i>G. Rossi, M. Leserri, A. Benitez Calle</i>	
At the roots of sustainability: Mediterranean vernacular architecture	513
<i>S. Talenti, A. Teodosio</i>	
Lessons from the past, architecture for the future. Coupling historic preservation with sustainable architecture	521
<i>P. Vitti</i>	

HERITAGE EDUCATION

RESEARCH IN HERITAGE EDUCATION

Community School Museums as a tool for education.....	537
<i>P. Alonso-Monasterio, L. Uixer Cotano</i>	
The interpretation of the vernacular in the modern work of Gherardo Bosio: the Albanian experience.....	545
<i>C. Castagnaro</i>	
“For sale: empty Spain” Raising awareness on abandoned buildings and depopulated villages	553
<i>V. Cristini, J. L. Baró Zarzo, C. Mileto, F. Vegas, M. Caruso, E. Tortajada Montalva</i>	
Qualitative, historical, spatial, stylistic, and social assessment of heritage buildings in Arequipa for Cultural Heritage teaching in Schools of Architecture	559
<i>T. B. Medina-Sánchez, D. L. Mayta-Ponce, D. Málaga-Montoya, S. Coll-Pla, F. A. Cuzziramos-Gutiérrez, A. Costa Jover</i>	
Vernacular architecture and art. The representation of traditional buildings in Lorenzo Ghiberti's Gates of Paradise in the Baptistery of Florence.....	567
<i>A. Merlo, G. Lavoratti</i>	
Defensive architecture and heritage education: analysis of the National Park Service and Parks Canada actions	575
<i>J. A. Mira Rico</i>	
HERITAGE EDUCATION AND SOCIAL INCLUSION	
<i>Gibellina and the identity of community. Brandi, Burri and the conservation of the 'ruins'</i>	<i>585</i>
<i>C. Accetta</i>	
The perceptive experience of the heritage landscape.....	593
<i>A. Barranco Donderis</i>	
The Role of University in Local Cultural Development Through Vernacular Architectural Conservation Education: The Case of Havran, Turkey.....	599
<i>D. U. Binan, H. İ. Alatli</i>	
The role of cultural heritage in urban reuse	607
<i>M. Domènech Rodríguez, D. López López, C. Cornadó Bardón</i>	
Involving society in the enhancement of old city centres	615
<i>A. Guardiola-Villora, L. Basset-Salom</i>	
3D Heritage as a catalyst for social participation in safeguarding cities in conflict. A Case study of Damascus in Syria	623
<i>S. Ibrahim</i>	

Heritage education as an effective approach to enhance community engagement: a model for classifying the level of engagement	631
<i>T. W. Lao</i>	
Preservation and promotion of the cultural heritage through University, public administration, and community engagement.....	639
<i>M. Mattone, N. Frullo</i>	
‘Acupuncture of Awareness’: a possible path for vernacular heritage preservation.....	647
<i>L. Rossato</i>	

HERITAGE COMMUNITIES

Overlooked heritage of Albania: chronicle of rescue, conservation and community involvement at Great Prespa Lake	657
<i>V. Cristini, B. Ludwig</i>	
The appropriation of traditional houses in Imbros/Gökçeada	663
<i>A. Dinççağ Kahveci</i>	
The SDGs as a useful tool in vernacular architecture management: The case of “17 objectives and a map”	671
<i>A. López Sabater, V. García López de Andújar, X. Laumain</i>	
An Odyssey to Heritage Education: The Inspiring Example of Bergama and Its Communities	679
<i>D. Ulusoy Binan, G. G. Okyay</i>	
The role of heritage communities in local development processes through the reuse of architectural heritage. Some examples in Italian rural areas	687
<i>C. Valiante, A. M. Oteri</i>	

CREATIVITY AND HERITAGE EDUCATION

Strategies for the recognition and the enhancement of the cultural heritage in Sant'Antioco	697
<i>M. Achenza, I. Blečić, L. Dipasquale, S. Mecca, A. Merlo</i>	
A collaborative Web App to foster a knowledge network on vernacular heritage, craftspeople, and sustainability	703
<i>J. Ammendola, L. Dipasquale, E. P. Ferrari, S. Mecca, L. Montoni, M. Zambelli</i>	
Cultural heritage: educating the next generation. Case study analysis of the Center of Preservation Research	711
<i>E. Vlahos</i>	

ARTISANS AND CRAFTS OF TRADITIONAL CONSTRUCTION

INTANGIBLE HERITAGE: THE MANAGEMENT OF KNOW-HOW AND LOCAL CONSTRUCTION CULTURE

The towns of the Popocateptl Volcano. Territorial symbolism, cultural identity and vernacular architecture	721
<i>B. Aguilar Prieto</i>	

Methodology for mapping Intangible Cultural Heritage through webGIS integral platforms. La Fontanalla neighbourhood as a case study 729
F. Conejo-Arrabal, F. J. Chamizo-Nieto, N. Nebot-Gómez de Salazar, C. Rosa-Jiménez

