

Sustainable Development and Renovation in Architecture, Urbanism and Engineering

Pilar Mercader-Moyano
Editor

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 Springer

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Preface

The parts published in this book are taken from the III International Congress on Sustainable Construction and Eco-Efficient Solutions, held in Seville, Spain, in March 2017, this being the fifth edition at a national level. The chapters that are collected in this book are the best ones that have been selected from the 150 chapters presented at this event, by a double-blind peer-review performed by an International Scientific and Technical Committee.

The congress has been established as a forum bringing together academics, researchers, and professionals mainly from the construction sector, where available multidisciplinary environmental information is shared, participating from different areas of the construction process.

Its aim is the search for new alternatives to conventional construction solutions that minimize the environmental impact of the construction activity, improve energy efficiency of buildings, build or refurbish, being thus considered individually or at neighbourhood scale, always from a rentable and optimal cost in time. Therefore, the theme of this edition aims to extend the fields of action involved in the development of an ecological and sustainable society from all areas of knowledge, which is “Sustainable Development and Renovation in Architecture, Engineering and Urbanism” in response to the objectives, not only raised in the Horizon 2020 but from all the people who seek a more sustainable world.

Through three days, professionals, scientists, researchers, and public administration representatives worked together in thematic and parallel blocks, in round tables and debating sessions, in order to reflect on the decision-making that helps to improve the technique innovation in both the public and private building sectors. The content of the communications presented at the Congress is divided into thematic blocks, which continues with “re-” as the motto of previous editions and introduces new ones and of which this book is structured: Sustainable Renovation of Buildings and Neighbourhoods; Minimizing the consumption of material resources; Sustainable planning and urban development; Energy efficiency; Sustainable engineering; Eco-economy; Architecture and society; Sustainable building.

At the same time, students worked intensively in the workshops to achieve innovative building solutions, as alternatives to conventional solutions, which are capable of minimizing the environmental impact generated by construction, thereby improving the energy efficiency of the pre-existent buildings, with an optimal economic cost, and affordability in the long term.

These objectives have brought together more than 100 international researchers from eight different countries, which demonstrate the international scope of this call. Argentina, Chile, Ecuador, Mexico, Portugal, and Spain are the most representative countries. And also around 200 students have participated from the branches of Architecture, Engineering, Urbanism, and Environmental Sciences, among others.

There are involved institutions from Argentina (National University of La Plata, Consejo Nacional de Investigaciones Científicas y Técnicas, Experimental Production Center, University of Buenos Aires: Faculty of Architecture, Design and Urbanism and National University of San Juan); Chile (Bío Bío University); Japan (University of Shiga Prefecture); Ecuador (University of Cuenca and Private Technical University of Loja (UTPL)); Italia (Sapienza Università di Roma); Mexico (Autonomous University of Tamaulipas, Autonomous University of Coahuila and Autonomous National University of Mexico (UNAM)), Bolivia (Autonomous University Juan Misael Saracho), and Portugal (National Laboratory of Civil Engineering).

At national level, there is representation from the Polytechnic University of Cartagena, Jaume I University (Castellón de la Plana), University of Malaga, Polytechnic University of Catalonia, Polytechnic University of Madrid, La Salle Engineering and Architecture School of Ramon Llull University, University of Seville, University of Cordoba, University of Huelva, Polytechnic University of Valencia and University of Zaragoza.

The Congress also counts the participation of Spanish organizations such as “Centro Tecnológico de la Construcción de la Región de Murcia”, Institute of Architecture and Building Science (IUACC), “Instituto Valenciano de la Edificación (IVE)”, “Unidad de Investigación en Cuidados de Salud (Investén-isciii)”, and the Eduardo Torroja Institute for Construction Science (CSIC).

The parts of this book provide a summary of the main debates and chapters that have taken place in this event and the results discussed in the sessions performed.

I would like to thank all the conference participants and especially the staff of the organization of the Congress for their valuable contributions and private and public companies and organizations that have contributed in the performance of the event.

