

University of Cantabria / University of Granada

Organizers:



REHABEND 2022

Euro-American Congress

CONSTRUCTION
PATHOLOGY,
REHABILITATION
TECHNOLOGY AND
HERITAGE MANAGEMENT

Granada (Spain) - September 13th-16th, 2022

Sponsor entities:



REHABEND 2022

***CONSTRUCTION PATHOLOGY, REHABILITATION TECHNOLOGY AND
HERITAGE MANAGEMENT***

(9th REHABEND Congress)

Granada (Spain), September 13th-16th, 2022

PERMANENT SECRETARIAT:

UNIVERSITY OF CANTABRIA

Civil Engineering School

Department of Structural Engineering and Mechanics

Building Technology R&D Group (GTED-UC)

Avenue Los Castros 34, 39005 SANTANDER (SPAIN)

Tel: +34 942 201 761 (43)

Fax: +34 942 201 747

E-mail: rehabend@unican.es

www.rehabend.unican.es

REHABEND 2022

ORGANIZED BY:



UNIVERSITY OF CANTABRIA (SPAIN)
www.unican.es // www.gted.unican.es



UNIVERSIDAD
DE GRANADA

UNIVERSITY OF GRANADA (SPAIN)
www.ugr.es

CO-ORGANIZERS ENTITIES:



CHILE-UNIVERSIDAD AUSTRAL DE
CHILE



ITALY-POLITECNICO DI BARI



MEXICO-UNIV. MICHOACANA DE
SAN NICOLÁS DE HIDALGO



PERU-UNIVERSIDAD NACIONAL
PEDRO RUIZ GALLO



PORTUGAL-UNIVERSIDADE
DE AVEIRO



PORTUGAL-INSTITUTO SUPERIOR
TÉCNICO | UNIV. DE LISBOA



SPAIN-TECNALIA RESEARCH &
INNOVATION



SPAIN-UNIVERSIDAD DEL
PAIS VASCO



SPAIN-UNIVERSIDAD POLITÉCNICA
DE CATALUÑA



SPAIN-UNIVERSIDAD DE BURGOS



SPAIN-UNIVERSIDAD POLITÉCNICA
DE MADRID



SPAIN-UNIVERSIDAD DE SEVILLA



SPAIN-UNIVERSIDAD EUROPEA
MIGUEL DE CERVANTES



UNITED STATES OF AMERICA-
UNIVERSITY OF MIAMI



URUGUAY-UNIVERSIDAD
DE LA REPÚBLICA

CONGRESS CHAIRMEN:

IGNACIO LOMBILLO
MARIA PAZ SÁEZ

CONGRESS COORDINATORS:

HAYDEE BLANCO
YOSBEL BOFFILL

EDITORS:

HAYDEE BLANCO
YOSBEL BOFFILL
IGNACIO LOMBILLO

GUEST EDITOR:

MARIA PAZ SÁEZ

INTERNATIONAL SCIENTIFIC ADVISORY COMMITTEE:

HUMBERTO VARUM – UNIVERSITY OF PORTO (PORTUGAL)
PERE ROCA – TECHNICAL UNIVERSITY OF CATALONIA (SPAIN)
ANTONIO NANNI – UNIVERSITY OF MIAMI (USA)

The editors does not assume any responsibility for the accuracy, completeness or quality of the information provided by any article published. The information and opinion contained in the publications are solely those of the individual authors and do not necessarily reflect those of the editors. Therefore, we exclude any claims against the author for the damage caused by use of any kind of the information provided herein, whether incorrect or incomplete.

The appearance of advertisements in these Scientific Publications (Printed Book of Abstracts & Digital Book of Articles - REHABEND 2022) is not a warranty, endorsement or approval of any products or services advertised or of their safety. The Editors does not claim any responsibility for any type of injury to persons or property resulting from any ideas or products referred to in the articles or advertisements.

The sole responsibility to obtain the necessary permission to reproduce any copyright material from other sources lies with the authors and REHABEND 2022 Congress can not be held responsible for any copyright violation by the authors in their article. Any material created and published by REHABEND 2022 Congress is protected by copyright held exclusively by the referred Congress. Any reproduction or utilization of such material and texts in other electronic or printed publications is explicitly subjected to prior approval by REHABEND 2022 Congress.

ISSN: 2386-8198 (printed)

ISBN: 978-84-09-42252-4 (Printed Book of Abstracts)

ISBN: 978-84-09-42253-1 (Digital Book of Articles)

Legal deposit: SA - 132 - 2014

Printed in Spain by Círculo Rojo

KEYNOTE LECTURES

1 THE USE OF TITANIUM IN CONSERVATION AND SEISMIC REINFORCEMENT OF MASONRY STRUCTURES <i>Corradi, Marco; Adkins, Jill</i>	.....	2
2 STRENGTHENING OF MASONRY STRUCTURES WITH INORGANIC MATRIX COMPOSITES (IMCS) <i>Aiello, Maria Antonietta</i>	.....	16
3 PROGRESSIVE COLLAPSE AND ROBUSTNESS OF BUILDINGS AND BRIDGES <i>Adam, José M; Buitrago, Manuel; Makoond, Nirvan</i>	.....	28
5 ARCHITECTURE OF MANY EPOCHS: THE SACROMONTE ABBEY IN GRANADA <i>Martín Muñoz, Antonio</i>	.....	35
6 CONSERVATION AND MANAGEMENT OF THE BUILT HERITAGE: RECENT WORKS ON MODERN HERITAGE BUILDINGS OF PORTUGUESE ORIGIN <i>Lourenço, Paulo B.; Mendes, Nuno; Ortega, Javier</i>	.....	45

1.- PREVIOUS STUDIES

1.1.- Multidisciplinary studies (historical, archaeological, etc.).

3	CHROMATIC ANALYSIS OF THE FINISH OF THE 17TH CENTURY WALL OF THE SANTO DOMINGO FORTRESS IN DOMINICAN REPUBLIC <i>Flores-Sasso, Virginia; Pérez, Gloria; Ruiz-Valero, Letzai; Martínez-Ramírez, Sagrario; Prieto-Vicioso, Esteban</i>	54
16	DEVELOPMENT OF THE CONSTRUCTION SYSTEM OF THE SOUTHERN GOTHIC CATHEDRAL PROFILE <i>Lluís-Teruel, Cinta; Lluís i Ginovart, Josep</i>	63
20	THE HOROLOGION OF ANDRONIKOS OF KYRROS IN ATHENS, GREECE: CULTURAL HERITAGE ISSUES AND HISTORICAL EVIDENCE <i>Panou, Evangelia; Alexopoulou, Athina Georgia</i>	72
33	RESTORATION AND ACCESS TO THE INCA CEREMONIAL SANCTUARY OF MAUCALLACTA AND ITS INSERTION IN THE TOURIST CIRCUIT OF SOUTHERN PERU <i>Cusihamán Sisa, Gregorio Nicolás; Alarcón Condori, Javier Guido</i>	83
34	THE CITY OF SUCEAVA - ASPECTS OF URBAN DEVELOPMENT <i>Cioban, Andreea G.; Agachi, Mihaela I. M.</i>	92
65	THE HISTORIC ARCHITECTURAL COMPLEX OF MANGUINHOS, RIO DE JANEIRO, RJ, BRAZIL <i>Oliveira, Benedito Tadeu de</i>	100
95	HISTORICAL ARCHIVE OF THE CITY OF LOJA, ECUADOR <i>Delgado Cruz, María José; Sanz González, Sofía</i>	109
148	MEXICAN TEMPLES OF MENDICANT CONVENTS: STRUCTURAL CONFIGURATION AND DAMAGES DUE TO EARTHQUAKES <i>García Gómez, Natalia; Peña Mondragón, Fernando; Chávez Cano, Marcos M.</i>	118
150	BLURRED FAÇADE AS THRESHOLD ARCHITECTURE <i>Yapicioglu, Balkiz; Cazacova, Liudmila</i>	126
194	OPTICAL AND COLOR ANALYSIS OF ROMAN WALL PAINTINGS FROM THE FORUM DISTRICT OF CARTHAGO NOVA <i>Martínez-Arredondo, Ana; Navarro-Moreno, David; Mestre-Martí, María; Lanzón, Marcos</i>	135
283	DOCUMENTARY RESEARCH AND CONSTRUCTIVE UNDESTANDING OF THE PICASSO AND NESJAR MURALS IN THE BUILDING OF THE ARCHITECTS' ASSOCIATION OF CATALONIA IN BARCELONA, SPAIN <i>Bosch González, Montserrat; González-Sánchez, Belén; Rosell Amigó, Joan Ramon</i>	143
290	THE FIRST APPROACH TO TRENCADIS OF GAUDI: METHODS OF GEOMETRIC ANALYSIS <i>Asadova, Zahra; Navarro, Isidro; Santana, Galdric</i>	150
294	SANTA COLOMA D'ANDORRA - THE CONCEPTION OF A CHURCH BEFORE THE 11TH CENTURY. <i>Pedragosa Batllori, Gemma</i>	160
297	ANALYSIS AND PROPOSAL FOR RECOVERY OF ARCHITECTURAL HERITAGE. THE CASE OF THE TEMPLAR COMMANDRY OF ABERIN IN NAVARRE <i>Roces Gonzalo, Clara; Torres Ramo, Joaquín</i>	170
318	ARCHAEOLOGY OF ARCHITECTURE APPLIED TO CONSERVATIVE ARCHITECTURAL RESTORATION: CASE STUDY OF STRATIGRAPHIC ANALYSIS OF VOLUMES AND COATINGS <i>Cascone, Santi Maria; Longhitano, Lucrezia; Longhitano, Giuseppe Antonio</i>	179
330	USE VALUE VS TECHNICAL REQUIREMENTS. METHODOLOGY FOR ASSESSING POTENTIAL USES IN HERITAGE BUILDINGS. THE CASE OF LUCENA (CORDOBA) <i>Mosquera-Pérez, Clara; Navarro-de-Pablos, Javier; Rodríguez-Lora, Juan-Andrés; Navas-Carrillo, Daniel</i>	188
348	ON ARCHITECTURE FROM THE SECOND HALF OF THE XX CENTURY IN POLAND <i>Zychowska, Maria J.; Bialkiewicz, Andrzej</i>	197
366	DETERIORATIONS AND RECOVERY PROJECTS IN THE FORTIFICATIONS OF THE CARIBBEAN COAST OF PANAMA, PORTOBELLO AND SAN LORENZO. <i>Durán, Félix; García, Elizabeth</i>	206
368	VERNACULAR ARCHITECTURE OF QUINGEO PARISH (AZUAY, ECUADOR). DEFINITION OF THE HISTORICAL-CONSTRUCTIVE CONTEXT FROM THE MURAL STRATIGRAPHIC ANALYSIS <i>López Suscal, Michelle; Aguirre Ullauri, María del Cisne</i>	215
372	CONSERVATION AS A DESIGN OPPORTUNITY. PROTECTION SYSTEMS IN THE ARCHAEOLOGICAL FIELD <i>Cadoni, Stefano</i>	226

391	SANTA MARÍA DEL CAMPO AND SANTA MARÍA DE RIOSECO: EVOLUTIVE CONCORDANCES OF TWO OUTSTANDING CASTILLIAN BELL-TOWERS <i>Sánchez Rivera, José Ignacio; Sáiz Virumbrales, Juan Luis</i>	238
-----	--	-----

1.2.- Heritage and territory.

25	TWO ICONS OF BILBAO'S INDUSTRIAL HERITAGE: ETXEBARRIA'S CHIMNEY AND ZORROZA'S CRANE <i>Díez Hernández, Jesús; Piñero, Ignacio; Ezquerro Andreu, Mikel; Briz, Estíbaliz</i>	246
74	METHODOLOGICAL PROPOSAL FOR THE ANALYSIS OF THE HERITAGE VULNERABILITY OF PRODUCTIVE RURAL GROUPS. THE CASE OF THE SAN PEDRO RIVER BASIN, LOS RÍOS REGION, CHILE <i>Vásquez Fierro, Virginia; Horn Morgenstern, Andrés</i>	257
103	JESUIT RANCHES HERITAGE OF NUEVA ANDALUCÍA AND TERRITORY ARTICULATION. A CASE FOR MANAGEMENT, PRESERVATION AND REACTIVATION <i>Saborido Forster, Gustavo Adolfo; Mosquera Adell, Eduardo; Ponce Ortiz de Insagurbe, María Mercedes</i>	267
111	THE SAN TELMO BRIDGE IN SEVILLE. A PIONEERING WORK IN REINFORCED CONCRETE AT THE BEGINNING OF THE 20TH CENTURY <i>González García de Velasco, Concepción; Agudo Martínez, Andrés; González Vilchez, Miguel</i>	277
121	FROM THE CATALAN MASIA TO THE MASSERIA OF SOUTHERN ITALY: PATHS FOR THE RECOVERY AND REUSE OF RURAL ASSETS IN BASILICATA <i>Guida, Antonella; Porcari, Vito Domenico; Andrulli, Giovanna</i>	285
126	CHARACTERIZATION OF NATIVE SHUAR ARCHITECTURE: ARCHITECTURAL TYPES, REPRESENTATIVE ELEMENTS AND CONSTRUCTION SYSTEMS <i>Soto Toledo, Katherine Haydee; Rodríguez Torres, María José</i>	294
127	19TH CENTURY MERSIN COMMERCIAL BUILDINGS, PRESENT CONDITIONS, AND PROBLEMS OF CONSERVATION <i>Darendeli, Tuğçe; Umar, Nur</i>	303
135	DEVELOPMENT LINE OF THE RESIDENTIAL ARCHITECTURE OF THE ISLAND OF SAN CRISTÓBAL-GALÁPAGOS: THE CHALLENGE OF OFFERING VERNACULAR ECOLOGICAL SOLUTIONS <i>Matapuncho-Davila, Elvira; Granda-Viñan, Paola; Aguirre-Maldonado, Eduardo</i>	311
144	CANTONA: THE URBAN ARCHEOLOGICAL HERITAGE, AS AN ANALYTICAL PATH TO RECONCEPTUALIZE THE SOCIAL PRODUCTION OF THE HABITAT <i>Álvarez, María del Pilar; Nava, José María Wildford</i>	319
217	EVALUATION OF PROPOSAL FOR THE CONNECTION OF ARCHITECTURAL HERITAGE AREAS. CASE STUDY: MANIZALES, COLOMBIA <i>Escobar, Diego A.; Giraldo, Sofía; Moncada, Carlos A.</i>	329
275	FENCE WALLS IN THE BAIXO TÂMEGA VALLEY <i>Pinto, Jorge; Reis, Cristina; Bento, Ricardo; Bentes, Isabel; Pereira, Sandra</i>	339
284	EUROPEAN SMART VILLAGES: STATE OF THE ART AND POSSIBLE DEVELOPMENT SCENARIOS <i>D'Andria, Emanuela; Fiore, Pierfrancesco; Falce, Carmelo</i>	348
292	TRANSFERENCE FROM INDUSTRIAL ARCHITECTURE TO RESIDENTIAL BUILDINGS: REYES CATÓLICOS STREET DURING THE EXPANSION OF THE SUGAR INDUSTRY IN GRANADA AS A CASE STUDY. <i>Martínez-Ramos e Iruela, Roser; Cervera Fuentes, María Teresa; Adelaida Martín Martín; García Nofuentes, Juan Francisco</i>	357
316	EARLY REPUBLIC PERIOD MALATYA STATION BUILDINGS <i>Sarı, Fatma Zehra; Umar, Nur</i>	367
394	THE RECONSTRUCTION OF ZIKUÑAGA CHAPEL OF HERNANI: BUILT HERITAGE LOST AND FOUND <i>Uranga, Eneko J.; Arraztio, Xabier; Uranga, Juan José</i>	376

1.3.- Urban regeneration.