The struggle for Stone-dry walling: the ambition to protect both processes and products 737
M. M. Grisoni

From intangible to tangible. Artisan Skills and Traditional Crafts for Preserving Venice's Built Heritage 745
A. Squassina

TRADITION AND INNOVATION IN TRADITIONAL CONSTRUCTION CRAFTS

The Craft of Stucco Mihrab carving in Oman in the 13th to 17th AD..... 755
N. Benkari

From prototypes to monotypes. Neo-craftsmanship in architecture and design 763
J. Bravo Bravo

PLANS AND EXPERIENCES FOR THE RECOVERY AND MAINTENANCE OF CONSTRUCTION CRAFTS

Vernacular architecture and seismic risk. The case of Mugello in Tuscany 773
P. Bordoni

Pinnettas de pedra: a guide for the valorisation of dry-stone artifacts 781
S. N. Cappai, A. V. Sotgiu

Vernacular architecture and traditional trades. Social innovation and cultural heritage in rural Andalusia 789
G. Carrera Díaz, B. Del Espino Hidalgo, A. Delgado Méndez

The role of craftsmanship in the conservation of Venice. State of the art and perspective..... 797
F. Trovò, E. Vettore

CONSERVATION, RESTORATION AND ENHANCEMENT OF VERNACULAR ARCHITECTURE

CONSERVATION AND RESTORATION PROJECTS OF VERNACULAR ARCHITECTURE

Is there a future for marginal communities? 807
M. Bocci

Restoration of the stained glass windows of the British Cemetery of Valencia 815
C. Burguete Gil

Studies and projects for the archaeological park of the Nuraghe s'Urachi (Sardinia, Italy). From knowledge for heritage conservation to project for the community 823
G. M. Chiri, F. Novelli

Vernacular heritage protection by the Superintendence of the Aosta Valley 831
C. De La Pierre, D. Martinet, B. Scala

Of earth, stone and wood: the restoration and conservation of a Buddhist temple in Ladakh, Indian Himalayas.....	839
<i>E. P. Ferrari</i>	
The <i>hórreos</i> in Riaño Mountain, León, Spain. Vernacular architecture between conservation and musealisation.....	847
<i>M. P. García Cuetos</i>	
Restoration project of vernacular architecture affected for ground subsidence: A case study in Juslibol Church (Zaragoza, Spain)	855
<i>A. Gracia, F. J. Torrijo, M. A. Pérez</i>	
Farmhouse interior restoration in bioconstruction	863
<i>V. Li-Puma Sforazzini</i>	
After the earthquake. Design processes for intervention on vernacular heritage in Central Italy.....	871
<i>G. Loffredo, F. Recla, N. Suraci, C. Tosco</i>	
Implementing the lesson of early 20th century traditional buildings for a real sustainability. The examples of Corviale (Rome) and ZEN (Palermo) districts.....	879
<i>E. M. Mazzola</i>	
From rural house to “villa of delights”: knowledge and conservation of Villa Murat in the Sorrento peninsula.....	889
<i>A. Pane, R. Catuogno, M. Parente</i>	
Vernacular earthen architecture. Construction techniques and restoration. From the international setting to some specific Italian regional cases	897
<i>E. Petrucci, R. Mancini, M. G. Putzu</i>	
Rigour, methodology and use, success in heritage conservation: the tower of the St. Mary Magdalene’s church.....	905
<i>P. Rodríguez Cantalapiedra</i>	
Strategies to value the dispersed heritage of rural Andalusia. Lagares, paseros and vineyards: the architecture of the raisin	913
<i>L. Royo Naranjo</i>	
Guidelines for the conservation of the ancient hydraulic mills of the Valle Sabbia, Brescia (Italy).....	921
<i>B. Scala, L. Aliverti</i>	
Bazaars between documentation and conservation. Case studies in Albania and Macedonia.....	929
<i>A. Trematerra, E. Mirra</i>	
Perspectives for the small historical centres at risk of abandonment. A pilot project for the Granfonte district in Leonforte (Italy).....	937
<i>M. R. Vitale, C. Circo, D. Sanzaro, S. Sebastián Franco, I. Cacciatore, M. Massimino</i>	
Repair grants for historic farm buildings in Dartmoor National Park.....	945
<i>N. White</i>	

MATERIALS AND INTERVENTION TECHNIQUES FOR VERNACULAR ARCHITECTURE

Syrian earthen villages: recovery of construction crafts to revive dome houses.....	955
<i>H. Asslan</i>	
Historic tuff masonry in Naples: different approaches to its conservation	963
<i>B. Balbi, R. Bosso, G. Russo Krauss</i>	
Vernacular architecture on archaeological remains. Conservation and enhancement of the “Villa San Limato” in Cellole	971
<i>L. Cappelli</i>	
Conservation and restoration of timber architecture in the Czech Republic.....	979
<i>M. Cernansky</i>	
Effects of the use of plant mucilage on the physico-mechanical properties of raw earth structures	987
<i>O. M. Medina Lorente, B. Carrascosa Moliner, L. Osete Cortina</i>	
Vernacular architecture and archaeological remains. Direct links in the Phlegraean Fields in Campania (Italy).....	995
<i>R. Picone</i>	