Seville, Spain

Pilar Mercader-Moyano

Prologue

Following a thorough and lengthy procedure, we would like to thank all the contributors for their chapters, which are of the highest calibre, comprising this Special Springer Issue on “sustainable development and renovation in architecture, engineering, and urbanism”.

In recent years, the building sector has been turning towards intervening in the existing city building stock. In fact, it is generally accepted that the refurbishment of buildings and the urban regeneration based on sustainability, must form the axis of reformulation of the building sector. Nowadays, achieving sustainable urban development inevitably involves improving existing buildings, thereby preventing the need for city growth, and for the emptying of established neighbourhoods. In order to meet this challenge, it is necessary to understand it in depth and thus break down any barriers that prevent its establishment. In this way, the topic of this Special Issue is framed; it encompasses the fields needed to guarantee sustainable renovation in architecture, engineering, and urbanism.

The research in the field of the rehabilitation of buildings and neighbourhoods provides the basis for a better formulation of the sector. Furthermore, it allows the design of short- and long-term strategies and policies for the sustainable development of cities. It is, undoubtedly, a broad subject that covers a multitude of aspects in this new way of addressing construction. In this Special Issue, we are proud to present 36 chapters authored by 91 researchers of various universities and companies in Argentina, Chile, Ecuador, Mexico, Portugal, and Spain. In Spain, several cities participate, including Barcelona, Cartagena, Castellon, Huelva, Madrid, Malaga, Seville, and Zaragoza. These chapters provide an overview of this issue, and delve into the most outstanding topics.

Part I, collects chapters related with Sustainable planning and urban development towards orderly and sustainable city growth. To this end, the development of synergies between sustainability and urban resilience provide the key for the adaptation of cities to future changes. The aim of Chapter “[Model to Integrate Resilience and Sustainability into Urban Planning](#)” is to clarify differences and synergies between these two approaches and to define a theoretical framework for the transition of sustainability and resiliency into urban planning.

Chapter “[An Approach to Daylight Contrast Assessment in Mediterranean Urban Environments](#)” proposes progress in the knowledge of urban daylight. The objective of this chapter is to attain a description of the visual environment in Mediterranean countries, in an urban context, in order to ascertain the range of outside luminance values and the expected contrast indoors.

Today, simulation software presents an important tool for the evaluation of the energy behaviour of buildings. The aim of Chapter “[Analysis of the Influence of Variables Linked to the Building and Its Urban Context on the Passive Energy Performance of Residential Stocks](#)” is, through the use of simulation software, to identify the level of influence in the passive energy performance of a set of covariates, linked to the urban scale and building scale, in an existing neighbourhood in the city of Castellon de la Plana (Valencian Community, Spain). Chapter “[Urban Heat Island and Vulnerable Population. The Case of Madrid](#)”, framed inside the MODIFICA project, titled “predictive model for the energy performance of dwellings under the urban heat-island effect”, contributes towards the continuous improvement of this software, and presents itself as a starting point for the integration of the urban heat island into the energy simulation process. This phenomenon, which increases the temperature in urban areas, is variable in both time and space, and implies a major lack of accuracy when simulating within an urban context.

Contemporary cities have existing buildings and land which are not in use, and these require recycling and refurbishment, both regarding the solution to their construction and the functional program offered to obtain a more sustainable city. Chapter “[Opportunity Detection of Empty Architectonical Lands and Their Recycle for a More Sustainable City](#)” carries out a study of existing tools in the city of Zaragoza, Spain to detect the needs and opportunities regarding the empty architectural voids.

The obsolescence of social housing built between 1950 and 1980 in Spain places these buildings as the principal objectives for regeneration. Chapter “[Typological Analysis of H-Plan Social Housing Blocks Built in Spain Between 1957 and 1981](#)” shows a study on 50 H-shaped blocks built in Spain between 1950 and 1980 as a contribution towards taking a step forward in the understanding of one of the most commonly used typologies in the construction of social housing in Spain.

In some cases, old buildings are protected by ordinances to maintain their historical character. These acts constitute a problem in building eco-efficient and sustainable constructions, since they impose a historic image that is not adapted to society’s current demands. Chapter “[The Arrabal of Alcázar viejo from Cordoba: Urban, Hereditary and Sustainable Regeneration of the Historic City Centre](#)” proposes improvements to obtain sustainable regeneration in the established suburban areas, especially in the field of urban planning applied to the *Arrabal de Alcázar Viejo* of Cordoba, Andalusia, Spain.