11	MORE THAN A GREEN FAÇADE: THE GREEN POTENTIAL FOR HISTORIC CENTRES <i>Vallejo Espinosa, Andrea; Davis, Michael Maks; Ramírez, Francisco</i>	385
45	BUILDING AND URBAN CHARACTERISTICS FOR THE DEVELOPMENT OF INTERVENTION STRATEGIES IN THE PONTE GÊA NEIGHBORHOOD OF BEIRA <i>Santos, Michael M.; Ferreira, Ana Vaz; Lanzinha, João C. G.</i>	395
58	THOUGHTS ON PUBLIC SPACE. PROPOSALS FOR THE NEW SQUARE OF THE CHURCH OF SAINT ANTHONY OF PADUA IN THE VILLAGE OF NOVENTANA, ITALY <i>Pietrogrande, Enrico; Dalla Caneva, Alessandro</i>	405
73	THE CHALLENGE OF DECENTRALISATION AND CONTEXTUAL VALUATION IN THE FRAMEWORK OF THE APPLICATION OF TERRITORIAL PLANNING INSTRUMENTS. THE CASE OF THE URBAN WETLANDS OF VALDIVIA AND TEMUCO, CHILE <i>Horn, Andrés; Vásquez, Virginia</i>	415

77	SOCIO-TERRITORIAL CONTEXTUALIZATION OF HERITAGE ON INTRA-URBAN SCALE. THE CURRENT HORIZON OF THE MOST RELEVANT OFFICIAL SOURCES <i>Usobiaga, Elena; De Cos, Olga</i>	426
106	GLOBAL ARCHITECTURE: REHABILITATION AND REGENERATION <i>Vitrano, Rosa Maria</i>	434
299	MANAGEMENT MODELS FOR ENERGY REGENERATION IN URBAN AND RURAL AREAS OF NAVARRA <i>Izcue, Isabel; García Madruga, Carolina</i>	443
369	THE HOUSING HARDSHIP IN ROME. PUBLIC RESIDENTIAL BUILDING VS SOCIAL HOUSING? <i>Crupi, Francesco</i>	454
370	AUGMENTED ARCHITECTURE AND MULTIFUNCTIONAL BUILDING EXOSKELETONS, A LOOK AT THE FUTURE OF EXISTING BUILDINGS IN URBAN AREAS <i>De Vita, Mariangela; Fabbrocino, Giovanni; Mannella, Antonio; Panunzi, Stefano</i>	466
373	URBAN REGENERATION OF VILLAGES AS AN OPPORTUNITY. TOOLS AND METHODS IN THE CASE STUDY OF MOGORO IN SARDINIA <i>Atzeni, Carlo; Cadoni, Stefano; Marras, Francesco</i>	474

1.5.- Social participation processes and socio-cultural aspects in rehabilitation projects.

13	RECOGNITION AND IMPROVEMENT OF LOCAL TECHNIQUES, CONTRIBUTION TO THE RE-ROOTING AND EMPOWERMENT OF COLOMBIAN COMMUNITIES IN POST-CONFLICT <i>Chica Segovia, Angélica; Ramos Zapata, María Camila; Fuya Chontal, Néstor; Mosquera Posso, John Keddy</i>	485
169	THE SOCIAL PARTICIPATION IN THE CASE OF MANGUINHOS HISTORIC ARCHITECTURAL NUCLEUS (NAHM) <i>Almeida, Roberta dos Santos; Pinheiro, Marcos José de Araújo</i>	497
327	CITIZEN PARTICIPATION FOR HERITAGE INTERVENTION. AN EXPERIENCE IN LUCENA (CORDOBA) <i>Navas-Carrillo, Daniel; Mosquera-Adell, Eduardo; Pérez-Cano, Teresa</i>	505

1.6.- Construction pathology.

5	COLLAPSES IN GLUED LAMINATED TIMBER STRUCTURES OF COVERED POOLS, DUE TO MISTAKES IN ASSIGNMENT OF USE CLASSES <i>Lozano, Alfonso; Lorenzo, David; Martínez, J. Enrique; Alonso, Mar; Álvarez, Felipe</i>	514
8	PERFORMANCE OF POZZOLANIC ADDITIONS TO CONTROL ALKALI-SILICA REACTION (ASR) PROMOTED BY AGGREGATES WITH DIFFERENT REACTION RATES <i>Menéndez, Esperanza; Sanjuán, Miguel Ángel; García-Roves, Ricardo; Argiz, Cristina; Recino, Hairon</i>	522
9	PATHOLOGICAL MANIFESTATIONS IN SANDWICH VERTICAL PANELS: CASE STUDY <i>Lordsleem Jr., Alberto Casado; Lira, Virginia Queiroz</i>	531
23	ANALYSIS OF RECURRENCE OF PATHOLOGICAL LESIONS IN LOW-RISE RESIDENTIAL BUILDINGS IN THE CITY OF MEDELLÍN <i>Cañola, Hernán-Darío; Urrego, Andrés; Granda-Ramírez Fidel; Venegas, Karen ; Arroyave, Joan</i>	539
30	PARAMETERISATION OF THE DEGRADATION PROCESSES IN COATED FAÇADES WITH ONE COAT MORTAR RENDERS <i>Carretero-Ayuso, Manuel J.; Pinheiro-Alves, M^a Teresa; Sáez-Pérez, M^a Paz</i>	548
53	THE USE OF MACROPOROUS MORTAR IN THE REHABILITATION OF HANDMADE BRICK WALLS WITH RISING DAMP <i>Camino-Olea, M^a Soledad; Llorente-Álvarez, Alfredo; Cabeza-Prieto, Alejandro; Martín-Aldudo, Ernesto; M^a Paz Sáez-Pérez; Rodríguez-Esteban, M^a Ascensión</i>	556
59	INFRARED THERMOGRAPHY AS A TOOL FOR INSPECTION OF BUILDING DEFECTS IN COATINGS - A SYSTEMATIC REVIEW <i>Lima, Wanessa; Cavalcanti, Lucas, Arruda, Vaness, Figueira, Amanda, Bentzen, Mariana, Póvoas, Yêda, Lordsleem Jr., Alberto</i>	564
62	CONSTRUCTIVE STUDY OF THE SHIPWRECKED HOUSE IN THE PORT OF BILBAO <i>Marcos, Ignacio; Díez, Jesús; Piñero, Ignacio; Egiluz, Ziortza</i>	577
84	MONTEVIDEO MUNICIPAL OSSUARY. INTEGRAL STUDY AND MANAGEMENT PLAN <i>Fontana, Juan José; Gambini, Jorge; Méndez, Mary; Tomeo, Fernando; Romay, Carola</i>	587
107	ASSESSING AESTHETIC AND STRUCTURAL DETERIORATION IN HISTORIC BUILDINGS - A CONTRIBUTION <i>Dias, L.; Rosado, T.; Bhattacharya, S.; Candeias, A.; Caldeira, A.T.; Mirão, J.</i>	596
128	ANALYSIS OF DOCUMENTAL AND EXECUTIVE PROCESSES OF CONSERVATION OF BUILDINGS TAKEN AS HISTORICAL HERITAGE <i>Andrade, Ana Paula Cintra</i>	606

132	STUDY OF THE HERITAGE BUILDING COMPLEX OF THE NATIONAL MUSEUM OF COSTA RICA FROM A HISTORICAL, ARCHITECTURAL AND PATHOLOGICAL PERSPECTIVE <i>Porras-Alfaro, David; García-Baltodano, Kenia; Méndez-Álvarez, Dawa</i>	615
162	FACADE DAMAGE MAPS: A LITERATURE REVIEW <i>Lopes, Melissa L. F.; Silva, Maykon V.; Bauer, Elton</i>	624
174	RADON EXHALATION FROM THE STRUCTURE OF HISTORIC BUILDINGS. A PROBLEM DETECTED AT THE TOWER OF HERCULES, CORUÑA <i>Frutos, Borja; Alonso, Carmen; Martín-Consuegra, Fernando; Sicilia, Isabel; de Frutos, Fernando; Perez, Gloria</i>	634
183	CLASSIFICATION OF BUILDING FACADES BY MEANS OF THE LEVEL OF PROTECTION CRITERIA <i>Souza, Ana Luíza Rocha de; Andrade, Daiane Teodoro de; Bauer, Elton; Souza, Jéssica Siqueira de</i>	643
196	PATHOLOGIES IN THE ORNAMENTATION OF FAÇADES IN THE ARCHITECTURE OF HISTORICIST ECLECTICISM - THE CASE OF MANIZALES (COLOMBIA) <i>Sarmiento, Juan Manuel; Bedoya, Lina Clemencia; Betancur, Angélica; Ramírez, Esteban</i>	655
203	THERMAL ANALYSIS OF SODIUM SULFATE CRYSTALLIZATION WITHIN POROUS BUILDING MATERIALS <i>Bednarska, Dalia; Koniorczyk, Marcin</i>	665
207	REALITY-BASED MODEL AND 3D INFORMATION SYSTEMS: A GIS 3D TO MAPPING THE CRACK PANEL OF THE CHURCH OF SANTA MARIA DEGLI ANGELI IN PIZZOFALCONE IN NAPLES <i>Acquaviva, Sabrina; Pulcrano, Margherita; Scandurra, Simona; Palomba, Daniela; di Luggo, Antonella</i>	673
216	BUILDINGS INVESTIGATION OF DEGRADATION VARIABILITY IN BRASÍLIA-BRAZIL CITY <i>Rodrigues Neto, Eduardo; Bauer, Elton</i>	682
226	THE WOOD MOISTURE FACTOR ON THE BIOLOGICAL DETERIORATION OF WOODEN STRUCTURES <i>Lima, Daniel F.; Tenório, Marina; Branco, Jorge M.; Nunes, Lina</i>	690
241	DEEP DETECTING FOR DETECTING CRACKS IN PAINTED BUILDING FAÇADES <i>Pereira, Sandra; Pires, João; Silva, João; Ferreira, Tomás; Neto, Alexandre; Cunha, António</i>	698
265	IDENTIFICATION OF HERITAGE STONE BUILDING DEGRADATION PATTERNS BASED ON DIGITAL PHOTOGRAMMETRY DATA <i>Jalón, María L.; Chiachío, Juan; Gil-Martín, Luisa María; Hernández-Montes, Enrique</i>	708
266	CASE OF STUDY: DIAGNOSIS OF 100 YEARS OLD ABANDONED MILL <i>Cetrangolo, Gonzalo; Romay, Carola; Mussio, Gianella; Spalvier, Agustin</i>	715
274	RECURRING DAMAGES IN THE EXECUTION OF CONCRETE SLABS ON LARGE SURFACES <i>Martínez Martínez, José Antonio; Manso Villalaín, Juan Manuel; García Castillo, Luis María; Aragón Torre, Ángel</i>	725
324	PATOLOGY AND NUMERICAL MODEL OF THE TEMPLE OF SAN FRANCISCO TZINTZUNTZAN <i>Márquez, Alberto; Olmos, Bertha ; Jara, José Manuel; Martínez, Guillermo</i>	734
349	CONSOLIDATION OF A POROUS SANDSTONE USED IN ANCIENT CONSTRUCTIONS <i>Lamas, Pedro; Pinho, Fernando</i>	744

1.7.- Diagnostic techniques and structural assessment (no destructive testing, monitoring and numerical modeling).