DIFFICULTIES AND POSSIBILITIES OF USING TRADITIONAL CRAFTS IN CONSERVATION

Impediments to Sustenance and Revival of Vernacular Architecture in Rural Madhya Pradesh, India.....	1005
<i>A. Tamhankar, V. Gupta</i>	

MANAGEMENT AND MAINTENANCE OF VERNACULAR ARCHITECTURE

Ghadames, Libya. A traditional earthen settlement, resilient to crises and environmental challenges.....	1015
<i>S. Abdulac</i>	
Architectural Heritage and seismic vulnerability: mapping the available knowledge to reduce damage during an emergency	1023
<i>E. Brusa, C. Chesi, S. Della Torre</i>	
Analysis and regeneration strategies for the abandoned villages of the Santerno valley in Tuscany	1031
<i>M. Coppola, L. Dipasquale, L. Mannucci, L. Rovero</i>	
Learning from the past. The loss of vernacular heritage in the interest of hydropower development in Spain.....	1039
<i>N. Fernández García</i>	
Post seismic intervention strategies over the last fifty years in Italy (1968 – 2016). Initial observations about the vernacular architecture’s conservation	1047
<i>V. Macca</i>	

Close to the volcan. Knowledge, conservation and enhancement of a Vesuvian vernacular heritage	1055
<i>B. G. Marino, A. Ragosta</i>	
Heritage and community centre in Matta Sur, Chile.....	1063
<i>A. Rivera Vidal, C. Gómez Maestro</i>	
Local materials and traditions in the conservation of vernacular buildings.....	1071
<i>C. Rodrigues</i>	
Vernacular earthen architectures. Institutionalisation and management models for its conservation in northern Argentina.....	1077
<i>J. Tomasi, J. Barada</i>	
Protection and reuse of a forgotten heritage: the Parmesan cheese buildings. Notes for a widespread museum in the lower Reggio Emilia plain	1085
<i>S. Varvaro</i>	

AUTHORS INDEX

CONSERVATION, RESTORATION AND ENHANCEMENT OF VERNACULAR ARCHITECTURE

**MANAGEMENT AND MAINTENANCE OF
VERNACULAR ARCHITECTURE**



Architectural Heritage and seismic vulnerability: mapping the available knowledge to reduce damage during an emergency

Enrica Brusa¹, Claudio Chesi², Stefano Della Torre³

¹Politecnico di Milano, Dep. of Architecture and Urban Studies (DASU), Milano, Italy, enrica.brusa@polimi.it;

^{2,3}Politecnico di Milano, Dep. of Architecture, Built Environment and Construction Engineering (DABC), Milano, Italy, claudio.chesi@polimi.it; stefano.dellatorre@polimi.it

Topic: T4.4. Management and maintenance of vernacular architecture

Abstract

Vernacular architecture has become a full part of our cultural heritage, since it constitutes evidence of our material culture and is tied to specific historical/geographical contexts. This type of 'lesser' heritage has withstood various transformations over time, whether negative transformations due to abandonment, or positive transformations due to expansion and renovation work on historical buildings or their simple adaptation to new living conditions. Thus, vernacular architecture often presents intrinsic vulnerabilities resulting from all the transformations it has undergone. The presence of this type of vulnerability within the vernacular built heritage also constitutes an even greater risk for buildings located in seismic areas, as this could lead to an increase in the level of damage due to an earthquake, often with irreversible losses. Achieving a good level of knowledge about the vulnerability of historical buildings in seismic areas is therefore important for their adequate preservation. This not only allows preventive maintenance to be planned, but also because when an earthquake occurs, this type of knowledge would allow decisions to be made with greater awareness regarding where to intervene first, and to more quickly identify where safety interventions for the most vulnerable buildings must be realised. As is well demonstrated by the collapses caused by the earthquakes that hit Central Italy in 2016, the possibility of promptly securing damaged historical buildings is of fundamental importance for conserving the built heritage damaged by an earthquake. To this end, the contribution describes some of the main instruments available in Italy for technicians and functionaries that intervene during a seismic emergency to secure the architectural heritage, with suggestions as to how these tools can be strengthened.

Keywords: seismic risk and seismic vulnerability; emergency management; interoperability.

1. Introduction

Architectural heritage is an important element of the cultural heritage: it bears witness to traditional architectural techniques and to artistic values and crafts specific to certain ages and places. Local populations have always ascribed a major value not only to the great monuments but also to the vernacular heritage, which often still has a social, historical and cultural pre-eminence for them.

In every region of Italy there are many examples of 'vernacular' architectural heritage, of which

churches are undoubtedly a particularly significant cultural testimony. In many cases, these buildings seem modest on the outside, but they keep a considerable artistic heritage – i.e. paintings, frescoes, sacred furnishings – on the inside. These churches, even small ones, still play a social role for the local population as a landmark of the local identity.