Part II, titled *Architecture and Society*, shows the close relationships between people, architecture, and urban areas. In recent years, the relationship between people and urban areas has changed and it has become necessary to reflect on this change. In this way, Chapter “[Heritage and Community Space as Contemporary](#)

[Housing Project Matters. Neighbors Courtyards.](#)” describes an approach to contemporary housing from the various ways of living and the appropriation of space. It allows the redefinition of a sociability that gives meaning to the urban space and favours the contribution of mechanisms that improve the city internally and rehabilitate community life through the revision of neighbours’ courtyards. The aim of Chapter [“The Empathic City. Towards a New Model of Urban Sociability”](#) is the development of an analysis strategy and guideline proposals to incorporate urban empathy into the construction of free space in order to return its character of sociability to public spaces.

Chapter [“Restoration of Pier-Dock of Clevedon. An Example of Involvement of Society in Defense of the Cultural Heritage”](#) states the case of Clevedon dock, in England, where the political decision for its demolition was supplanted by a massive popular response that ultimately forced the structure to remain as part of their heritage.

Part III collects chapters about the Sustainable Renovation of buildings and neighbourhoods. Chapter [“Steps Towards the Integration of Regeneration Processes Obsolete Buildings Envelope Spanish in the Paradigm of Sustainable Development”](#) is a review of the current state of those aspects related to the approach of passive strategies on the energy rehabilitation of buildings in temperate climatic contexts, focusing on countries such as Argentina and Spain. The aim is the development of a model of sustainability assessment of potential regenerative actions on the envelope of types of buildings, in order to determine the suitability of such operations.

Quantitative studies of the improvement obtained in eco-efficient rehabilitations are shown in Chapter [“Energy Retrofitting and Social Housing Instrumentation Attending Passive Criteria. Case Study in Winter”](#) and [“Environmental Assessment and Energy Certification for the Sustainable Restoration of a Traditional Residential Building”](#). In Chapter [“Environmental Assessment and Energy Certification for the Sustainable Restoration of a Traditional Residential Building”](#), a comparative study is carried out between the sustainability and the percentage of improvement in terms of reduction of energy consumption in the case of the refurbishment of a residential building located in the city of Seville. Three states are evaluated: original, refurbishment of strict regulatory compliance, and refurbishment with sustainability criteria. Chapter [“Energy Retrofitting and Social Housing Instrumentation Attending Passive Criteria. Case Study in Winter”](#) proposes the adaptation of the Passivhaus standard for energy rehabilitation in existing buildings, and shows the case study of an envelope retrofit of a dwelling.

Chapter shows the results obtained in the I+D (Re)Programa research project carried out on 11 locations in the cities of Seville, Cordoba, and Jerez de la Frontera, Spain. This Chapter [“\(Re\)Programa. Architectural Rehabilitation Incorporating Sustainability Criteria in an Andalusia Neighborhood”](#) offers a reflection on the response that these residential compounds, built after the 40s, gives to its users, thereby clearly displaying the lack of energy efficiency and accessibility.

Social housing, which, predictably, has a greater risk of fuel poverty, is dealt with in articles 17, 15, and 18. The first article concerns current rental housing, while the other two refer to estates built in the mid-twentieth century.

Chapter “[Social Rent Housing Refurbishment Demonstrator of LIFE Project “New4Old” \(LIFE10 ENV/ES/439\)](#)” presents the experience and the result obtained in the refurbishment of two rental social housing buildings in the city of Zaragoza, and clearly shows that the proposed action improves the passive behaviour of the building and achieves greater thermal comfort and habitability without increasing the economic cost related to energy consumption.

Chapter “[Assessment Method of Urban Intervention in Social Housing Developments: The Rehabilitation of Caño Roto \(Madrid\) Case Study](#)” presents a graphic evaluation that enables the assessment of the quality and sustainability of social housing estates built in Spain following the Spanish War and during the period of Transition, in terms of both the state of the estates and the urban processes focused on their reactivation. To this end, the study of a concluded intervention, that of the Urban Rehabilitation of “Poblado Dirigido de Caño Roto” in Madrid, Spain is taken as a reference.