18	CHARACTERIZATION OF PIGMENTS USED AS PROTECTION AND DECORATION ON EXTERIOR FACADES OF HISTORIC BUILDINGS <i>Martínez-Ramírez, Sagrario; Flores Sasso, Virginia; Ruiz-Valero, Letzai; Pérez, Gloria; Guerrero, Ana; Prieto Vicioso, Esteban; Vučetić, Snežana</i>	752
26	VALIDATION OF ULTRASONIC PULSE TO QUALITY CONTROL OF RECYCLED AGGREGATE SELF-COMPACTING CONCRETE <i>Revilla-Cuesta, Víctor; Santamaría, Amaia; Espinosa, Ana B.; Chica, José A.; Manso, Juan M.; Ortega-López, Vanesa</i>	761
44	NUMERICAL APPROCHES FOR SOIL-STRUCTURE INTERACTION IN A HISTORICAL INDUSTRIAL MASONRY BUILDING <i>Longarini, Nicola; Crespi, Pietro; Zucca, Marco; Scamardo, Manuela</i>	770
46	ENGINEERING SKILLS AIDED BY THERMOGRAPHY AND BIM <i>Ribeiro Antunes, Maria Luisa; Cabaleiro Cortizo, Eduardo; Magalhães Lenz, César Júnior, Kleos</i>	779
60	SEISMIC VULNERABILITY AND RETROFITTING OF A HISTORICAL MASONRY BUILDING <i>Scamardo, Manuela; Crespi, Pietro; Longarini, Nicola; Zucca, Marco</i>	787

64	THE FOURTH ARCH OF THE AUGUSTUS BRIDGE AT NARNI (ITALY): A CASE STUDY OF ROMAN ARCH WITH RIBS <i>Custodi, Alberto; Scaia, Flora</i>	795
78	ANALYSIS OF VARIABILITY AND RELIABILITY OF STRESS WAVE MEASUREMENTS ON STRUCTURAL TIMBER ELEMENTS IN SITU <i>Osuna-Sequera, Carlos; Luengo, Emilio; Cabrero, Juan Carlos; Hermoso, Eva</i>	803
90	A NEW METHODOLOGY BASED ON NON-DESTRUCTIVE TECHNIQUES FOR OLD STRUCTURAL TIMBER <i>Peñalver Oltra, Manuel; Abián Pérez, Miguel Ángel; Segura Orenga, Guillem; Martínez Ruiz, Guillermo Vicente; Redón Santafé, Miguel</i>	813
129	STRUCTURAL ASSESSMENT UNDER LATERAL ACCELERATIONS OF A CONCRETE VAULTED MAYA BUILDING OF BONAMPAK, CHIAPAS, MEXICO <i>Hamad, Omar; Sennyondo, Justin; Kimanya, Humfrey; Nguyen, Dung; Tezcan, Selman; Perucchio, Renato</i>	822
158	FUNICULAR ANALYSIS OF MASONRY VAULTS UNDER GENERAL LOADING CONDITIONS THROUGH A CONSTRAINED FORCE DENSITY METHOD <i>Bruggi, Matteo; Taliercio, Alberto</i>	830
159	EL HÓRREO, ARCHITECTURAL HERITAGE ELEMENT OF THE PRINCIPALITY OF ASTURIAS. METHODOLOGY FOR THE INSPECTION AND DIAGNOSYS FOR ITS CONSERVATION <i>Vega, Abel; Rodríguez, Soledad</i>	838
173	SHAKING TABLE TEST DESIGN OF A TYPICAL CHURCH OF MORELOS STATE <i>Chávez, Marcos M.; Durán, Daniel</i>	845
179	DISPLACEMENT ANALYSIS OF WOODEN TRUSSES THROUGH DIGITAL SURVEY AND VISUAL PROGRAMMING TOOLS. THE BASILICA OF SAN PETRONIO IN BOLOGNA <i>Massafra, Angelo; Prati, Davide; Predari, Giorgia</i>	854
205	CONDITION ASSESSMENT OF SIDE CORRIDORS WITH THE USE OF AGGREGATIONS BASED ON FUZZY INFERENCE METHOD <i>Bukovics, Ádám; Lilik, Ferenc; Kóczy, László T.; Liszi, Máté</i>	864
237	THE ROLE OF THE EARTHQUAKE VERTICAL COMPONENT ON THE SEISMIC BEHAVIOUR OF MASONRY WALLS <i>Camata, Guido; Di Primio, Alice; Sepe, Vincenzo</i>	873
243	EXPERIMENTAL STUDY ON CALIBRATION FACTOR OF FLAT - JACKS <i>Blanco, Haydee; Boffill, Yosbel; Lombillo, Ignacio; Renedo, Carlos; Sosa, Israel; Carrasco, Cesar</i>	882
256	INSPECTION AND STRUCTURAL EVALUATION OF A MASONRY ARCH FOOTBRIDGE, BAIRRO DOS ANJOS BRIDGE - LEIRIA <i>Christo, Guilherme; Veludo, João; Gaspar, Florindo</i>	892
258	INVESTIGATION OF MASONRY DEFORMABILITY THROUGH FLAT-JACK TESTING: A NUMERICAL STUDY <i>Alecci, Valerio; De Stefano, Mario; Marra, Antonino Maria; Stipo, Gianfranco</i>	900
264	AMBIENT VIBRATION TESTING, DYNAMIC IDENTIFICATION, AND MODEL UPDATING OF A CULTURAL HERITAGE BUILDING. THE CHURCH OF THE ROYAL MONASTERY OF SAN JERÓNIMO (GRANADA, SPAIN). <i>Rodríguez, Rubén; Pachón, Pablo; Sáez, Andrés; Aguilar, Jaime; Compán, Víctor</i>	909
268	METHODOLOGY TO MONITORING THE STATE OF CONSERVATION OF BUILDINGS' ROOFS USING MULTISPECTRAL IMAGES: CASE STUDY OF LEIRIA DOWNTOWN HISTORICAL CENTRE <i>Gonçalves, Luisa M.S.; Gaspar, Florindo; Veludo, João</i>	919
281	DIAGNOSIS OF MONUMENTAL STRUCTURES CONSIDERING HISTORY RELATED-PHENOMENA: A SYSTEMATIC OPERATING METHOD APPLIED TO THE BAPTISTERY OF PISA <i>Bartolini, Giada; De Falco, Anna; Giuliani, Francesca</i>	928
282	GEOMETRIC APPROACH AND STRUCTURAL ANALYSIS OF THE TERCELETE VAULTS OF THE CAPTAIN MONTE BERNARDO CHAPEL OF THE SANTA DE SEVILLA CHURCH BY USING PHOTOGRAMETRY TECHNIQUES AND THE FINITE ELEMENTS METHOD <i>Valseca, J.A.; Tarín, María; Rodríguez, Rubén; Compán Cardiel, Víctor Jesús; Cámara, Margarita</i>	937
302	SEISMIC VULNERABILITY ASSESSMENT AND RETROFIT MEASURES FOR MEDIEVAL STONE MASONRY MINARETS IN EGYPT <i>Hamdy, Gehan</i>	950
303	MANAGING DIAGNOSTIC DATA FOR SEISMIC VULNERABILITY ASSESSMENT OF BUILDING STOCKS BY AN INTEGRATE GIS/VR APPROACH <i>De Fino, Mariella; Lasorella, Margherita; Fatiguso, Fabio</i>	960
321	FROM SURVEY TO ANALYSIS OF THE DAMAGE MECHANISMS IN STONE WALLS: DIAGNOSTIC INVESTIGATIONS ON A BASTION OF THE VENETIAN FORTRESS IN BERGAMO <i>Nannei, Virna Maria; Azzola, Pietro; Mirabella Roberti, Giulio</i>	971

325	STRUCTURAL ANALYSIS BY IN-SITU EXPERIMENTAL CAMPAIGN AT THE “TORRE DE LA VELA” OF THE ALHAMBRA DE GRANADA (SPAIN) <i>Suárez, Fco. Javier; Ortega, Javier; Vuoto, Annalaura; Lourenço, Paulo B.</i>	981
326	HOMOGENIZED NONLINEAR PROPERTIES OF URM STRUCTURES <i>Valadao, Ryan Manuel; Pantazopoulou, S.J.</i>	993
355	NON-DESTRUCTIVE TECHNIQUES USED IN THE DIAGNOSIS OF THE MANSARD ROOF STRUCTURE OF THE URIARTE DE HEBER PALACE <i>Torán, Susana</i>	1001
359	EVALUATION OF HISTORICAL STONE STRUCTURES UNDER EXTREME ACTIONS USING RIGID SOLID DYNAMICS METHODS. CASE STUDY: THE ALCÁNTARA BRIDGE, SPAIN <i>Suárez, Diana; Goicolea, José María; Tarque, Nicola</i>	1009
380	APPLICABILITY OF THE GROUND PENETRATING RADAR TO DETECT BUILDING SETTLEMENTS: THE SINGULAR CASE OF AN INDIANA HOUSE <i>Solla, Mercedes; López-Leira, José Manuel; Fernández, Norberto; Rodríguez, Juan Luis</i>	1020
385	ANALYSIS OF THE SHEAR STRENGTH OF MASONRY WALLS ACCORDING TO THE DISTRIBUTION OF THE BRICK AND MORTAR <i>Reynau, Ricardo; Ivorra, Salvador; Bru, David; Estevan, Luis</i>	1028
387	FROM PRELIMINARY STUDIES TO RESTAURO OF CASA BATLLÓ BY ANTONI GAUDÍ <i>Olona, Joan; Bosch, Mireia; Villanueva, Xavier; Villanueva, Ignasi</i>	1036
390	VULNERABILITY ANALYSIS OF HISTORIC MASONRY TANK-TOWER USING THE PHOTOGRAMMETRIC SURVEY: A CASE STUDY <i>Hyseni, Alba; Cascardi, Alessio; Micelli, Francesco; Aiello, Maria Antonietta</i>	1047
399	PETROGRAPHIC STUDY OF THE MURAL PAINTING COATINGS OF THE SAN JORGE CHURCH (LEDANTES, CANTABRIA) <i>Sánchez Carro, Miguel A.; Quevedo González, Lydia</i>	1055
400	NDT MORPHOLOGICAL AND SPECTROSCOPIC ASSESMENT OF NANO CONSOLIDATION OF THE LIMESTONE, THEBAN TOMB 109 OF WEST BANK, LUXOR, EGYPT <i>Ahmed Sallam; Sayed Hemeda ; Haitham Eid; Moustapha Hassan; Mona Khalil</i>	1063

1.8.- Vulnerability studies and risk management.

14	CONSISTENCY ANALYSIS IN THE APPLICATION OF THE ANALYTIC HIERARCHY PROCESS METHOD, TO DETERMINE VULNERABILITY CRITERIA OF SOCIAL HOUSING IN VALDIVIA - CHILE, AGAINST SEISMIC EVENTS <i>Alvial, Jorge; Vidal, Luis; Chicuy, Yessenia</i>	1070
42	A CRITICAL ROUTE FOR DOCUMENTING THE SEISMIC VULNERABILITY ON MEXICAN HISTORICAL CITIES ON GIS DATABASES <i>Ramírez Eudave, Rafael; Ferreira, Tiago Miguel; Romeu, Vicente</i>	1078
66	ON THE VULNERABILITY OF ANCIENT TOWN WALLS TO SLOW ONSET EVENTS: FORMULATION OF A SYNTHETIC INDEX <i>De Falco, Anna; Giuliani, Francesca; Gaglio, Francesca; Ladiana, Daniela; Di Sivo, Michele</i>	1088
79	A MULTILEVEL APPROACH FOR THE SEISMIC VULNERABILITY ASSESSMENT OF MASONRY CHURCHES IN CUSCO (PERU) <i>Cocco, Giulia; Di Pietro, Erika; Fusella Stefano; Mazzanti, Claudio; Alfaro, Crayla; Brando, Giuseppe</i>	1097
82	EMERGENCY INTERVENTIONS AND COST ASSESSMENT FOR SEISMIC DAMAGES ON CULTURAL HERITAGE <i>Ferrari, Lia</i>	1106
98	HOW ARE HEAT WAVES PUTTING AT RISK HISTORIC URBAN AREAS? FIRST STEPS FOR DEVELOPING RISK ASSESSMENT METHODOLOGIES <i>Quesada-Ganuza, Laura; Garmendia, Leire; Rojí , Eduardo; Álvarez, Irantzu; Briz, Estibaliz; Gandini, Alessandra</i>	1114
130	SEISMIC PERFORMANCE OF TYPICAL HYBRID BUILDINGS IN THE URBAN CENTRE OF BARCELONA <i>Dimovska, Sara; Saloustrós, Savvas; Pelà, Luca; Roca, Pere</i>	1122
134	THE “ALQUERÍA DE FALCÓ” (VALENCIA): SEISMIC VULNERABILITY ASSESSMENT AND INTERVENTION STRATEGIES <i>Basset-Salom, Luisa; Guardiola-Villora, Arianna</i>	1130
213	RISK MANAGEMENT IN THE CONTEXT OF INTERVENTION WORKS IN HISTORIC BUILDINGS <i>Coelho, Carla; Sá, Bruno; Carcereri, Maria Luiza; Zouain, Rosana</i>	1140
245	CULTURAL HERITAGE BUILDINGS AND RELEVANT USES: SEISMIC RISK ASSESSMENT IN FLORENCE <i>Cardinali, Vieri; Cristofaro, Maria Teresa; De Stefano, Mario; Tanganelli, Marco</i>	1148

278	PASSIVE ENERGY DEVICES FOR RETROFITTING FIRST SOFT-STORY BUILDINGS IN MEXICO <i>García, Carlos; Jara, José; Olmos, Bertha; Martínez, Guillermo</i>	1156
289	TOWARDS AN EXPEDITIOUS METHOD TO ASSESS THE VULNERABILITY OF HISTORICAL MASONRY CHURCHES: PRELIMINARY ANALYSES BASED ON EMILIA (ITALY) 2012 EARTHQUAKES DAMAGE <i>Rosso, Federica; Bernabei, Letizia; Vaiano, Generoso; Quagliarini, Enrico; Mochi, Giovanni</i>	1165
315	RISK COMMUNICATION AND AWARENESS OF THE BUILT ENVIRONMENT THREATENED BY DISASTERS WITH DIGITAL MODELS <i>Fatiguso, Fabio; Bruno, Silvana; Cantatore, Elena; Currà, Edoardo; D'Amico, Alessandro; Russo, Martina; Angelosanti, Marco; Quagliarini, Enrico; Bernardini, Gabriele; Mochi, Giovanni; Salvalai, Graziano</i>	1175
332	OUT-OF-PLANE FAILURE RESISTANCE OF ADOBE FACADES IN CUENCA - ECUADOR FOR DIFFERENT SEISMIC ACCELERATIONS <i>Cárdenas-Haro, Xavier; Tarque, Nicola; Todisco, Leonardo; León, Javier; Pino, Julver</i>	1184
336	EFFECTS OF THE 1755 LISBON EARTHQUAKE ON RIVERS AND CORRESPONDING COMPARATIVE PROPOSAL ON INTENSITY SCALE <i>Tavares, Alice; Costa, Aníbal; S. Oliveira, Carlos</i>	1193

1.9.- . Guides and regulations.

48	REGULATION AND STANDARDIZATION ON THE QUALITY OF THE INDOOR ENVIRONMENT APPLICABLE TO KINDERGARTENS AND ELDERLY CARE CENTERS: PORTUGAL - BRAZIL <i>Pinto, Manuel; Lanzinha, João; Silva, Fernando</i>	1202
184	PRESERVO - COMPLEX OF FIOCRUZ COLLECTIONS: PATH OF A CULTURAL HERITAGE PRESERVATION STRATEGY <i>Pinheiro, Marcos José de Araújo; Coelho, Carla</i>	1211
261	DOES THE FINAL FLOOR HEIGHT OF AN EXISTING DOMESTIC BUILDING INFLUENCE THE FATALITY RISK WITH REGARDS A FIRE. A STUDY OF THE LONDON BOROUGH OF LAMBETH <i>Kirk, Mark; Pesce, Giovanni</i>	1222
393	IN-PLANE STRENGTH OF MASONRY PANELS REINFORCED WITH INORGANIC-BASED SYSTEMS: NOVEL DESIGN-ORIENTED FORMULAS <i>Longo, Fabio; Cascardi, Alessio; Aiello, Maria Antonietta</i>	1230

2.- PROJECT

2.1.- Theoretical criteria of the intervention project.