Churches also represent a building typology that is particularly vulnerable to seismic actions due to the large size of the *aula*, often lacking

of suitable reinforcing elements. Frequently, these buildings are also poorly maintained since they're rarely attended during the year. For these reasons, when an earthquake occurs, churches regularly suffer major damage. The most common causes of their vulnerability are, for instance, the lack of effective seismic protection elements (*presidi antisismici*), the inadequate connection between the walls, the poor quality of the materials, as well as the lack of retrofitting intervention and an inadequate level of general maintenance.

Provisional works, if promptly executed during the first phase of a seismic emergency, may prove to be an effective temporary solution. They could successfully limit the damage caused by seismic aftershocks, especially those of strong intensity, as recent earthquakes that hit Central Italy in 2016-17 have shown.

The ability to promptly install the necessary countermeasures to stop the progression of seismic damage is not a simple process. In order to reach a positive effect, it is necessary to know the characteristics of the building, such as which and where the most vulnerable elements are. Moreover, all the entities that are involved in the emergency should rapidly activate a series of operations in a coordinated manner. Concerning the architectural heritage, the public authorities that intervene to safeguard it are: the Ministry of Culture (MiC), which is responsible for the protection of the heritage; the National Fire Brigade (NFB) and the Civil Protection Department (CPD), which are charged with implementing the interventions. Aiming to promptly manage the emergency, the involved operators should know in advance which are the listed buildings that are located in seismic areas so that they can efficiently organise all the securing activities, from the damage surveys to the realisation of appropriate countermeasures.

1.1 Architectural heritage and emergency

When an earthquake occurs, emergency operators are immediately activated. In Italy, the management of a seismic emergency is entrusted to the National System of Civil Protection, which is designated to manage both the first relief operations and the

assistance to affected populations. During the early stages of an emergency, search and rescue activities and measures to assist the displaced population are carried out, together with first surveys to assess the damage that has occurred in the most relevant buildings – i.e. hospitals, administrative centres/public buildings, schools, etc. During this time, an evaluation of where public access should be prohibited is also carried out – i.e. in those areas that show the greatest risk of suffering further damage and collapses. These latter activities are performed by the National Fire Brigade, a component of the Civil Protection Department with specialist teams trained to carry out emergency operations, such as rescuing people, evaluating the stability of structures and implementing technical countermeasures.

In the case of a severe emergency, such as when an earthquake of high intensity causes significant damage, the CPD requires the collaboration of other public security authorities, such as the Italian Army, starting from the corp of *Carabinieri*.

Regarding the architectural heritage, the emergency activities mainly concern:

- for the immovable heritage, the assessment of the occurred damage, the design/execution of securing countermeasures to contain the damage/progression of the activated collapse mechanisms;
- for the movable heritage, the recovery and transfer to temporary warehouses in order to restore the damaged items and to protect them from possible further damage or theft.

When a natural/anthropic emergency occurs, the MiC activates specific crisis units called '*Unità di Crisi per il coordinamento Nazionale – UCCN*' (Crisis Unit for the National Coordination) and '*Unità di Crisi per il coordinamento Regionale – UCCR*' (Crisis Unit for the Regional Coordination). The UCCN does coordination tasks for the activities carried out by the UCCR, and it supports communication with other public authorities that intervene during the emergency. The UCCR instead deals with giving specific indications for the emergency activities that are conducted locally by the officers of the MiC. Each UCCR is organized into different operational units: the 'O.U. for the damage surveys', the 'O.U. for the realisation of the provisional countermeasures

systems' and the 'O.U. for the displacement and restoration of the movable heritage'. During an emergency, the officers of the MiC collaborate directly with both the CPD / NFB and the teams of qualified researchers/professionals.

The officers of the National Fire Brigade play an important role in securing the damaged architectural heritage: they have to evaluate, design and implement technical countermeasures. Starting in 2015, the NFB has defined a specific operating protocol for the realisation of the provisional systems, called 'Short-Term Countermeasures System – STCS'. It regulates the reconnaissance of damage scenarios, the supply of necessary means/materials and the execution of technical countermeasures.

The NFB has a special operative unit named 'Nucleo Interventi Speciali – NIS' (Team for special intervention), which is trained to design the technical countermeasures. In order to define an intervention, the officers of this unit participate in special surveys called 'GTS surveys'¹. When the evaluation concerns the architectural heritage, surveys are performed jointly by the NFB, the Civil Protection Department, the local administration and the MiC.



Fig. 1. Emergency Operative Units activated by MiC and NFB.

Moreover, in order to properly design the countermeasures for damaged buildings, the NFB has prepared a specific manual with some technical sheets². These documents have been developed based on the experience from the L'Aquila seismic emergency in 2009. They allow the NFB to design and implement the technical countermeasures

according to some codified intervention schemes, which define the most appropriate solution starting from the constructive characteristics of a building, also considering the typology/extent of damage and the risk conditions which may exist in the context and/or in adjacent dwellings.