Article 18 carries out a study of existing mappable indicators for the prioritization of the refurbishment of social housing estates, for the case of Urban States in the city of Zaragoza, Spain. This study provides the available indicators and discusses how to combine these indicators for decision-making purposes.

Chapter “[From Recovery Constructively Towards the Social Reactivation. The Integrated Knowledge of Traditional Architecture as a Sustainable Strategy](#)” of this Part III proposes social reactivation in order to preserve local knowledge for society. In this, challenge is for improvement of the knowledge of small hydraulic constructions, whose remains are in a deteriorated state or largely lost. This involves the enhancement of built heritage, considered here as part of the common heritage of a place that must be protected.

In order to achieve the goal of sustainability, it is necessary to minimize the consumption of natural resources and research on this topic is collected in this way in Part IV. A prominent field in achieving this goal is given by the reuse of construction and demolition waste, and related to this topic, Chapters “[Study of Fine Mortar Powder from Different Waste Sources for Recycled Concrete Production](#),” and “[Concrete Sustainable Light and of High Performance](#)”. The first 21 performs a comparison between different sources of waste mortar, by applying dehydration processes of recycled material, and by obtaining a raw material that allows it to be experimentally observed whether there are significant differences between the source and condition of the recycled material and its relationship with the resistance of the recycled concrete on compression. The study carried out in the following Chapter “[Concrete Sustainable Light and of High Performance](#)” obtains results that allow recycled concrete to be manufactured that is light and of high strength with less clinker and quarry aggregate.

Natural fibres are regenerable materials that enable reduction of the extraction and use of conventional materials. Chapter “[Assessment of the Relationship Between Diameter and Tensile Strength of Piassaba \(*Aphandra natalia*\) Fibers](#)” presents the assessment of the relationship between diameter and tensile strength of one of the species of palm, which is considered one of the most economically important plant groups.

The management of water resources is dealt with in Chapter “[Selection of Criteria for the Systematization of Technologies for a Sustainable Urban Water Cycle Management](#)” of this part, whereby systematization of the information presently available is carried out, for the implementation of hydro-efficient strategies and technologies

Part V, titled *Sustainable Engineering*, collects chapters on the optimization and eco-efficient improvement of the facilities, structures, systems, and industrial processes that are part of contemporary construction. Chapter “[Structural Refurbishment Projects. The Sustainability of Reinforcements Using Composite Materials.](#)” of this part studies the efficiency and environmental impacts of the structural refurbishment and reinforcement using composite materials, and states that reinforcement work using polymer reinforced with carbon fibre is of high efficiency. The objective of Chapter “[NESS[®], an Alternative System to Double Strand of Hot Water that Saves Water and Energy](#)” is to establish the main differences between two water-saving systems: the double stream of hot water; and an alternative system called NESS. The results show that this alternative system is able to generate significant energy savings.

Ephemeral architecture is addressed in Chapter “[Rethinking Ephemeral Architecture. Advanced Geometry for Citizen-Managed Spaces](#)”, whose aim is to lay the foundations to produce low-impact architecture, produced by digital processes, with low environmental impact and an innovative production cycle that minimizes assembly costs, thus rendering it more affordable.

Chapter “[Project AURA: Sustainable Social Housing](#)” presents the Aura Project, an award-winner of the XIII Biennial of Spanish Architecture, which is focused on very specific conditions: the tropical climate and problems of social housing and urban growth in the city of Cali, Colombia. The project is as a declaration of principles and intentions, leading to the implementation of social housing in a tropical climate, under the premise of the extrapolation of the results from the rest of Latin and trans-Mediterranean culture.

Certain mining cities in Mexico have expanded their territory in such a way that human settlements have been formed in places contaminated by deposits of mining waste. This causes open spaces, destined as green areas, to fail in their development of vegetation due to changes in the physical and chemical parameters of the soil. Chapter “[Vegetation as a Design Element to Recover Green Areas in Settlements Developed on Contaminated Soils](#)” presents a factorial experiment on the growth of seven plants that can be used for the design of such green areas.