124	INDICATORS FOR THE PRIORITISATION OF INTERVENTIONS IN HISTORIC ARCHITECTURAL HERITAGE: AN APPROACH USING THE HYBRID DELPHI-AHP METHOD <i>Parra, Jaime; Lombillo, Ignacio; Ribalaygua, Cecilia</i>	1241
165	CARLO SCARPA AT THE QUERINI STAMPALIA PALACE: A STUDY OF THE RELATIONSHIP BETWEEN OLD AND NEW <i>Bosch-Roig, Luis; Marcenac, Valeria; Bosch Reig, I; Ballester-Bordes, M.J.</i>	1254
320	THE EFFECTS OF THE EARTHQUAKE OF SEPTEMBER 19TH, 2017 ON THE RELIGIOUS HERITAGE IN MORELOS AND PUEBLA: DAMAGES AND INTERVENTIONS <i>Tepox, Nayde</i>	1262
375	TRADITIONAL ANDALUSIAN ARCHITECTURE. ACTIVE PRESERVATION OF THE PATIO HOUSE: TYPE, TECHNIQUE AND PROJECT <i>Bellicoso, Alessandra; Berti, Krizia; Albarreal Nuñez, María Jesús; Tosone, Alessandra</i>	1270
398	RESTORATION AS AN ARCHITECTURAL DISCIPLINE AND ENGINE OF A NEW ELEMENT OF LIFE. THE TOWER OF ST. MARÍA MAGDALENA'S CHURCH <i>Rodríguez Cantalapiedra, Pedro</i>	1283

2.2.- Traditional materials and construction methods.

29	BUILDING CONSTRUCTION AVANT-GARDE IN ITALIAN IMPERIALISM: AN ARCHITECTURE AND TECHNICAL LABORATORY <i>Pagliuca, Antonello; Trausi, Pier Pasquale; Gallo, Donato</i>	1291
43	DECIMONONIC WOODEN BRIDGES IN THE CENTRAL REGION OF COLOMBIAN ANDES <i>Galindo-Díaz, Jorge; Escobar-García, Diego; Flórez, Gilberto</i>	1299
94	EXPERIMENTAL STUDY OF THERMAL AND ACOUSTIC PERFORMANCE OF RAMMED EARTH PANELS LIGHTENED WITH ANGUSTIFOLIA KUNTH BAMBOO TUBES <i>Aguirre-Maldonado, Eduardo; Guzmán Rojas, Jonathan; Balcázar-Arciniega, Cristian</i>	1307
105	USE OF CHALCEDONITE POWDER AS A SUPPLEMENTARY MATERIAL IN LIME MORTARS <i>Vyšvařil, Martin; Krebs, Martin; Bayer, Patrik</i>	1314
112	USE OF FINE-GROUND LAVA SAND AS A POZZOLANIC ADDITIVE IN AERIAL LIME-BASED MORTARS <i>Žižlavský, Tomáš; Vyšvařil, Martin</i>	1321
123	CONSTRUCTIVE TYPOLOGIES ON PREHISPANIC STONE WALLS IN THE REGION OF PUNO, PERU <i>Tarque, Nicola; Lipa Cusi, Leonel</i>	1327
167	ADVANCED TECHNOLOGIES FOR NATURAL STONE | INOVSTONE 4.0 - IMPORTANT RESULTS FROM A RESEARCH PROJECT ON NATURAL STONE CONSTRUCTION MATERIALS SELECTION AND PERFORMANCE ANALYSIS <i>Pires, Vera; Mirão, José; Sitzia, Fabio; Lisci, Carla; Duarte, José; Dias, Luis; Alves, Tiago; Lopes, Luís; Martins, Ruben</i>	1337
185	HISTORICAL HOSPITALS IN NAPLES: ENHANCING CONSTRUCTION TECHNIQUES AS A STRATEGY FOR POTENTIAL URBAN REGENERATION INTERVENTIONS <i>Sicignano, Claudia; Diana, Lorenzo; Marmo, Rossella; Polverino, Francesco</i>	1351
193	STRUCTURAL ANALYSIS FOR CONSTRUCTIVE HYPOTHESIS OF THE ANNULAR VAULT OF CARLOS V PALACE IN GRANADA (SPAIN) <i>Puertas, Esther; Gallego, Rafael</i>	1360
224	THE "ORO NERO" IN THE ARCHITECTURE OF THE THIRTIES IN SOUTHEASTERN SICILY. MEANINGS AND IMITATIONS OF A LOCAL MATERIAL <i>Cavallo, Alessandro</i>	1368
287	CONTRIBUTIONS TO THE IDENTIFICATION OF THE SYSTEMS USED TO CREATE ISLAMIC PLASTERWORK BASED ON THE STUDY OF DECORATIVE ELEMENTS AT THE ROYAL ALCAZAR OF SEVILLE <i>Alejandro, Francisco J.; Torres-González, Marta; Blasco-López, Francisco J.; Flores-Alés, Vicente</i>	1376
337	REHABILITATION OF EARTHEN ARCHITECTURE, FROM COURTYARD HOUSES TO BRAZILIAN HOUSES IN THE CENTER OF PORTUGAL <i>Tavares, Alice; Costa, Aníbal</i>	1384
353	METHODOLOGY OF EVALUATION OF TECHNOLOGIES. PROPOSAL APPLIED TO BUILDING INTERVENTIONS <i>Bozzo, Laura</i>	1393

362	PORTUGUESE VERNACULAR CONSTRUCTION AND ITS SUSTAINABLE REHABILITATION CHALLENGES: THE SCHIST VILLAGES, LOUSÃ <i>Mouraz, Catarina P.; Silva, J. Mendes; Ferreira, Tiago Miguel</i>	1402
363	INFLUENCE OF REGIONAL GEOLOGICAL CHARACTERISTICS ON PORTUGUESE VERNACULAR CONSTRUCTION: CASE STUDIES <i>Silva, J. Mendes; Mouraz, Catarina; Ferreira, Tiago Miguel; Catarino, Lúcia; Almeida, Vanessa</i>	1411
371	EARTH BUILDINGS IN CRETE: BUILDING CONSTRUCTION KNOWLEDGE THROUGH THE DOCUMENTATION AND PRESERVATION OF EARTHEN ARCHITECTURAL HERITAGE <i>Kada, Dimitra; Mandalaki, Maria</i>	1419

2.3.- Novelty products applicable and new technologies.

41	SERVICE LIFE AND EARLY AGE DURABILITY ENHANCEMENT DUE TO COMBINED METAKAOLIN AND NANOSILICA IN MORTARS FOR MARINE APPLICATIONS <i>García, Ramiro; Reyes, Encarnación; Villanueva, Paula; De La Rubia, Miguel Angel; Fernández, Jaime; Moragues, Amparo</i>	1427
70	SIDERURGICAL MORTARS IN SPAIN: REHABILITATION OPPORTUNITIES AND AN OVERVIEW OF PROGRESS <i>Santamaría, Amaia; Esteban, Alberto; Skaf, Marta; García-Cortés, Verónica; González, Javier Jesús</i>	1436
71	EXPERIMENTAL STUDY ON MECHANICAL PROPERTIES OF MICROCEMENT-BASED GROUTS <i>Hortigon, Beatriz; Ancio, Fernando; Espinal, Jose Santiago; Rodriguez-Mayorga, Esperanza</i>	1444
72	LIGHTWEIGHT CEMENT COBBLE MADE WITH RECYCLED ROOF WASTES <i>Alonso Díez, Álvaro; Arroyo Sanz, Raquel; Alameda Cuenca-Romero, Lourdes; Gutiérrez-González, Sara; Calderón Carpintero, Verónica; Rodríguez Sáiz, Ángel.</i>	1452
91	CLIMATIC PERFORMANCE INDICATOR BASED ON FUZZY LOGIC: APPLICABILITY TO THE ARCHITECTURE, ENGINEERING AND CONSTRUCTION SECTOR <i>Prieto, Andrés J.; Carpio, Manuel</i>	1460
125	FEASIBILITY OF DEFECT DETECTION IN CONCRETE CYLINDERS BY MEANS OF MUON SCATTERING RADIOGRAPHY (MSR) <i>Orio, Aitor; Martínez, Pablo; Díez, Carlos; Gómez, Pablo</i>	1468
157	THE BUILDING STOCK REHABILITATION: THE CONTRIBUTION OF VERTICAL GREENERY SYSTEMS (VGS) <i>Lo Faro, Alessandro; Moschella, Angela; Lombardo, Grazia; Salemi, Angelo; Sciuto, Gaetano; Nocera, Francesco; Costanzo, Vincenzo</i>	1476
166	PRELIMINARY STUDIES TO IDENTIFY SUITABLE DEMONSTRATORS FOR RADON REMOVAL WITH INNOVATIVE PAVEMENTS <i>Alonso, Carmen; Frutos, Borja; Manglano, Libertad; Castaño, Enrique; Sicilia, Isabel; Baño, Antonio; Martín-Consuegra, Fernando</i>	1485
239	EXPERIMENTATION OF NEW PRODUCTS AND SOLUTIONS AT FULL SCALE IN KUBIK. ITS EVOLUTION AND TRANSFORMATION IN 10 YEARS OF OPERATION <i>San Mateos Carretón, Rosa; Garay-Martinez, Roberto; Egiluz, Ziortza</i>	1493
247	REUSE OF RESIDUAL DIATOMACEOUS EARTH FOR THE PRODUCTION OF GEOPOLYMERS – A REVIEW <i>Magalhães, Leandro; Ferreira, Débora; Luso, Eduarda; Lima, Óscar</i>	1504
252	NUMERICAL EVALUATION OF THE STRUCTURAL CONTRIBUTION OF STRENGTHENING FOR PERPENDICULAR TENSILE AND FOR SHEAR IN REINFORCED CONCRETE JOINTS FOR TIMBER FRAMES <i>Ribeiro, Aléxia; Negrão, João; Dias, Alfredo</i>	1511
257	GRAPHENE OXIDE AS ADDITIVE FOR INCREASING THE STRENGTH AND DURABILITY PERFORMANCE OF EXISTING CONCRETE STRUCTURES <i>Longarini, Nicola; Cabras Luigi</i>	1519
260	USE OF REMOTELY PILOTED AIRCRAFT (DRONES) FOR THE INSPECTION OF ARCHITECTURAL HERITAGE AND ANCIENT STRUCTURES <i>Rodríguez Elizalde, Rubén</i>	1528
269	USE OF BIOCEMENTATION FOR SEALING STONE JOINTS <i>Cardoso, Rafaela; Barroso, Ana Catarina; Borges, Inês; Fernández Rodríguez, Román; Flores-Colen, Inês</i>	1543
277	APPLICATION OF NANOTECHNOLOGY TO OBTAIN SUSTAINABLE CEMENT-BASED MATERIALS WITH HIGH DURABILITY <i>Ruiz, Alberto; De la Rubia, Miguel Ángel; Reyes, Encarnación; Moragues, Amparo</i>	1551
306	POSSIBILITIES OF USING CALCIUM HYDROXIDE-BASED NANOMATERIALS IN THE CARE OF HISTORICAL SURFACES <i>Kroftova, Klara; Witzany, Jiri; Zigler, Radek; Cejka, Tomas</i>	1560

351	GEOPOLYMER CEMENTITIOUS SOLUTIONS WITH INTEGRAL SUSTAINABILITY AND HIGH ADDED VALUE BASED ON CONSTRUCTION WASTES. KEOPS PROJECT: PRELIMINARY FINDINGS <i>Prego Martínez, Francisco Javier; García Carrillo, Pablo; Miguéns Blanco, Alberto; Martínez García, Carolina</i>	1569
383	HEAT AND PRESSURE DEVELOPMENTS IN CHEMICAL DEMOLITION AGENTS <i>Atteyeh, S. Natanzi; Laefer, Debra F.</i>	1584

2.4.- Sustainable design and energy efficiency.