1.2 Tools for finding the preliminary level of vulnerability

It is therefore clear that, at the time of an emergency, the NFB need to know which are the main constructive characteristics of a damaged building, thus being able to define in a correct and a timely way the most appropriate technical countermeasures. The most important data are those related to the structure, including external/internal dimensions, materials and changes occurred over time. Unfortunately, these data are not always available in public/ministerial archives or they are not easily/immediately accessible. Thus, even when these data exist, they are not readily usable at the time of an emergency.

Otherwise, knowing this information before starting to design the countermeasures could be a valuable resource for the NFB since it would make it easier for technicians to understand the effective vulnerability of buildings and, consequently, to design appropriate, urgent technical countermeasures for those parts that might be subject to a greater risk of collapse.

It was several years ago that, aware of the connection existing between the vulnerability of a building and its expected seismic damage, the Italian 'Istituto Centrale per il Restauro – ICR' (Central Institute for Restoration) started a study to survey the constructive vulnerability of national built heritage. This study is part of a larger project called 'Carta del Rischio' (CdR), aimed at identifying those natural/environmental or anthropic risks that might threaten the Italian architectural heritage³. 'CdR' is a geographic

¹The acronym 'GTS' means: 'Gruppi Tecnici di Sostegno' (Technical Support Groups). These teams include both specialised officers and technicians from different public agencies.

²'Manuale opere provvisionali' and 'Schede tecniche STOP'.

³Nevertheless, this is not the first analysis carried out to define the causes of degradation of the cultural heritage that stands in a territory: a first important project, aimed at mapping this link by identifying methods, professionalisms and experts able to carry out preventive interventions of 'planned conservation', was already proposed in 1975 by G.Urbani, who was the director of the ICR. That project was called

information system developed to map, on a cartographic basis, what are the assessed risk conditions for the architectural and archaeological immovable heritage. The system evaluates the risk of each item by assessing its vulnerability and the hazard of the area. These parameters allow for the evaluation of the level of danger from environmental, hydrogeological or seismic risk.



Fig. 2. An example from the Italian 'CdR'. The map shows the areas where the seismic risk has already been assessed.

Concerning the seismic risk assessment, the evaluation is determined both through filling in specific forms which catalogue the vulnerability level of buildings⁴ and through the seismic hazard level, which is determined by the 'Istituto Nazionale di Geofisica e Vulcanologia – INGV' (National Institute of Geophysics and Vulcanology) depending on the seismo-geological properties of the region. Some analyses of this type have been carried out in Southern Italy, especially in Calabria and in Sicily. Nonetheless, they have not yet been completed everywhere, nor in those areas that are characterised by high seismic activity.

⁴ 'Piano Pilota per la conservazione programmata dei beni culturali dell'Umbria' (Pilot plan for the planned conservation of the Umbria cultural heritage).

⁴ There are specific forms that catalogue the 'architectural vulnerability' and the 'seismic vulnerability' of buildings. They differentiated one from other depending on building typologies.

Therefore, it is not yet possible to have a complete map of seismic vulnerability and risk for the architectural heritage.

2. The earthquake of Central Italy

The earthquake that hit Central Italy on 24th August 2016 was the first in a long sequence, which saw more than 3,000 tremors during the whole year. The earthquake affected an area that stands along the two sides of the Apennines, between the Sibillini and the Laga Mountains, in the inner part of the valley of the River Tronto, among the regions of Lazio, Marche, Umbria and Abruzzo. The seismic sequence, known as the 'Amatrice-Visso-Norcia seismic sequence', was characterised by 7 events with a magnitude of $M_w \geq 5.5$. Among these events, two occurred on 24th August 2016, whose epicentres were registered near Accumoli (RI) in Lazio and near Norcia (PG) in Umbria. Strong aftershocks occurred again on 26th and 30th October 2016⁵, worsening the damage that had already been induced by the events in August.

Indeed, many buildings which had been damaged by the earthquake of 24th August had not yet been secured. Thus, at the end of October, they suffered further irreversible damage. This was also the case for the architectural heritage, where the most serious damage happened in the churches. Two examples of churches belonging to the vernacular heritage that collapsed almost completely due to the aftershocks at the end of October 2016, after already being damaged by the earthquake of 24th August 2016, will be briefly presented below. These examples are particularly significant as in both the churches, some securing interventions had been started by the NFB, even if they had not been completed by the end of October.

⁵ On 2016.10.26, two aftershocks with a magnitude of $M_w=5.5$ and 6.1 occurred, followed, on 2016.10.31, by a further one with a magnitude of $M_w=6.6$. The epicentres of these events were registered in Castelsantangelo sul Nera (PG), and in Norcia (PG) in Umbria. Two strong tremors with a magnitude of $M_w=5.7$ and 5.6 happened on 2017.01.18 in Monteleone (AQ).

2.1 S. Antonio Abate church in Frascaro (PG)

Sant'Antonio Abate is a small church in the countryside near Norcia, whose construction started in the 15th century. The church had great artistic and cultural interest with frescoes and polychrome wooden statues from the 16th and 17th centuries inside and a carved stone portal on the façade, which dated back to the middle of the 16th century. After the earthquake of 24th August, the most evident damage occurred in the carved stone portal, where part of both the lintel and the upper masonry collapsed partially. Cracks had also opened at the impost blocks of the cross vaults inside the church, and the collapse of the portal made the building inaccessible.

After that event, both the damage surveys and the assessment of the technical countermeasures were promptly defined by the functionaries of the MiC, who started the first intervention less than two weeks after 24th August. In September, the NFB also carried out the initial countermeasures, which involved the securing of the collapsed portion of the façade. It was also planned to construct shoring systems on the external walls, hooping them with steel cables and wooden beams in order to prevent the façade from overturning. These countermeasures were not started at the same time or promptly, probably due to some logistical problems, such as the lack of availability of the NFB specialised teams, who were entirely engaged in other securing work. On 26th and 30th October, when the main aftershocks occurred, the church had not yet been completely secured: only the countermeasures that were designed to strengthen the collapsed part of the façade had been finished. Thus, the church of Sant'Antonio Abate suffered an irreversible worsening of the previous damage: it collapsed almost entirely, with only part of the apse wall surviving thanks to the presence of the sacristy dwelling that stood behind it.

The study carried out on archival sources that are kept in the Diocese of Spoleto and Norcia has highlighted that the church had already suffered previous damage as a consequence of the earthquake that hit Valnerina in 1979.

That earthquake had caused damage on the cross vaults and the opening of some deep cracks, both in the external walls and below the belfry. After that event, the church had been restored by consolidating the extrados of the cross vaults with a reinforced concrete layer and by inserting cement mortar and armed perforations, both in the perimeter walls and in the portal of the façade⁶.



Fig. 3. The church of *S. Antonio Abate* after the earthquake of 24th August 2016 (left) and in 2017, after its collapse (right) (Source: <https://frascarodinorcia-noprofit.webnode.it/galleria-immagini/> (a); <https://www.iluoghidelsilenzio.it/frascaro-norcia-pg/> (b)).

2.2 S. Maria Assunta in Castelluccio (PG)

The church of Santa Maria Assunta was in Castelluccio di Norcia, a hamlet situated at the top of a mountain, 1,452-metres above the sea level, in the plateau called '*Piano Grande*' within the *Sibillini* Mountains. The church had a square plan and it was possibly built in the 16th century inside the fortified village, partly in adherence to other buildings. This church also had a carved stone portal with a considerable value. It was sculpted in 1528 and it was very similar to the one of Frascaro. Inside the church, which had been repainted in 1862, there were fragments of some frescoes dating back to the 16th century and wooden statues from the same period, albeit restored on several occasions. After the earthquake of 24th August, the worst damage to the church was in the 18th century bell tower, where

⁶ Technical reports and drawings are stored in the technical office of the Diocese of Spoleto-Norcia, to whom the church belonged. This was also the case for the second example.

some angular masonry blocks had been inserted. There had also been local collapses of some wall blocks inside the church.

The ministerial officers reacted promptly in this case as well, carrying out the damage surveys at the beginning of September and arranging the recovery of movable heritage to the temporary warehouses that had been set up for restoration – thanks also to the help received from the NFB. The functionaries of the superintendence, coordinated by the UCCR Umbria, defined the necessary countermeasures for the bell tower, aiming to consolidate the ruined portion of the masonry and to hoop steel tie-rods all around the belfry. The first part of the intervention was carried out by the NFB in mid-September, but there is no evidence of other countermeasures being realised to contain the damage inside the church, nor other provisional works outside. After the earthquakes of October, both the bell tower and the church have unfortunately completely collapsed, as well as many other buildings of the hamlet, which had already suffered a great deal of damage on 24th August. It was, however, possible to save the wooden polychrome altar that was inside the large wall niche used as an apse, which had remained intact even after the collapse in October.



Fig. 4. The church of *S. Maria Assunta* before the earthquake of 2016 (Source: <http://www.sabap-umbria.beniculturali.it/index.php?it/257/norcia-fraz-castelluccio>).

The research has once more highlighted the existence of archival sources, which are stored in the technical archive of the Diocese of Spoleto-Norcia. The archival documents concern the restoration that was carried out during the 80's to repair the damage produced by the 1979 earthquake. That earthquake caused the opening of cracks in the

interior walls of the church and also the presence of some vertical bending phenomena in the walls. The restoration was provided by strengthening the internal walls with reinforced plaster and by waterproofing both the roof and the external walls of the church. It also appeared that the roof of the church had been restored a few years earlier, with the external coverage built in concrete.

3. Discussion

The analysis of the 2016 seismic emergency has shown some critical issues related to the realisation of the technical countermeasures for the damaged architectural heritage. These issues have contributed to a reduction in the number of interventions completed in a timely manner. Therefore, most historical buildings that had not yet been secured before the end of October then suffered further damage and collapses. In most cases, precise information regarding materials, structures, the constructive history or previous damage due to past earthquakes weren't available for the built heritage. Moreover, vulnerability analyses provided by the system '*CdR*' hadn't yet been completed for the area affected by earthquake. On the contrary, if these investigations had been carried out in the past, they were not readily accessible at that moment. Thus, they weren't used for the first emergency surveys. In addition to this, the damage provoked by the earthquake meant it wasn't possible to enter the buildings, since it wasn't considered safe. Therefore, this limitation contributed to making the damage surveys incomplete and partial, often only detecting cracks that were visible from the outside. For this reason, the extent of the damage may have been underestimated in some cases, as well as the urgency assessed for the implementation of the technical countermeasures.

Moreover, in many cases it wasn't possible to proceed promptly to secure the architectural heritage due to the insufficient number of NFB, who were already really busy carrying out other public safety interventions. Thus, the finalisation of technical countermeasures for cultural heritage were executed only after having completed other public interventions assumed more urgent.

Therefore, when the aftershocks at the end of October occurred:

- not all the damage assessments for the buildings belonging to the architectural heritage had been carried out;
- some surveys were carried out only externally, giving an incomplete assessment of the real extent of damage;
- many of the necessary technical countermeasures for the architectural heritage had not yet been completely realized.

4. Conclusions

During the seismic sequence of 2016, the recurrence of severe aftershocks two months after the first event demonstrated for the built heritage the importance of prompt technical countermeasures to reduce possible further damage and/or collapses. During the emergency, the employment of a large number of specialised units was required, due to both the extension of the affected area and the need to carry out damage surveys in order to understand where countermeasures were urgently required. This was true not only for the functionaries of the MiC but also for those of other public agencies that intervene during emergencies. Thus, the earthquake of Central Italy has shown that it would be desirable to increase the number of firefighters specialised in the 'STCS' procedure, as they are also able to realise the technical countermeasures for the architectural heritage.

The problem related to an insufficient availability of specialised operators in the affected area also concerns the number of qualified restorers who, already knowing the damaged heritage, would be able to promptly intervene – i.e. protecting the movable pieces at the very least.

In fact, this problem did not come to light only recently: indeed, it had already been highlighted after the seismic emergency that hit the Umbria Region in 1997. Some negative issues were also identified in that period. They were not only the lack of knowledge on buildings and churches – also those

belonging to the 'vernacular' heritage – or the absence of preventive maintenance intervention but also an insufficient number of both qualified professionals and means/materials needed to promptly install the countermeasures or to safely remove the sacred furnishings and artworks from churches. Conversely, in 1997 some qualified restorers who had previously completed specific training courses organised by the Umbria Region and the ICR were present in the affected territory. The availability of these specialised professionals, who had the specific knowledge of both the damaged heritage and the operating procedures that were useful to realise the protection/transport of movable artworks, in some cases enabled the prompt securing of cultural heritage ⁷.



Fig. 5. The provisional intervention on the bell tower of *Santa Maria Assunta*, realized by the MiC and the NFB (© *Vigili del Fuoco*) (Source: <https://www.vigilfuoco.tv/umbria/perugia/noceria/messa-sicurezza-chiesa-smaria-assunata>).

Finally, the difficulties encountered during the surveys, especially regarding the availability of detailed information on both the constructive history and the level of vulnerability of built heritage, highlighted the importance of carrying out the analysis in advance, before the occurrence of an earthquake. Indeed, knowing these data at the time of an emergency would be an advantage for both technicians and public functionaries. On the one hand, knowing the existent vulnerability of the architectural heritage would allow damage surveys to be carried out primarily in those buildings that are exposed to a greater risk. On the other hand, the firefighters who

⁷ Some meaningful examples are the safety intervention that has been realised by some trained restorers to protect the paintings of Benozzo Gozzoli in the apse of San Francesco in Montefalco (PG) or the one achieved in the homonymous

church in Nocera Umbra (PG). On the contrary, the same result hasn't been achieved in Sellano (PG), due to the lack of both means and materials.

are entrusted with designing the technical countermeasures could better understand where the most vulnerable elements of a building are, therefore also predicting the evolution of damage and defining the most appropriate intervention more easily. It is thus clear that it is desirable to continue enforcing the collaboration between the MiC and the NFB.

A further advantage in the management of the emergency operations for the architectural heritage could be given by:

- increasing the number of NFB units that are specialised in architectural heritage;
- extending the number of the surveys aimed at deepening the knowledge of the Italian architectural heritage in order to understand the level of vulnerability and other important parameters, such as materials, structure and constructive history of buildings.

The systematic organisation of this knowledge could be implemented by exploiting the already existing databases / information systems, such as the 'Cdr' project.

References

Archives of the Diocese of Spoleto-Norcia (ADSN), Technical Office of Spoleto, Folder: "69 - Lavori sisma Frascano, Norcia, chiesa parrocchiale di S. Antonio abate", subfolder: "36B - Chiesa e casa parrocchiale di S. Antonio Frascano in comune di Norcia - PG - (esercizio 1985)", envelope: "Progetto L-10214 chiesa di S. Antonio abate in Frascano di Norcia - PG- n. 36".

ADSN, Technical Office of Spoleto, Folder: "Progetto - L 10050 - Castelluccio - Chiesa di S. Maria Assunta".

Brusa, E. (2021). The Italian emergency management for the built heritage after the 2012 earthquake: Emilia-Romagna – and Lombardy. In Arefian F., Ryser J., MacKee J. & Hopkins, A. (Eds), *Historic Cities in the Face of Disasters*.

Cacace, C. (2019). La carta del rischio per il patrimonio culturale. In Fiorani, D. (Ed.), *Il futuro dei centri storici - Digitalizzazione e strategia conservativa*. Quasar.

Chesi, C. (2018). L'acciaio nell'emergenza post-sisma. *Costruzioni metalliche*, 5.

Chiaraluce L., Di Stefano R., Tinti E., Scognamiglio L., Michele M., Casarotti E., Cattaneo M., De Gori P., Chiarabba C., Monachesi G., Lombardi A., Valoroso L., Latorre D. & Marzorati S. (2017). The 2016 Central Italy seismic sequence: a first look at the mainshocks, aftershocks, and source models. *Seismological Research Letters*, 88 (3).

Cutarelli, S. (2019). Gestire l'emergenza: la Carta del Rischio del Patrimonio Culturale per il recupero delle opere d'arte nelle aree terremotate. *Archeomatica*, 3.

Della Torre, S. (2021). Italian perspective on the planned preventive conservation of architectural heritage. *Frontiers of Architectural Research*, 10.

Della Torre, S. (2018). The management process for built cultural heritage: preventive systems and decision making. In Van Balen, K. & Vandesande, A. (Eds), *Innovative Built Heritage Models* (pp.13-20), Taylor & Francis Group.

Dogliani, F., Moretti, A. & Petrini, V. (Eds.) (1994). *Le chiese e il terremoto*. National Research Council - Gruppo Nazionale per la Difesa dai terremoti. Lint Editoriale.

Galanti, E., Goretti, A., Foster, B. & Di Pasquale, G., (2008). Civil Protection Management. In Oliveira, C.S., Roca, A. and Goula, X. (Eds), *Assessing and Managing Earthquake Risk. Geotechnical, Geological And Earthquake Engineering*. Springer.

Grimaz, S., Malisan, P. & Zorzini, F., (2018). Short-term countermeasures for securing cultural heritage buildings during a seismic emergency: improvements after the 1976 Friuli earthquake. *BGTA*, 59 (4).

Konsta, A. & Della Torre, S. (2021). Risk Management and Built Heritage: towards a systematic approach. In Roca, P., Pelà, L. & Molins, C. (Eds.), *SAHC 2021, Proceedings of the 12th International Conference*.

Parisi M.A., Chesi C. & Sferrazza Papa, G. (2018). Damage evolution in churches due to repeated earthquake shocks. In *Proceedings of the 16th ECEE European Conference on Earthquake Engineering, Thessaloniki, 18-21 June 2018*.

Podestà, S. & Scandolo, L. (2017). L'assenza di opere di pronto intervento: l'evoluzione del danno nelle chiese a seguito degli eventi sismici del Centro Italia. In *L'ingegneria sismica in Italia, Proceedings of the XVII National Conference, Pistoia, 17-21 settembre 2017*.

Rossi A., Tertulliani A., Azzaro R., et al. (2019). The 2016-2017 earthquake sequence in central Italy: macroseismic survey and damage scenario through the EMS-98 intensity assessment, *Bulletin of Earthquake Engineering*, 17.

SABAP Umbria (2021, November 17). *L'Umbria che resiste*. <http://www.sabap-umbria.beniculturali.it/index.php?it/257/norcia-fraz-castelluccio>

Tonna, S., Boriani, M., Giambruno M.C. & Chesi, C., (2021). Criteria for the vulnerability analysis of structural aggregates in historical centers. In Roca, P., Pelà, L. & Molins, C. (Eds.), *SAHC 2021, Proceedings of the 12th International Conference*.

Urbani, G. (2000). Piano pilota per la conservazione programmata dei beni culturali dell'Umbria. In Zanardi, B. (Ed.), *Intorno al restauro*. Skira.

Zanardi, B., (1999). *Conservazione, restauro e tutela. 24 dialoghi*. Skira.

ISBN 978-84-1396-020-3



HERITAGE 2022 INTERNATIONAL CONFERENCE
VERNACULAR HERITAGE:
CULTURE, PEOPLE AND SUSTAINABILITY

Eds. C. Mileto, F. Vegas, V. Cristini, L. García-Soriano

Vernacular architecture, tangible and intangible heritage of great importance to European and global culture, represents the response of a society culturally linked to its territory, in terms of climate and landscape. Its construction features are born from the practical experience of the inhabitants, making use of local materials, taking into consideration geographical conditions and cultural, social and constructive traditions, based on the conditions of the surrounding nature and habitat. Above all, it plays an essential role in contemporary society as it is able to teach us important principles and lessons for a respectful sustainable architecture.

Vernacular Heritage: Culture, People and Sustainability will be a valuable source of information for academics and professionals in the fields of Environmental Science, Civil Engineering, Construction and Building Engineering and Architecture.