Part VI, titled *Energy Efficiency*, collects chapters on research that can contribute towards the efficiency of energy consumption. Chapters “[Update of the Urban Heat Island of Madrid and Its Influence on the Building’s Energy Simulation](#)” and “[Urban Heat Island of Madrid and Its Influence over Urban Thermal Comfort](#)” present studies funded by the aforementioned research project: the MODIFICA project. The first article 28 establishes the geospatial connection between the urban heat island and the most vulnerable population living in the city of Madrid. The study is aimed at understanding the influence of the urban heat island over this most vulnerable population. The aim of Chapter “[Urban Heat Island of Madrid and Its](#)

Influence over Urban Thermal Comfort” is to show the influence of heat island and the conformation of the urban fabric in the urban climate in order to identify the zones in which the worst conditions are produced, with the objective of improving comfort in public spaces.

Studies on buildings for tertiary use, such as hospitals, schools, and office buildings, are presented in Chapters **“Method for the Implementation Of Active Solar Systems in Hospitals, in the Hospitalization Unit of the Hospital Clínico del Sur, Concepción, Chile”**, **“Validation of a Dynamic Simulation of a Classroom HVAC System by Comparison with a Real Model”**, **“Study on Envelope in Office Buildings Under the Influence of Climate Change in Santiago, Chile”**, and **“Methodology for the Optimisation of Thermal Performance and Daylight Access to the Retrofit of Hospital Rooms in Mediterranean Climate”**. One of these articles 33 presents a study that includes both simulation and monitoring, performed in a hospital in Seville, Spain, to improve indoor thermal comfort and to reduce energy consumption of the hospital wards in the Mediterranean area, associated to the influence of the size and thermal properties of windows. Chapter **“Method for the Implementation of Active Solar Systems in Hospitals, in the Hospitalization Unit of the Hospital Clínico Del Sur, Concepción, Chile”** reviews current procedures for the installation of solar equipment in a hospital, in order to present a comprehensive methodology in the case of a hospitalization unit of a hospital in the city of Concepcion, Chile. Chapter **“Validation of a Dynamic Simulation of a Classroom HVAC System by Comparison with a Real Model”** defines and develops the validation process of a thermal dynamic simulation tool by means of comparison with a real enclosure, in medium-sized rooms with high internal loads. The study is carried out in a standard classroom of a school in the city of Lisbon, Portugal. The effect of the percentage and orientation of windows on the energy demand of office buildings is studied in Chapter **“Study on Envelope in Office Buildings Under the Influence of Climate Change in Santiago, Chile”**. The research is focused on the effect of these variables on the energy demand of office buildings located in Chile.

The envelope is the most important part of buildings in terms of energy efficiency. Chapter **“Thermal Energy Refurbishment of Envelope in Mass Neighbourhood Housing, Located in Semi-arid Climate of Argentina”** presents technological variants to improve the thermal energy behaviour of the envelope in the case of a representative building in Argentina and the performance of each variant is evaluated, associated with its lifetime cost. Chapter **“Threshold Values for Energy Loss in Building Façades Using Infrared Thermography”** proposes a new methodology for the detection of the most significant sectors in energy transmission through the envelope of a building by means of infrared thermography. The main goal of this research work is to select building elements or zones of a thermal envelope according to their energy losses in order to avoid indiscriminate intervention on the opaque parts of envelopes. Chapter **“Assessment of the Energy Efficiency of a “Cool Roof” for Passive Cooling. Comparative Study of a Case of Tropical Climate and a Case of Southern Spanish Climate”** presents a study to determine, under tropical climate conditions, the energy efficiency of the ventilated

façades that have proven their success in terms of passive cooling in those latitudes, and compares the results with those obtained for a typical climate in southern Spain.

In closing, on behalf of the Journal, we would like to express our sincere gratitude to all the authors of the chapters and to the reviewers for their systematic and innovative work.

Seville, Spain

Pilar Mercader-Moyano

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