6	ASSESSING THE THERMAL ENVIRONMENT OF SOUTH INDIAN HISTORIC TEMPLE TOWNS BY USING CFD MODELLING <i>Kiruthiga, K.; Thirumaran, K.</i>	1592
19	EXPERIMENTAL STUDY OF THE THERMAL AND MECHANICAL PROPERTIES OF ECO-FRIENDLY CEMENT MORTAR INCORPORATING RECYCLED PET AND PP <i>Bourzik, Oumaima; Akkouri, Nacer; Baba, Khadija; Simou, Sana; Nounah, Abderrahman</i>	1600
38	PROPOSITION FOR HEALING MECHANICAL VENTILATION SYSTEMS WITH RESONANT KEPPE MOTOR TECHNOLOGY: ANALYSIS IN A BRAZILIAN PRIVATE SCHOOL <i>Koivukangas, Sari Hannele</i>	1609
52	BIOCLIMATIC STUDY OF ARCHITECTURE IN EASTERN ALMERÍA (SPAIN) <i>García-Ruiz, Luisa-María; García-Ruiz, Almudena; Sáez-Pérez, María-Paz</i>	1618
54	PORTUGUESE PUBLIC SOCIAL HOUSING IN COVILHÃ, PORTUGAL. A CASE STUDY ON INDOOR THERMAL CONDITIONS DURING SUMMER SEASON <i>Brandão, Pedro; Lanzinha, João C. G.</i>	1626
67	AN OVERVIEW OF SUSTAINABLE CONCRETES WITH MAXIMIZED AGGREGATE CONTENT: NATURAL LIMESTONE VERSUS STEEL-MAKING SLAGS <i>García-Cortés, Verónica; García, David; Revilla-Cuesta, Victor; Romera, Jesús-María; San-José, José-Tomás</i>	1634
108	THE POLYFUNCTIONALITY IN THE SINGULAR ARCHITECTURES: KEY OF PERMANENCE AND KEY OF SUSTAINABILITY <i>Agudo Martínez, Andrés; Vázquez Sánchez, Gloria; Lucas Ruiz, Rafael</i>	1643
114	SEISMIC AND ENERGY RETROFIT OF HISTORIC BUILDINGS: A MODEL TO SUPPORT INTEGRATED DESIGN <i>Roncaccia, Elisa; Losco, Giuseppe</i>	1652
116	ANALYSIS OF PASSIVE AIR-CONDITIONING SOLUTIONS IN THE RENOVATION OF COURTYARDS IN A MEDITERRANEAN CLIMATE. <i>Rivera-Gómez, Carlos; Diz-Mellado, Eduardo; López-Cabeza, Victoria; Roa-Fernández, Jorge; Galán-Marín, Carmen</i>	1663
120	BUILDING RETROFITTING IN VULNERABLE CONTEXTS USING END-OF-LIFE HOUSEHOLD MATERIALS AS SUSTAINABLE AND LOW-COST INSULATING SOLUTIONS: THERMAL AND ACOUSTIC ANALYSIS <i>Neri, Manuela; Pilotelli, Mariagrazia; Traversi, Marco; Levi, Elisa; Piana, Edoardo Alessio; Bannó, Mariasole; Pardo-Bosch, Francesc; Cuerva, Eva; Guardo, Alfredo; Pujadas, Pablo</i>	1671
153	INSTALLATION OF DIFFERENT PHOTOVOLTAIC SYSTEMS IN A BUILDING FOR EDUCATIONAL USE <i>Zurro, Belén; González, Sara; González, José Manuel; Rodríguez, Ángel</i>	1680
154	CHECKING THE TECHNICAL SUITABILITY OF THE VENTILATED FAÇADE SOLUTION <i>Zurro, Belén; González, Sara; González, José Manuel; Rodríguez, Ángel</i>	1689
155	CATALOGING ROOFS FOR THE APPLICATION OF NBS IN EDUCATIONAL BUILDINGS <i>Alonso, Carmen; de Frutos, Fernando; Martínez, Arturo; Torres, Salustiano; Frutos, Borja; Martín-Consuegra, Fernando</i>	1698
163	APPLICATION OF EE-HBIM METHODOLOGY TO THE ENERGY RETROFITTING OF A HERITAGE PUBLIC BUILDING IN VALENCIA <i>Carnero Melero, Pablo; Ramírez Pareja, Lucía; Lázaro Moreno, Cecilia; Navarro Escudero, Miriam</i>	1706
171	SIMULATION ANALYSIS AND THE ROLE OF OCCUPANCY MEASUREMENTS ADDRESSING THE ENERGY PERFORMANCE GAP. STUDY OF AN OFFICE BUILDING IN ALMERÍA <i>Soutullo, Silvia; Giancola, Emanuela; Sánchez, María Nuria; Díaz-Hernandez, Heidi Paola; Jiménez, María José</i>	1714
177	HYBRID SOLUTION FOR ELECTRIC AND COLD-WATER PRODUCTION WITH A DUAL DAY-NIGHT BEHAVIOR AS A NATURAL AIR CONDITIONING TECHNIQUE <i>Castro Medina, Daniel; Guerrero Delgado, María del Carmen; Palomo Amores, Teresa Rocío; Cerezo Narváez, Alberto; Sánchez Ramos, José; Álvarez Domínguez, Servando</i>	1722
180	INNOVATIVE INTEGRATION OF ACTIVE ROOF ON 140 SOCIAL HOUSING <i>Castro Medina, Daniel; Guerrero Delgado, MCarmen; Palomo Amores, Teresa; Molina Félix, José Luis; Sánchez Ramos, José; Álvarez Domínguez, Servando</i>	1731

191	INTEGRATED REDEVELOPMENT OF INDUSTRIAL BUILDINGS: A CASE STUDY IN CENTRAL ITALY <i>Banti, Neri; Di Naso, Vincenzo; Ciacci, Cecilia; Bazzocchi, Frida</i>	1740
212	ENERGY EFFICIENCY AND PRESERVATION OF DIFFUSE HISTORIC BUILDINGS: OPPORTUNITIES AND OPEN QUESTIONS <i>Pizzoli, Rolando; Cardani, Giuliana; Bassani, Paola</i>	1752
323	ENERGY EFFICIENCY AND COST OF ENERGY (POSSIBLE SCENARIOS) <i>Balbás, Francisco Javier; Aranda, José Ramón; Carrasco, César; Ceña, Alberto; García, Javier</i>	1760
346	THE IMPACT OF SEISMIC RETROFIT ON THE THERMAL PERFORMANCE OF TRADITIONAL MASONRY WALLS <i>Barreira, Eva; Almeida, Ricardo; Ferreira, Tiago Miguel; Vicente, Romeu; Alves, Pedro</i>	1768
377	NEW MATERIALS IN THE RESIDENTIAL THERMAL CONDITIONING. APPLICATION IN A HOUSE IN THE CITY OF LOJA, ECUADOR. <i>Correa-Jaramillo, Ramiro; Ojeda-Espinosa, Analía; Zúñiga-Torres, Berenice; Torres-Gutiérrez, Mercedes</i>	1776
382	PRELIMINARY THERMAL ANALYSIS OF A CONTAINER HOUSE IN THE NORTHERN REGION OF PORTUGAL <i>Kuninari, Thomas; Pinto, Jorge; Reis, Cristina; Pereira, Sandra; Pappalardo, Alfonso</i>	1784
396	USING DIGITAL MODELS OF BUILT ENVIRONMENT ARCHETYPES TO ANALYZE AND COMMUNICATE CLIMATE RELATED RISK OUTDOORS <i>Blanco Cadena, Juan Diego; Caramia, Martha; Salvalai, Graziano; Quagliarini, Enrico</i>	1793

3.- BUILDING INTERVENTION

3.1.- Intervention plans.

186	SPECIAL PROTECTION PLANS OF HISTORICAL SETS IN SEISMIC AREAS: THE PEPRICH OF LORCA <i>García Martínez, María del Sagrado Corazón; Martínez Ríos, Carmen</i>	1804
214	DIGITAL SURVEY FOR BUILT HERITAGE PRESERVATION. AN ADAPTIVE REUSE PROPOSAL OF THE COMPLEX OF SANTA MARIA NASCENTE <i>Costantino, Carlo; Ruocco, Sara; Predari, Giorgia; Ferrante, Annarita</i>	1813
360	CHALLENGES OF THE PRESERVATION OF HERITAGE BUILT IN STONE AND ARMED CONCRETE ON THE ISLAND OF MOZAMBIQUE <i>Alcolete, Isequiel; Silva, J. Mendes; Lage, Luís; Mouraz, Catarina</i>	1822

3.2.- Rehabilitation and durability.

104	HOW A REFURBISHMENT CAN BLATANTLY MISS ITS GOALS: THE PALAZZO STABILE IN POLLA (SALERNO, ITALY) <i>Marino, Francesco Paolo R.; Lembo, Filiberto; Bruno, Pierluigi</i>	1831
137	CONCRETE CRACK REPAIR WITH EXPANSIVE GROUTS: CHLORIDE PENETRATION RESISTANCE <i>Pedrosa, Filipe; García Calvo, José Luis; Carballosa, Pedro; Revuelta, David</i>	1844
143	EFFECTS OF THE APPLICATION OF ORGANIC PLASTERS WITH ADDITIONS OF BEESWAX ON THE DURABLE CHARACTERISTICS OF EARTH-BASED MORTARS IN RURAL ARCHITECTURE <i>Encalada, Luz; Balcázar, Cristian; Aguirre-Maldonado, Eduardo</i>	1854
189	DIAGONAL COMPRESSION TESTING OF TUFF MASONRY PANELS STRENGTHENED WITH INORGANIC-BASED SYSTEM: AN EXPERIMENTAL INVESTIGATION <i>Verre, Salvatore; Cascardi, Alessio; Gallo, Fiorella</i>	1862
206	NEW GENERATION ETICS COATINGS: AN INNOVATIVE AND HIGH-PERFORMANCE CASE STUDY <i>Curado, António; Figueiras, Ricardo; Gonçalves, Hélder; Sambento, Filipe</i>	1871
232	REINFORCEMENT TECHNIQUES FOR REINFORCED CONCRETE STRUCTURES <i>Guimarães, Marcos B.; Prola, Luis C.; Rodrigues, Paulo C.</i>	1879
295	INFLUENCE OF THE POLARIZATION RESISTANCE MEASUREMENT PROCEDURE WHEN MADE POTENTIODYNAMIC ON THE EVALUATION OF THE POWER OF CORROSION INHIBITORS <i>Argiz, Cristina; de la Fuente, Diego; Moragues, Amparo; Andrade, Carmen</i>	1887
301	EXPERIMENTAL STUDY ON BOND BETWEEN BASALT FRCM REINFORCEMENT AND CALCAREOUS STONE <i>Bramato, Giuseppe; Leone, Marianovella; Perrone, Daniele; Aiello, Maria Antonietta</i>	1895
354	THE IMPORTANCE OF THE "IN SITU" BEHAVIOR OF MORTARS IN THE REHABILITATION OF BUILDINGS <i>Torres, Isabel; Flores-Colen, Inês</i>	1903
361	CHALLENGES OF SALVAGUARD AND REHABILITATION OF THE RELIGIOUS HERITAGE BUILT OF VILA VIÇOSA <i>Silva, J. Mendes; Ganito, Jorge</i>	1911
389	BEHAVIOR OF SUPPLEMENTARY CEMENTITIOUS MATERIALS IN ELECTRO REMEDIATION PROCESSES APPLIED TO CONCRETE STRUCTURES <i>Martinez, Isabel; Castellote, Marta</i>	1920
403	DIFFICULTIES IN INTERVENING ON PROTECTED HERITAGE ACCORDING TO PREFERRED STANDARDS OF REFURBISHMENT <i>Calderon Bello, Enrique</i>	1927

3.3.- Reinforcement technologies.

61	COMPARATIVE STUDY OF TECHNIQUES IN REINFORCED ADOBE FOR THE SUSTAINABLE RECONSTRUCTION OF THE COLCA VALLEY AFTER THE 2016 EARTHQUAKE <i>Cárdenas Gómez, José Carlos; Bosch González, Montserrat; Damiani Lazo, Carlos</i>	1936
99	STRENGTHENING OF FLAT SLABS WITH FIBRE REINFORCED POLYMERS USING THE EXTERNALLY BONDED REINFORCEMENT ON GROOVES METHOD: A REVIEW <i>Torabian, Ala; Isufi, Brisid; Mostofinejad, Davood; Ramos, António Pinho.</i>	1946
100	MECHANICAL CHARACTERISATION OF VEGETAL FRCM COMPOSITES: EXPERIMENTAL AND ANALYTICAL APPROACH <i>Mendizabal, Virginia; Bernat-Maso, Ernest; Mercedes, Luís; Gil, Lluís</i>	1954

152	EXPERIMENTAL AND NUMERICAL ANALYSIS OF THE CYCLIC IN-PLANE BEHAVIOUR OF RETROFITTED MASONRY WALLS <i>Garcia-Ramonda, Larisa; Pelà, Luca; Roca, Pere; Camata, Guido</i>	1962
160	DESIGN AND DETAILING OF ANCHORS FOR SEISMIC ACTIONS <i>Gramaxo, Jorge; Cardo Fernández, Antonio</i>	1971
164	STEEL MESH REINFORCED COATING CHARACTERIZATION FOR MASONRY UPGRADING <i>Crespi, Pietro; Cattaneo, Sara; Scamardo, Manuela; Vafa, Navid</i>	1980
172	PUNCHING POST-INSTALLED REINFORCEMENT OF FLAT SLABS <i>Kunz, Jakob; Cardo Fernández, Antonio</i>	1989
192	BILINEAR EXPERIMENTAL CURVE OF MASONRY WALLS MADE WITH HORIZONTAL HOLLOW BRICK UNITS <i>Díaz, Christian; Tarque, Nicola</i>	1999
202	COMPARISON OF IN-PLANE BEHAVIOR OF UNREINFORCED MASONRY WALLS STRENGTHENED WITH FABRIC-REINFORCED CEMENTITIOUS MATRIX (FRCM)/ FIBER REINFORCED POLYMERS (FRP) SYSTEMS SUBJECTED TO DIAGONAL COMPRESSION <i>Kaddouri, Hajar; Cherradi, Toufik; Kourdou, Ibtissam</i>	2008
350	ON-SITE REHABILITATION OF DECAYED TIMBER FLOORS WITH EPOXY-RESIN COMPOSITES <i>Bender, Tom; Schober, Kay-Uwe; Ihle, Robin</i>	2022

3.4.- Restoration of artworks.

63	ARTISTIC BLACKSMITHING IN THE URUGUAYAN BUILT HERITAGE <i>Aguiar, Sofía; Beretta, Ernesto; Hojman, Miriam; Marchese, Valentina; Mussio, Gianella; Olivera, Leticia; Rimbaud, Tatiana; Romay, Carola; Ulfe, Veronica</i>	2030
195	RECOVERY OF A HISTORIC STAINED-GLASS WINDOW OF THE HOUSE MAUMEJEAN IN SAN MARCOS 43 ST. MADRID <i>Pinilla Melo, Javier; Castrillo Sevilla, Elena; Moreno Fernández, Esther., Lasheras Salgado, Raquel</i>	2038

3.5.- Conservation of industrial heritage.

81	PROPOSAL OF SUSTAINABLE REHABILITATION OF INDUSTRIAL BUILDING FOR INTERNSHIP AND TRAINING SPORTS CENTER <i>Lopes, Vera; Iñigo, Miriam; Lanzinha, João</i>	2048
267	EXAMINING THE DEFECTS AND INTERVENTIONS IN THE COMPONENTS OF REUSED INDUSTRIAL BUILDINGS-CASE OF TURKEY <i>Çakar, H. Yasemin; Edis, Ecem</i>	2056
279	ANALYSIS OF THE FRENCH TRAIN SYSTEM IN A SUGAR MILL OF THE 18TH CENTURY ON THE ISLAND OF SANTO DOMINGO AND RESTORATION CRITERIAS <i>Prieto-Vicioso, Esteban; Flores-Sasso, Virginia</i>	2067

3.6.- Examples of intervention.

17	REHABILITATION OF THE ACCESS TO THE SAN JUAN DE GAZTELUGATXE HERMITAGE <i>Baraibar, José Manuel; Escobal Marcos, Iñigo</i>	2076
24	INTEGRAL RECOVERY OF THE HERMITAGE OF SAN BLAS IN BROTO-HUESCA <i>Febas Borra, José Luís; Díez Hernández, Jesús; Rojí, Eduardo</i>	2084
80	MODEST HERITAGE PRESERVATION IN SAN SALVADOR HISTORIC CENTER. THE GREEN HOUSE REHABILITATION CASE <i>Avendaño, Ayansi</i>	2096
83	LIGHT AND SPACE - TRANSFORMING A VILLA INTO THE CHRISTIAN YOUTH CENTRE TIMISOARA <i>Andreescu, Ioan; Dinu, Dan – Răzvan</i>	2106
110	ARCHITECTURAL REHABILITATION OF THE ROOF OF THE CENTRAL COURTYARD OF THE FACULTY OF ECONOMICS AND BUSINESS SCIENCES OF THE UNIVERSITY OF SEVILLE. A CASE OF ARCHITECTURAL INTERVENTION IN MODERN HERITAGE PROPERTIES <i>Agudo Martínez, Andrés; Basallote Neto, Francisco</i>	2115
115	TECHNOLOGICAL REFURBISHMENT AND ENERGY RETROFIT OF LARGE, FLAT ROOFS BY USING METAL SHEET SYSTEMS: THE CASE STUDY OF A MULTIFUNCTIONAL BUILDING <i>Scrinzi, Giacomo; Mazzucchelli, Enrico Sergio; Stefanazzi, Alberto; Lucchini, Angelo</i>	2129

118	REHABILITATION OF THE TXATXARRAMENDI BRIDGE IN BUSTURIA-SUKARRIETA (BIZKAIA) <i>Pérez Salazar, Laura; Barroso Prados, Fran; Piñero Santiago, Ignacio; Orbe Mateo, Aimar; Ezquerro Andreu, Mikel</i>	..... 2139
175	MEMORIES OF IMMIGRATION - THE RESTORATION OF THE HOTEL LANFREDI <i>Betemps Vaz Da Silva, Juliana; Rauber Motter, Cristiane; Werner, Priscila; Lorscheiter, Aline; Matozo da Silva, Luana; Herpich, Bruna</i>	..... 2148
178	THE RESTORATION OF SANTA CRUZ CHURCH IN ECIJA (SEVILLE): THE BUILDING AS PLOT <i>Rincón-Calderón, José María; de Sola-Caraballo, Javier; Galán-Marín, Carmen; Rivera-Gómez, Carlos</i>	..... 2156
223	ANALYSIS OF LEAN CONSTRUCTION INFLUENCE IN BUILDING PROCESSES USING BIM 4D: CASE STUDY <i>Ferrer, Pedro A. M.; Ribeiro, Rodrigo S.; Oliveira, Rui A. F.</i>	..... 2165
225	PLANNING AND MANAGEMENT OF AGRICULTURE WAREHOUSE CONVERSION PROJECT: A CASE STUDY <i>Oliveira, Rui A. F.; Abreu, Maria Isabel; Lopes, Jorge</i>	..... 2174
228	THE ROOF OF THE SANTA LUCIA CHURCH - FERREÑAFE: INTERVENTIONS FOR THE MAINTENANCE OF THEIR STRUCTURAL AND FUNCTIONAL INTEGRITY <i>Chirinos, Haydeé; Zárate, Eduardo; Beltrán, Freddy</i>	..... 2184
229	INCORPORATION OF HIGH ENERGY PERFORMANCE AND SUSTAINABILITY CRITERIA IN THE ARCHITECTONIC AND STRUCTURAL RETROFIT OF INDUSTRIAL HERITAGE BUILDINGS: THE CASE OF THE NEW COURTS IN SERENA, CHILE <i>Videla, José Tomás; Huenchuñir, Marcelo; Bustamante, Fermín; Martínez, Patricia</i>	..... 2192
259	THE GOTHIC OF THE TWENTIETH CENTURY IN COLOMBIA. RESTORATION PROJECT OF THE CHURCH OF THE INMACULADA CONCEPCIÓN IN CARAMANTA, ANTIOQUIA <i>Carvajal Jaramillo, Henry H.; Ochoa Botero, Juan C.</i>	..... 2200

4.- MAINTENANCE
4.1.- Construction maintenance and infrastructures.

21	COVID-19 LESSON ON FACILITY MANAGEMENT OF PUBLIC BUILDINGS <i>D’Orazio, Marco; Bernardini, Gabriele; Di Giuseppe, Elisa</i>	2212
32	INFLUENCE OF THE USERS’ PERFORMANCE CRITERIA ON THE IMPACT OF MAINTENANCE OF CERAMIC CLADDINGS <i>Ferreira, Cláudia; Silva, Ana; de Brito, Jorge</i>	2220
51	METHODOLOGY FOR IMPROVING THE EFFICIENCY OF INVESTMENTS OF THE INDUSTRIAL INFRASTRUCTURES OF THE FORMER PORT AREA IN THE BAY OF HAVANA <i>Piñero, Ignacio; de la Cruz, Raimundo; Bresó, Juan Carlos, Cuadrado, Jesús; Ezquerro, Mikel</i>	2226
69	A NEW METHODOLOGY FOR RAILWAY BRIDGE INSPECTION FROM OPTICAL IMAGES AND HD VIDEOS OBTAINED BY RPAS <i>Cano, Miguel; Pastor, José Luis; Tomás, Roberto; Riquelme, Adrián; Asensio, José Luis; Pagán, José Ignacio</i>	2235
85	FEASIBILITY ASSESSMENT OF HEIGHT WORKING EQUIPMENT, IN SOUTH-ITALIAN RESIDENTIAL BUILDINGS MAINTENANCE <i>Di Ruocco, Giacomo; Melella, Roberta</i>	2245
176	PUBLIC BUILDINGS MAINTENANCE MANAGEMENT <i>Ferreira, Lélia; Paiva, Anabela; Silva, J. Mendes</i>	2254
352	THE REHABILITATION THROUGH EXTERNAL PRESTRESSING OF HISTORICAL REINFORCED CONCRETE BRIDGES WITH REDUCED PERFORMANCE: A CASE STUDY <i>Granata, Michele Fabio; Messina, Davide; Colajanni, Piero; La Mendola, Lidia; Recupero, Antonino; Lo Giudice, Elio</i>	2262
378	DIAGNOSIS OF A MODERNIST WORK: THE “PARADOR ARISTON” <i>Valcarce, María Beatriz; Vázquez, Marcela</i>	2272
388	REMOTE INSPECTION OF THE INTERIOR OF CHANNELS AND TANKS OF THE WATER SUPPLY AND SANITATION NETWORK <i>Tárrago Garay, Nerea; Barroso Prados, Francisco Javier; Espada, Fran; Borrás Morrison, Mikel</i>	2280

4.2.- Preventive conservation of built heritage.

15	MANUAL OF GOOD PRACTICES IN THE TRADITIONAL RURAL ARCHITECTURE OF GRAN CANARIA: THE DWELLING-CAVE <i>Delgado Quintana, Guacimara; Lozano Más, María Yazmina; Cabrera Librada, Javier; Medina Arias, Aarón; González Navarro, José</i>	2290
36	PREVENTIVE MAINTENANCE OF EXISTING BUILDINGS USING BIM TECHNOLOGY FOR THE OPTIMISATION OF RETROFITTING PROCESSES <i>Sagarna, Maialen; Otaduy, Juan Pedro; Mora, Fernando; Leon, Iñigo</i>	2299
50	PRESERVING THE 20TH CENTURY INDUSTRIALIZED BUILDING HERITAGE IN ITALY: COMBINING HISTORICAL SURVEYS AND PHILOLOGICAL BIM <i>Mornati, Stefania; Giannetti, Ilaria</i>	2308
86	MICROCLIMATE FOR PRESERVATION IN A LIBRARY: ASSESSMENT OF TEMPERATURE AND RELATIVE HUMIDITY PRE AND POST CONFINEMENT <i>Diulio, María de la Paz; Gómez, Analía Fernanda</i>	2317
92	APPLICATION OF A FUZZY LOGIC SYSTEM WITH EMPHASIS ON CLIMATE CONDITIONS IN THE BUILDING SECTOR IN CHILE <i>Carpio, Manuel; Prieto, Andrés J.</i>	2325
136	ANALYSIS OF ANTHROPIC AND SOCIAL THREATS OF THE ARAB WALL OF ALZIRA <i>Guardiola-Villora, Arianna; Basset-Salom, Luisa</i>	2332
138	SLOPE STABILIZATION BY ROAD ROTATIONAL SLIDE IN THE JUNGLE OF PERU <i>Soplopuco Quiroga, Serbando; Soplopuco Torres, Rubén Ronald; Martínez Quiroz, Enrique Napoleón; Alarcón Zamora, José Evergisto</i>	2343
151	CHARACTERISTICS OF THE CULTURAL HERITAGE PREVENTIVE CONSERVATION SYSTEM OF SOUTH KOREA <i>Hwang, Minhye</i>	2353
238	SAN JUAN DE GAZTELUGATXE, HOW TO MANAGE THE RESILIENCE OF A UNIQUE LOCATION ON THE COAST OF THE BASQUE COUNTRY <i>San Mateos Carretón, Rosa; Ezquerro Andreu, Mikel; Eppich, Rand; Quesada, Laura</i>	2359
357	THE CONTRIBUTION OF DECONSTRUCTION TO THE PRESERVATION OF PORTUGUESE OLD BUILDINGS <i>Ranna, Gabriela; Torres, Isabel; Silva, José</i>	2369

5.- DIFFUSION AND PROMOTION
5.1.- Heritage and cultural tourism.

35	DISUSED RAILWAY STATIONS AND BUILDING AND ENVIRONMENTAL RECOVERY STRATEGIES <i>Radogna, Donatella</i>	2378
47	INDUSTRIAL HERITAGE IN THE PROVINCE OF ALMERÍA. ANALYSIS AND REUSE FOR A SUSTAINABLE TOURISM <i>García-Ruiz, Almudena; García-Ruiz, Luisa-María; Sáez-Pérez, María-Paz</i>	2387
49	EVOLUTIONARY, MORPHOLOGICAL AND ACOUSTIC ANALYSIS OF CLASSICAL GREEK THEATRES. PARAMETERS FOR PRE-DIMENSIONING AND REHABILITATION <i>Mesto, Suleiman; Rubio, María Jesús</i>	2396
87	AN EXAMPLE OF THE ANALYSIS OF RURAL SETTLEMENTS: ASAGI BELEMEDIK VILLAGE <i>Ortakaya, Esra Nur; Umar, Nur</i>	2404
109	PROPOSAL FOR INTERVENTION IN ABANDONED ARCHITECTURE: THE ROMAN TEMPLE OF VIÑEROS OF THE CITY OF MERIDA <i>Agudo Martínez, Andrés; Fernández Castelló, Francisco; Vázquez Sánchez, Gloria</i>	2414

5.2.- Teaching and training.

188	ADVANTAGES OF FLIP TEACHING ACTIVE METHODOLOGY DURING THE COVID-19 PANDEMIC <i>Tuesta Durango, Nelson; Villanueva Valentín-Gamazo, David; Mansilla Blanco, M^a Isabel; Rey de las Moras, M^a Cruz; Cantalapiedra Cantalapiedra, Ángel; Martínez Iranzo, Fco. Javier</i>	2424
-----	--	------

5.3.- New technologies applied to the heritage diffusion.

12	INVENTORIES FOR THE PRESERVATION AND DISSEMINATION OF THE ARCHITECTURAL HERITAGE <i>Quintilla, Marta; Agustín, Luis</i>	2433
27	THE GEOMETRIC APPEARANCE OF COLUMNS AND FRAMES IN THE PALATIAL OTTOMAN ARCHITECTURE OF THE ALGIERS CASBAH: WHAT PROCESS TO CREATE? <i>Aïcha, Bibimoune; Samia, Chergui</i>	2441
75	PLANIMETRIC SURVEY, 3D PRINTING AND VIRTUAL RECREATION FOR THE MUSEALIZATION OF THE HOYA DE LOS MOLINOS SITE, IN CARAVACA DE LA CRUZ (REGIÓN DE MURCIA, SPAIN) <i>Collado-Espejo, Pedro-Enrique; García-León, Josefina; González-García, Jesús Ángel</i>	2450
113	3D MODELING AS A VALIDATION SYSTEM FOR THE RECONSTRUCTION OF THE DISAPPEARED HISTORICAL ARCHITECTURAL HERITAGE: THE OCTOGON OF VALLADOLID <i>Villanueva-Valentín-Gamazo, David; Arcones-Pascual, Gustavo; Bellido-Blanco, Santiago</i>	2458
286	MIXED VIRTUAL TOUR FOR THE DISSEMINATION OF THE DECONTEXTUALIZED HERITAGE. THE OVIEDO CATHEDRAL CHOIR STALLS <i>Sanchez Riera, Alberto; Pàmies Sauret, Carles; Navarro Delgado, Isidro</i>	2467
291	DEFENSIVE ARCHITECTURE, DIFFUSION AND NEW TECHNOLOGIES. ANALYSYS OF THE NATIONAL PARK SERVICE AND PARKS CANADA STRATEGIES <i>Mira Rico, Juan A.</i>	2476
304	MALAKA.NET AS A COMPREHENSIVE WEBGIS PLATFORM TO MANAGE CULTURAL HERITAGE. A COMPARATIVE CASE STUDIES <i>Conejo-Arrabal, Francisco; Chamizo-Nieto, Francisco José; Rosa-Jiménez, Carlos; Nebot-Gómez de Salazar, Nuria</i>	2484
312	A COMPARATIVE STUDY BETWEEN A STATIC AND A MOBILE LASER SCANNER FOR THE DIGITALIZATION OF INNER SPACES IN HISTORICAL CONSTRUCTIONS <i>Villanueva Llauro, Paula; Maté González, Miguel Ángel; Sánchez Aparicio, Luis Javier; Benito Pradillo, María Ángeles; González Aguilera, Diego; García Palomo, Luis Carlos</i>	2492
317	THE INTANGIBLE CULTURAL HERITAGE THROUGH DIGITAL INVENTORIES. CASE STUDY IN MÁLAGA, SPAIN <i>Nebot-Gomez de Salazar, Nuria; Chamizo-Nieto, Francisco José; Conejo-Arrabal, Francisco; Rosa-Jiménez, Carlos</i>	2499

5.4.- Accessibility to cultural heritage.

187	ACCESSIBILITY AND CULTURAL HERITAGE: THE CASE STUDY OF THE BRAZILIAN FEDERAL SUPREME COURT PALACE USING THE MATRIX OF AUTHENTICITY AND ACCESSIBILITY <i>Máximo, Marco Aurélio da Silva; Ferreira, Oscar Luís</i>	2508
-----	---	------

5.5.- Built heritage management.

40	HBIM & GIS INTEGRATION FOR THE 3D VISUALISATION OF VIRTUAL LIBRARIES IN EXISTING BUILDINGS: A CASE STUDY <i>Carrasco, César A.; Lombillo, Ignacio; Blanco, Haydee; Boffill, Yosbel; Sánchez-Haro, Javier</i>	.....	2518
209	THE RESILIENT CONSTRUCTION SITE OF THE HISTORICAL CENTERS. A CASE STUDY <i>Rotilio, Marianna; Laurini, Eleonora; De Berardinis, Pierluigi</i>	.....	2527
210	GUNPOWDER HOUSE – VALPARAÍSO. AN URBAN ARCHAEOLOGICAL SITE AND ITS HERITAGE RECOVERY <i>Kaplan, Paulina</i>	.....	2536
215	REVIEW OF THE MANAGEMENT OBJECTIVES OF THE WORLD HERITAGE DECLARATION OF ÚBEDA AND BAEZA <i>Hervás-Molina, María; Loren-Méndez, Mar</i>	.....	2542

KEYNOTE LECTURES

CODE 98

HOW ARE HEAT WAVES PUTTING AT RISK HISTORIC URBAN AREAS? FIRST STEPS FOR DEVELOPING RISK ASSESSMENT METHODOLOGIES

**Quesada-Ganuza, Laura^{1*}; Garmendia, Leire¹; Rojí, Eduardo¹; Álvarez, Irantzu²;
Briz, Estibaliz¹; Gandini, Alessandra³**

1: University of the Basque Country UPV/EHU, School of Engineering in Bilbao, Mechanical Engineering Department, Plaza Ingeniero Torres Quevedo s/n (48013) Bilbao. Spain.

e-mail: laura.quesada@ehu.eus, leire.garmendia@ehu.eus, eduardo.roji@ehu.eus, estibaliz.briz@ehu.eus

2: University of the Basque Country UPV/EHU, School of Engineering in Bilbao, Department of Graphic Design and Engineering Projects, Rafael Moreno "Pitxitxi", (48013) Bilbao. Spain

e-mail: Irantzu.alvarez@ehu.eus

3: TECNALIA, Basque Research and Technology Alliance (BRTA), Parque Tecnológico De Bizkaia, Astondo Bidea, Edificio 700, Derio, 48160, Spain

e-mail: alessandra.gandini@tecnalia.com

ABSTRACT

It is worldwide accepted that climate change is affecting cities and that the conservation of the cultural heritage contributes to sustainable development. However, despite the high level of interest and research in climate-change risks, a holistic understanding of the risk that heat waves and heat urban island phenomena present to urban cultural heritage is noticeably absent from literature. Aside from understanding the impacts that heritage faces with climate change, the consideration of loss of heritage and cultural values and assets due to extreme heat waves will promote the resilience and sustainability of both social and built environmental systems.

The aim of this paper is double, first to identify key performance indicators for risk assessment methodologies that address both the elements of historic urban areas as a system and the potential impact of prolonged heat waves. Second, this study aims at developing a categorization for both buildings and urban spaces within historic urban areas regarding their vulnerability to heat waves, which will be the basis for further risk assessment. For this twofold purpose, the interaction between urban spaces, heat waves, and the urban heat island is addressed as well as the vulnerability and behaviour of traditional materials and building typologies.

To define the elements that conform historic urban areas, the system is addressed from two perspectives, as an urban system, and as a historic area. At the same time, for a holistic approach, every element of the system is assessed, distinguishing between socio-economic, cultural, governance (services and resources) and physical (gathering tangible characteristics of all infrastructures, elements and buildings) aspects. The indicators and categorization are, therefore, essential for the evaluation of the impacts of heat waves and the urban heat island on the elements that conform the system of the historic urban area.

KEYWORDS: Historic Urban Areas; Climate Change; Risk Assessment; Vulnerability; Key Performance Indicators.

1. INTRODUCTION AND OBJECTIVE

Global warming continues to increase, according to reports from the World Meteorological Organization (WMO) [1] the 21st century is now the warmest on record. This ongoing rise in global mean temperature is increasing the risk and frequency of extreme events, with one of the main threats being heat waves [2]. Maximum temperatures are recorded in and around urban areas [3], where now resides over half of the world's population. With most of the world's population predicted to be living in the largest urban agglomerations (based on their 2025 populations) [4], they will be exposed to a minimum temperature rise of 2 ° C above pre-industrial levels, excluding urban heat island effects.

To ensure a resilient future, the most recent special report from the Intergovernmental Panel on Climate Change (IPCC) [3] identifies urban areas and infrastructure as one of the systems in need of mayor transformation. Heat waves can adversely the health of urban residents, their assets, wellbeing and livelihoods, as well as ecosystems and infrastructure within urban areas [5] and is expected for climate to aggravate heat wave events, with a rise of their frequency, duration and intensity [3]. Population in urban areas are very vulnerable to extremes in heat and relative humidity, and heat wave events can increase mortality rates. Even when being under the same climatic conditions, cities have specific microclimates resulting in heat-island effects, when compared to the surroundings countryside [6]. Specific urban characteristics like low permeability of the soil, higher population densities, higher concentrations of productive activities, and materials differentiate their response to the changing climate.

Historic urban areas are very relevant as the source of cultural identity, and important economic assets and have very specific characteristics that differentiates them when facing extreme events [7]. These distinct vulnerabilities are because of not only physical characteristics of the built and tangible assets, but also related to the complete cultural landscape, such as specific population patterns, tourism, or traditional socio-economic activities. Moreover, over the past decade, climate change has become a central focus for relevant heritage organizations such as ICOMOS and UNESCO [8,9]. Consequently, a priority for future policy and research is to assess the risk faced by historic urban areas with respect to climate change and the related extreme events.

The objective of this paper is twofold, to identify key performance indicators for heat wave impacts on historic urban areas, and to develop a categorization for the elements of a historic urban area according to their vulnerability. Therefore, the paper is divided into three sections, the first sets the framework for the research work, setting goals and developing a methodological approach, in the second part key performance indicators for risk assessment methodologies are identified that address both the elements of historic urban areas as a system and the potential impact of prolonged heat waves. In the final part, a categorization is proposed for both buildings and urban spaces within historic urban areas regarding their vulnerability to heat waves.

2. FIRST STEPS FOR A RISK ASSESSMENT METHODOLOGY

2.1. Framework and methodological approach

Heat wave vulnerability assessment for historic areas is noticeably missing from literature [10]. This fact motivated the present study with the goal of assessing vulnerability of historic urban areas by considering their complexity as physical and socioeconomic entities and provide the framework for a risk assessment methodology. With this motivation, the goal for this paper is to develop the first steps for the development of a holistic and multi-criteria methodology for risk assessment of historic urban areas towards heat waves. The future methodology should aim at identifying vulnerabilities and risks in historic areas with a holistic perspective, providing support for the prioritization for future adaptation actions.

The work carried out for this research is done with a multi-scalar approach, considering both the building scale and the urban space. Both the development of indicators and the characterization not only consider the singularities of historic areas, but all of all urban areas to promote integration at city scale. The assessment should start defining the objectives (why), system being analysed (who/what; in this case the historic urban system), the stressors (to what; for us, heat waves) and the time horizon (when) [11,12]. Individual or composite indicators are the foundation for vulnerability and risk assessment; used to generate information about non-measurable conditions and comparing different measured data [13].

Heat waves are characterized differently depending on the climate of the region, but for a general definition the WMO guidance on heat-health warning (WMO-No.1142) defines heatwaves as periods of unusually hot and dry or hot and humid weather that have a duration of at least two to three days and a discernible impact on human activities [14]. Following this definition, heat waves are characterized by the use of two main indicators, temperature and relative humidity (RH); distinguishing between dry humid heat waves [15]. Hence, the effects of high heat and low or high humidity on the elements that conform the system of a historic urban area must be the origin for the development of the indicators, including the variables that conform exposure.

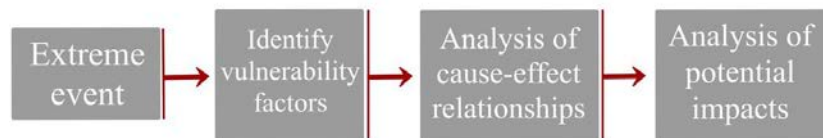


Figure 1. Development of indicators (Adapted from [16])

The studies carried out on urban heat island phenomenon show that the morphological layout of an urban area that affects shading and ventilation, combined with the technical and characteristics of urban elements and the type and distribution of green spaces are the main factors influencing its intensity [17]. This is due to the way urban geometry and materials influence wind flow, energy absorption, and the ability of surfaces to release long wave radiation back to space [18].

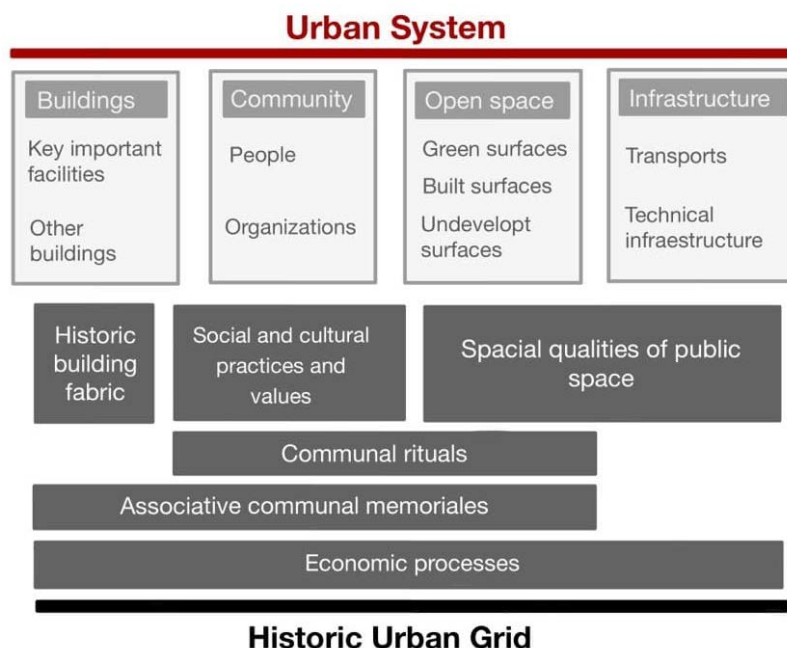


Figure 2. Framework for the analysis of historic urban areas

To define the elements that conform historic urban areas, we needed to address the system from two perspectives, as an urban system, and as a historic area. The indicators derive mainly from literature review, either from an urban perspective, or weathering of historic materials, following the approach from figure 1.

As shown in figure 2, the historic urban area is considered as a combination of an urban system [19] with the addition of carriers of significance in historic urban landscapes [20], linking each carrier to the element of the urban system. To provide a more holistic approach, every element of the system needs to be assessed, distinguishing between social and economic, cultural, governance (services and resources) and physical (gathering tangible characteristics of all infrastructures, elements and buildings)

3. KEY PERFORMANCE INDICATORS

Consequently to the groundwork explained in the previous section of this paper, the indicators are a result of characterizing the potential impacts of heat waves and the urban heat island on the elements that conform the historic urban area. From this approach, combined with the AR5 framework from the Intergovernmental Panel on Climate Change (IPCC), the impact chain would be as shown in figure 3 and the indicators divided into hazard, exposure and vulnerability.

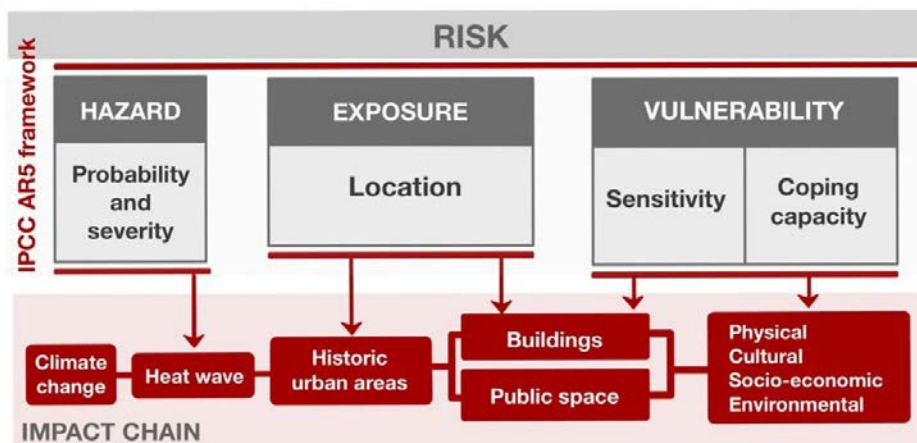


Figure 3: Relation between IPCC AR5 framework for risk assessment and the proposed impact chain for historic urban areas.

Beginning with the characterization of heat waves as the hazard, the main parameters to take into consideration will be temperature, humidity and sun exposure (short-wave solar radiation). As a consequence of the way the different variations in humidity can affect traditional materials, humidity cycles and shocks need to be taken into consideration [21].

For exposure, in regards to the buildings, sun exposure is the main indicator. Therefore, the orientation of the building exposure of the different façades to the sun and shading of the surrounding buildings have to be taken into consideration along with the number of daily hours during which the envelope is hit by solar radiation. At the same time, for open public spaces urban heat island indicators such as the Sky View Factor and Normalized Difference Vegetation Index have to be considered. Sky view factor is a main parameter in determining the phenomenon known as urban canyon [18], it indicates the proportion of an urban space related to heat storage [22] and Normalized Difference Vegetation Index (NDVI) uses satellite images to quantify vegetation. Along with these two main indicators, tropospheric Ozone (O₃) levels and acoustic pollution appear in literature linked to heat. Research shows an increase in ozone levels under conditions such as high temperature, intense solar radiations, and long sunshine hours, all specific meteorological characteristics linked to heatwaves [23], with high ozone levels being dangerous for human health [24]. In the case of acoustic pollution, heat storage inside buildings can be higher in high street noise areas because of inhabitants tending to ventilate less [25].

Finally, sensitivity indicators are divided between buildings, and open spaces. Starting with the buildings, their sensitivity tackles four main areas, social, physical, economic, and cultural sensitivity. Social characteristics as population density, age group and socioeconomic data are the main indicators for social sensitivity. In regards to their physical sensitivity, the possible weathering of sensitive traditional materials under heat wave conditions [21] linked to their construction date and style, and the thermal characteristics of the materials, like albedo or thermal diffusivity provide the main indicators. The indicators for economic sensitivity are based on the use of the building, considering either its productive use, residential, public etc., or because of touristic importance. In relation to cultural sensitivity, the link of the building either to communal memories or to rituals or traditions are the proposed indicators. When considering the sensitivity of public spaces to heat waves, the indicators are proposed divided among its physical characteristics (mainly albedo), its use, and its cultural value, mainly its link either to communal memories or to rituals and traditions.

Coping capacity indicators are divided in social, building, and public space. For the assessment of social coping capacity healthcare access (distance to hospital and availability of hospital beds), and awareness of the population to the hazard, like the existence of emergency plans are considered. In the case of buildings and open public spaces, accessibility is the main parameter considered, with the existence of elevator in the case of buildings, and accessibility for ambulances and firefighters in the case of open spaces, as the main indicators.

4. CATEGORIZATION OF HISTORIC URBAN AREAS

Categorization is a very relevant step in a risk assessment methodology when it comes to its replicability. For the analysis of a large and varied stock of buildings and public spaces such as an urban area, a statistical approach may be used, with the aim to describe all the assets using archetypes or sample assets. Sample assets refer to real elements of the area that include measured data, on the other hand, archetypes include estimated statistical data [26,27]. The methodology for the categorization of an area will be, therefore, a statistical distribution of the characteristics of both buildings and open spaces, starting from samples and then extrapolating these results to elements of the same category, thereby obtaining an overall vulnerability assessment for the historic area. With this goal in mind, the objective is to create a limited number of samples that are able to represent almost the entire building stock and public space of the historic urban area considering the limitations imposed by data availability. These categories should reflect the vulnerabilities of both buildings and public space to heat waves, considering their cultural value, use, social and constructive characteristics following the approach used for the development of the indicators. Furthermore, data should be as widely available as possible, in order to build a replicable model for different case studies [28][29]. Hence, for the step of the generation of the categories, the characteristics of the urban area and the concentration of different values is very relevant.

It is important to consider the equilibrium between the amount of categories and their representativeness considering the relevance of the indicators. Once the categories are developed, a minimum threshold is set to discard the less representative ones. Depending on the size and characteristics on homogeneity that the area presents, the threshold should be set between the 2% and 5% for the best results [29].

According to the above-mentioned requirements, for buildings the categorization will be based on their following parameters divided between physical sensitivity, use, cultural value and social sensitivity.

- Physical sensitivity: This is composed of the correlation of year of construction (divided into construction periods that have similar construction techniques/materials, and consequently, the same vulnerability to heat waves) and state of conservation
- Use: for this category the buildings main use is considered, distinguishing between residential, industrial, public use and touristic use, while adding relevant added characteristics such as commercial use, the existence of touristic apartments in, or the sensitivity of the public use to heat wave conditions.

- Cultural value: for cultural value the main category is the protection level of the buildings with the addition of if it is linked or not to communal memories or traditions.
- Social sensitivity: population density is the main category in this area, subdivided considering the percentage of population older than 65.

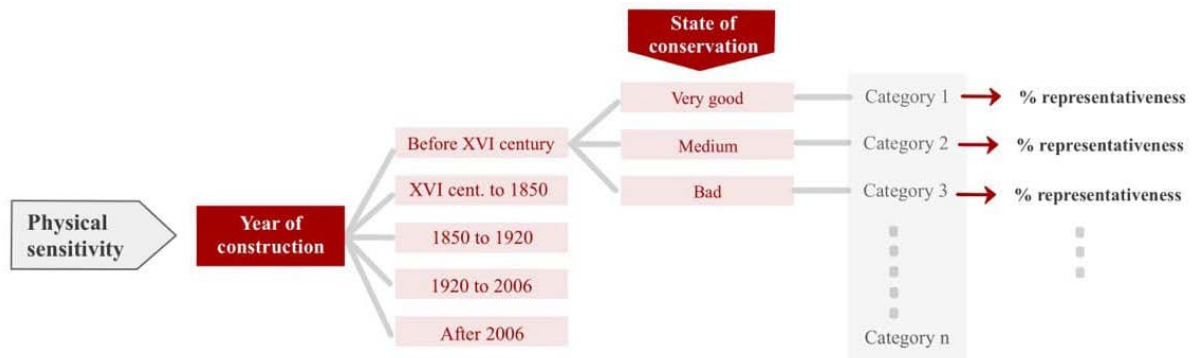


Figure 4: Example of the categorization process for buildings regarding physical sensitivity.

For the categorization of public space, the following parameters were chosen following physical sensitivity, cultural value and environmental characteristics:

- Physical sensitivity: this main category for public space is created with three subdivisions, starting with the Sky View Factor to predict the possible street canyons, then adding NVDI levels to measure the amount of vegetation and adding the albedo of the spaces as the last characteristic.
- Cultural value: for cultural value the relevance of the space for the live in the area is considered, then adding if it is linked or not to communal memories or traditions.
- Environmental characteristics: at last, this category considers the density or scale of the space, distinguishing between main and secondary streets, subdivided considering the existence of traffic or if it is pedestrian only.

5. CONCLUSIONS

Heat wave vulnerability assessment for historic areas is a noticeable gap in research and climate change risk assessment is a very relevant and necessary topic to ensure a resilient future for cities. The present study presents the first steps for the development of a holistic and multi-criteria methodology for risk assessment of historic urban areas towards heat waves. Further work for the development of a full methodology should identify risks in historic areas with a holistic perspective, as a tool for the prioritization for future conservation and adaptation actions.

6. ACKNOWLEDGEMENTS

The authors wish to acknowledge funding from the European Commission through the SHELTER project (GA 821282), as well as the support of the SAREN research group (IT1619-22, Basque Government).

7. BIBLIOGRAPHY

- [1] WMO, WMO statement on the status of the global climate in 2012, 2013. http://www.wmo.int/pages/mediacentre/press_releases/documents/WMO_1108_EN_web_000.pdf.

- [2] IPCC, V. Masson-Delmotte, P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, R. Matthews, Y. Chen, X. Zhou, M. Gomis, E. Lonnoy, T. Maycock, M. Tignor, M. Tabatabaei, Global warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, 2018.
- [3] IPCC, Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, United Kingdom and New York, NY, USA, 2014. https://www.ipcc.ch/site/assets/uploads/2018/02/WGIIAR5-PartA_FINAL.pdf.
- [4] UN-Habitat, World Cities Report 2016: Urbanization and Development - Emerging Futures, 2016. <https://unhabitat.org/world-cities-report> (accessed December 28, 2020).
- [5] J. Zuo, S. Pullen, J. Palmer, H. Bennetts, N. Chileshe, T. Ma, Impacts of heat waves and corresponding measures: A review, *J. Clean. Prod.* 92 (2015) 1–12. <https://doi.org/10.1016/j.jclepro.2014.12.078>.
- [6] B.-J. He, J. Wang, H. Liu, G. Ulpiani, Localized synergies between heat waves and urban heat islands: Implications on human thermal comfort and urban heat management, *Environ. Res.* 193 (2021) 110584. <https://doi.org/10.1016/j.envres.2020.110584>.
- [7] C. Sabbioni, P. Brimblecombe, M. Cassar, N.A. (Project), The atlas of climate change impact on European cultural heritage : scientific analysis and management strategies, Anthem, London ; SE - xiv, 146 pages : color illustrations, color maps ; 29 cm., 2010.
- [8] M. Cassar, Christopher Young, T. Weighell, ICCROM, ICOMOS, D. Sheppard, B. Bomhard, P. Rosabal, UNESCO, Climate Change and World Heritage. Report on predicting and managing the impacts of climate change on World Heritage and Strategy to assist States Parties to implement appropriate management responses, 2007.
- [9] A. Markham, E. Osipova, K. Lafrenz Samuels, A. Caldas, World Heritage and Tourism in a Changing Climate, United Nations Environment Programme, Nairobi, Kenya and United Nations Educational, Scientific and Cultural Organization, Paris, France., 2016. <http://whc.unesco.org/document/139944>.
- [10] L. Quesada-Ganuza, L. Garmendia, E. Roji, A. Gandini, Do we know how urban heritage is being endangered by climate change? A systematic and critical review, *Int. J. Disaster Risk Reduct.* 65 (2021) 102551. <https://doi.org/10.1016/j.ijdrr.2021.102551>.
- [11] C. Apreada, V. D'Ambrosio, F. Di Martino, A climate vulnerability and impact assessment model for complex urban systems, *Environ. Sci. Policy.* 93 (2019) 11–26. <https://doi.org/10.1016/j.envsci.2018.12.016>.
- [12] GIZ, Vulnerability Assessments. Experiences of GIZ with Vulnerability Assessments at the local level | Enhanced Reader, Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, Bonn and Eschborn (DE), 2013. [moz-extension://b5a0e280-3e2f-4112-b842-c17e1f801aad/enhanced-reader.html?openApp&pdf=https%3A%2F%2Fwww.adaptationcommunity.net%2F%3Fwpfb_dl%3D136](https://www.giz.de/Projekte/Climate_Change/Climate_Change_Vulnerability_Assessments_at_the_local_level/Enhanced_Reader/reader.html?openApp&pdf=https%3A%2F%2Fwww.adaptationcommunity.net%2F%3Fwpfb_dl%3D136) (accessed December 30, 2020).
- [13] A. Kalisch, S. Satapath, I. Porsché, D. Rolke, S. Bhatt, S. Tomar, S. Nair, A Framework for Climate Change Vulnerability Assessments | CCARDESA, 2014. <https://www.ccardesa.org/knowledge-products/framework-climate-change-vulnerability-assessments> (accessed December 29, 2020).
- [14] D. Jarosińska, M.-È. Héroux, P. Wilkhu, J. Creswick, J. Verbeek, J. Wothge, E. Paunović, Development of the WHO Environmental Noise Guidelines for the European Region: An Introduction, *Int. J. Environ. Res. Public Health.* 15 (2018) 813.

- <https://doi.org/10.3390/ijerph15040813>.
- [15] X. Chen, N. Li, J. Liu, Z. Zhang, Y. Liu, Global heat wave hazard considering humidity effects during the 21st century, *Int. J. Environ. Res. Public Health*. 16 (2019). <https://doi.org/10.3390/ijerph16091513>.
- [16] UNESCO, *Managing Disaster Risks for World Heritage*, UNESCO World Heritage Center, Paris, 2010. <https://whc.unesco.org/en/managing-disaster-risks/> (accessed December 30, 2020).
- [17] D. Li, E. Bou-Zeid, Synergistic Interactions between Urban Heat Islands and Heat Waves: The Impact in Cities Is Larger than the Sum of Its Parts*, *J. Appl. Meteorol. Climatol.* 52 (2013) 2051–2064. <https://doi.org/10.1175/JAMC-D-13-02.1>.
- [18] L. Gartland, *Heat islands : understanding and mitigating heat in urban areas*, Earthscan, London SE - xiii, 192 p. : il., 2010.
- [19] K. Rus, V. Kilar, D. Koren, Resilience assessment of complex urban systems to natural disasters: A new literature review, *Int. J. Disaster Risk Reduct.* 31 (2018) 311–330. <https://doi.org/10.1016/j.ijdrr.2018.05.015>.
- [20] G.F. Araoz, *World-Heritage and Defining Historic Protecting Urban Landscapes : Authenticity*, *APT Bull. J. Preserv. Technol.* 2–3 (2008) 33–37.
- [21] P. Brimblecombe, C.M. Grossi, I. Harris, *Climate Change Critical to Cultural Heritage*, *Surviv. Sustain.* (2011) 195–205. <https://doi.org/10.1007/978-3-540-95991-5>.
- [22] M. Dirksen, R.J. Ronda, N.E. Theeuwes, G.A. Pagani, Sky view factor calculations and its application in urban heat island studies, *Urban Clim.* 30 (2019) 100498. <https://doi.org/10.1016/j.uclim.2019.100498>.
- [23] A. Pyrgou, P. Hadjinicolaou, M. Santamouris, Enhanced near-surface ozone under heatwave conditions in a Mediterranean island, *Sci. Rep.* 8 (2018) 9191. <https://doi.org/10.1038/s41598-018-27590-z>.
- [24] J.R. Stedman, The predicted number of air pollution related deaths in the UK during the August 2003 heatwave, *Atmos. Environ.* 38 (2004) 1087–1090. <https://doi.org/10.1016/j.atmosenv.2003.11.011>.
- [25] M. Núñez Peiró, C. Sánchez, A. Sanz-Fernández, M. Heredia, J. López-Bueno, J. Neila, C. Linares, J. Díaz, G. Muñoz, Exposure and Vulnerability towards Summer Energy Poverty in the City of Madrid: A Gender Perspective, in: 2020: p. IN PRESS.
- [26] I. Ballarini, S. Corgnati, V. Corrado, N. Talà, *Improving energy modeling of large building stock through the development of archetype buildings*, (2011).
- [27] L.G. Swan, V.I. Ugursal, Modeling of end-use energy consumption in the residential sector: A review of modeling techniques, *Renew. Sustain. Energy Rev.* 13 (2009) 1819–1835. <https://doi.org/https://doi.org/10.1016/j.rser.2008.09.033>.
- [28] A. Gandini, L. Garmendia, I. Prieto, I. Álvarez, J.-T. San-José, A holistic and multi-stakeholder methodology for vulnerability assessment of cities to flooding and extreme precipitation events, *Sustain. Cities Soc.* 63 (2020). <https://doi.org/10.1016/j.scs.2020.102437>.
- [29] A. Egusquiza, I. Prieto, J.L. Izkara, R. Béjar, Multi-scale urban data models for early-stage suitability assessment of energy conservation measures in historic urban areas, *Energy Build.* 164 (2018) 87–98. <https://doi.org/10.1016/j.enbuild.2017.12.061>.

[14] Consejería de Cultura. *Conjuntos monumentales de Úbeda-Baeza: patrimonio mundial: enclave dual del Renacimiento español*. Sevilla. 2003.

[15] Fernández Ruiz, R. Anexo de Gestión en *Conjuntos monumentales de Úbeda-Baeza: patrimonio mundial: enclave dual del Renacimiento español*. Sevilla. 2003

www.rehabend.unican.es

Coordinator:



Co-Organizers:

