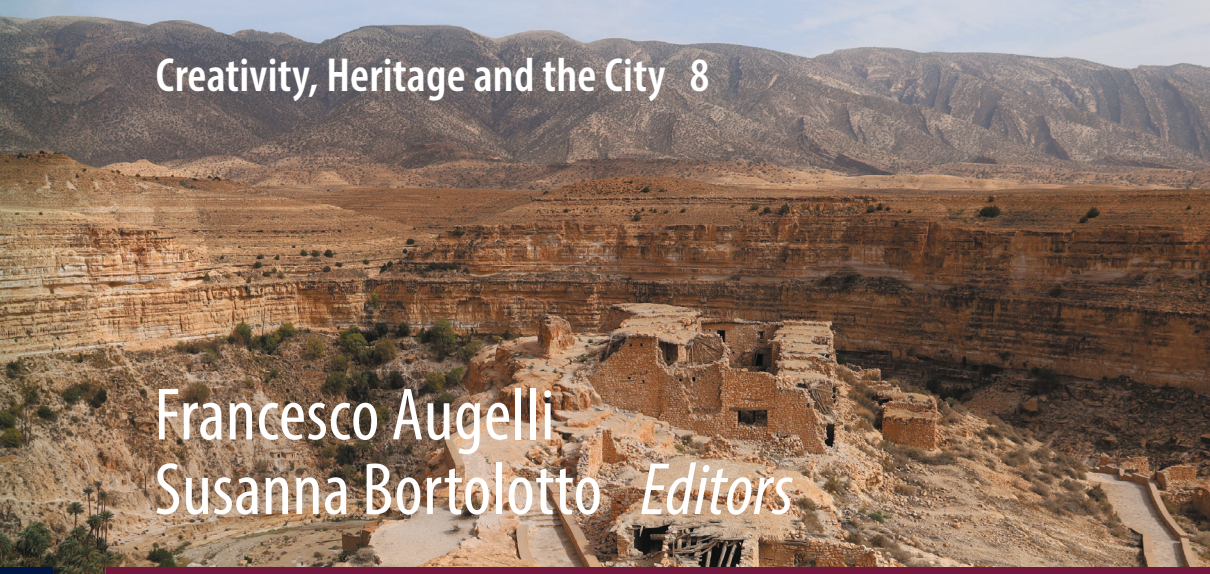
Creativity, Heritage and the City 8



Francesco Augelli
Susanna Bortolotto *Editors*

Cultural Heritage Preservation for Vulnerable Territories

The Aurès Region in Algeria

Springer

Creativity, Heritage and the City

Volume 8

Cities are faced with various problems, including terrorism, energy challenges, and environmental issues, as well as inter-urban competition brought about by expanding globalization forces. What is required is to gather theoretical insights from various scientific areas, not only social science– humanities but also natural science, and connect them to the practical insights already gained through numerous efforts to deal with these issues on the ground. In this way, paradigms for urban creativity can be developed and we can start to accrue dependable practice and theoretically based intelligence that can be used for improved policymaking. The keywords for this book series are "urban creativity", "(cultural) heritage", and "social development". Developing cultural and natural resources, including heritage, so as to take the lead in evaluating, implementing, and suggesting urban or regional designs that harmonize ecology, society, and people, and to further develop urban and regional culture is essential. There is a particular focus in this book series on fostering individuals who can design, manage, and direct models, technologies, and tools for promoting interfaces between such actors as policymakers, urban planners, engineers, and residents. The above-stated goals can be implemented through cooperation with international research communities and networks, international organizations, and natural history institutions, academies of science, and research institutes.

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Editors

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Preface

There are many contributions hosted in this book. Writings that collect the experiences of the interdisciplinary and international scope of research in Italy, abroad and mainly Algeria in the Heritage field. This publication intends to give due prominence to places and cultures that can add a piece to advancing studies in the sector and to a modern key in understanding and respect between different cultures. The central topic was the way of responding to territorial fragility in multiple directions—a theme in which the Department of Architecture and Urban Studies, Politecnico di Milano, is considered by our Ministry of University and Research (MIUR) as an excellence—marked by strong orientations with operational practices, with a strong international openness and with a place-based and social impact approach.

The research groups thus measured themselves against the now inescapable aspects of fragility at the centre of the debate on conserving cultural, architectural and landscape heritage.

The common thread between the various papers, which are presented here, therefore, runs through three main thematic parts:

- Part I—*Introduction*: research and training from 2017 to today between the Politecnico di Milano and Algerian universities. This part also contains a theoretical historical contribution about the fragility of material culture and of diffused cultural heritage in Italy and abroad, and a contribution about how traditional agricultural practices have long shaped the Italian landscape, creating distinctive rural features like terraces and irrigation systems. These elements now face challenges of abandonment but remain vital cultural and environmental assets.
- Part II—*Vulnerable Vernacular Territories Experience*: international scope thanks to contributions of experiences in Italy and abroad (Armenia, Colombia, Saudi Arabia, Eritrea).
- Part III—*The Case Study of Aurès Valley (Algeria)—The Territory*: the fragility of the situations faced on the territorial scale of Aurès, a massif that is part of the Atlas Mountains in eastern Algeria, formed by parallel mountain ranges separated by deep valleys furrowed by torrential rivers.

- Part IV—*The Case Study of Aurès Valley (Algeria)—The Architecture*: interdisciplinary expertise at the architectural scale of Aurès, a region inhabited by populations mainly of Berber origin.

The critical issues, the peculiarities, the integrated methodological approach between multiple disciplines, and the future potential have been highlighted for the case studies considered.

What emerges is a framework of skills and "best practices" adopted in terms of the management of processes that concern the area of knowledge and conservation of architectural artefacts, historical buildings, their contexts and the landscape, inevitably encountering also the delicate "geo-political" aspects that characterise the relationships of missions and research with the sites where they operate.

An attempt has also been made to bring together multiple "worlds", building a common language, sharing the lines of research that are being pursued, identifying possible collaborations, defining common projects, and making known to the public probable future users (local stakeholders), the results achieved and their potential both for development in studies and their applications to concrete cases of intervention.

To promote these "positive forces" an attempt has been made to focus on the value of interdisciplinary skills capable of deepening, across the board, knowledge of places and acting as attractors for constructive cooperation initiatives.

Operational practices aimed at conservation, valorisation and management, the rigour of responsible interventions, non-destructive or minimally invasive diagnostics, and finally, new innovative technologies on a small and large scale can—together with an ethical assumption that stems from the individual and collective responsibility to conserve the heritage of the past—preserve the historical integrity and allow the architectural, landscape and environmental heritage to last over time.

The special nature of this heritage and its unique, unrepeatable and fragile character must place us in a position to have a moral obligation to hand it down to present and future generations and to make professionals, citizens and the political world aware of its genesis, its history, its vulnerability and its protection.

Milan, Italy

Francesco Augelli
Susanna Bortolotto

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The book is the result of great teamwork, whose success has been possible thanks to the enthusiasm and collaboration of Algerian and Italian colleagues over the course of ten years. In this regard, in addition to all the authors of the essays in this book, for the realization of the bilateral research and training between the Politecnico di Milano and the three Algerian universities of Annaba, Biskra and Khenchela, we thank all the colleagues, professors of these universities and in particular:

- Badji Mokhtar University of Annaba: M. Manaa (Rector), H. Maoui (Vice Rector of External Relations) R. Attoui, A. Bordjiba, M. Abdeldjaouad, A. Nahel (Surface Engineering Laboratory) and their students C. Bouzbid, N. F. Z. Hoggas, H. Bedjaoui, I. Hammadi, Y. Chettibi, L. Ramdan, H. Manaa, N. E. Ouhib, W. Bennai;
- Mohamed Khider University of Biskra: A. Boutarfaia (Ex-Rector), M. Debabeche (Rector pro-tempore), M. Moummi (Erasmus+ Officer), H. Ghodbane (Faculty of Sciences and Technology Dean; N. Belghar (Energy and Materials Engineering Laboratory and Environmental Materials Laboratory, Chemical Methods and Sustainable Development), B. Guerira (Department of Mechanical Engineering Director), N. Zemmouri (Laboratory of Design and Modeling of Architectural and Urbain Forms), S. Guergazi (Laboratory for Subterranean and Surface Hydraulics Research); M. Benabbas (Laboratory of Design and Modeling of Architectural and Urban Forms Director), and Ph.D. students: M. A. Kethiri, O. Guergueb, M. Ghennai, R. Mokrane, C. Beldjani, Y. Boutera;
- Abbes Laghrour University of Khenchela: A. Chala (Rector), M. Iken (Secretary General), S. Merdaci (Deputy Secretary General), W. Kefali (Head of Intensive Languages Teaching Center), M. Falek (Dean of the Faculty of Natural and Life Sciences).

We thank for being at our side in the diplomatic relations between the two countries and in facilitating all the formalities of entry visas:

- Algerian Ministry of Foreign Affairs: Algerian Embassy in Rome H.E. Ambassador A. Touharia, H.E. Ambassador M. Khelifi; Consulate in Milan: H.E. Consul A. Talbi, H.E. Vice Consul H. Sloughi;
- Italian Ministry of Foreign Affairs and International Cooperation: Italian Embassy in Algiers: H.E. Ambassador G. Pugliese, H.E. Ambassador A. Cutillo; the Director of the Italian Cultural Institute of Algiers A. Grande;

We want to remember the Mayor K. Arab and the community of M'Chouneche for his warm welcome.

And finally, we acknowledge the funding received by Politecnico di Milano under the Polisocial Award 2022, the Team IRS Polisocial Award; the International Mobility Unit (Erasmus office) of Politecnico di Milano; the Directors of the Department of Architecture and Urban Studies M. Bricocoli, the Department Civil and Environmental Engineering A. Frangi, and from the administrative office L. Castiglioni, L. Ruggiero, and E. Zonca who facilitated and supported the development of scientific research with a high social impact and mobility. And last but not list we express gratitude to I. Valente (Vice-Rector for International Relations), E. Colombo (Science Diplomacy Delegate), and N. Aste (International Relations with Africa) of the Politecnico di Milano.

Contents

Part I
Introduction

Chapter 1
The Vulnerable Cultural and Natural Heritage of Aurès Region in Algeria. Research, Teaching Collaborations and Experiences 2017–2024 Between Politecnico di Milano and Algerian Universities

Susanna Bortolotto and Francesco Augelli

Abstract This publication presents the outcomes of nearly a decade of academic cooperation (2017–2024) between the Politecnico di Milano and several Algerian universities, focusing on the vulnerable cultural and natural heritage of the Aurès region in eastern Algeria. The collaboration, initiated through agreements and supported by programmes such as Erasmus+ and MAECI, has enabled joint research, field missions, student and staff exchanges, and training activities. Central to these efforts is the preservation and valorisation of vernacular architecture and cultural landscapes, particularly in sites such as Ghoufi and M'Chouneche. Through interdisciplinary and community-engaged methodologies, projects like the AMAZING initiative have addressed global challenges such as desertification, abandonment, and loss of traditional knowledge. The work exemplifies how scientific cooperation and local engagement can foster sustainable development and cultural diplomacy in fragile contexts.

Keywords Aurès region · Cultural heritage preservation · International academic cooperation · Vernacular architecture · Community engagement conservation · Vulnerability · Cultural diversity

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Since 2015, the Politecnico di Milano (PoliMi) has started a series of academic collaborations with several Algerian universities. These agreements foster cooperation between Italian and Algerian institutions to conserve cultural heritage. But only in 2017 started the occasion to collaborate on Algeria's cultural heritage, historical architecture, and landscape due to the Algerian active colleague Redha Attoui, who was formed in Italy in Architectural Preservation and a restoration professor of the Department of Architecture, Surface Engineering Laboratory, Badji Mokhtar University of Annaba.

Redha Attoui is a well-known expert in the history and preservation of Algeria's historical architecture, mainly of the archaeological sites where he has initiated research with study, survey, conservation, protection, and enhancement. Thanks to Attoui, we met professors and researchers on that occasion and lectured the Algerian students. The initial missions also included visits to Annaba, Algier, and Ghoufi.

After that, the rectors Politecnico di Milano and the University of Annaba signed an Agreement with the Joint Management Committee for collaborations in teaching (from bachelor students to Ph.D.), professors exchange mobility, workshops and training activities and research and consultancies in the restoration work sites. This agreement has been renewed and is still active today. Finally, Attoui suggested we concentrate on the research and teaching activities in the Aurès Valley, a historic site with abandoned vernacular buildings, oases, and an amazing landscape characterised by the canyons. Since 2002 "Parc des Aurès avec les établissements oasiens des gorges du Rhoufi et d'El Kantara" are on the tentative list of Human World Heritage sites, of UNESCO (UNESCO 2002).

The Aurès, meaning "Mountains of Awras", is a mountain range in the eastern part of Algeria. Its name has remained almost unchanged since ancient times, as the Romans called *Regnum Aurasius*.

The Aurès form the eastern part of the Pre-Saharan Atlas, with its highest peak, Djebel Chelia (Mount Chelia), reaching 2328 m. The massif's terrain offers few north-to-south routes, but there is a synclinal depression through which the Souf Amellal flows, partially crossing the region from northeast to southwest. The region is home to Berbers who speak Tashawit. The Aurès region encompasses the *wilayas*, which refers to administrative divisions or provinces. Each wilaya is governed by a *wali* (a provincial governor), representing a geographical area with political, economic, and administrative functions. It's similar to "province" in other countries. In the Aurès valley, the *wilayas* are Batna, Khenchela, Oum el-Bouaghi, Souk Ahras, Tebessa, and the northern part of Biskra. However, the Tashawit-speaking area extends further, including the southern part of the wilaya of Guelma (Falck 1930; Keun 1930; Lebbal 1989; Fallot 1899) (Figs. 1.1 and 1.2).

The Kingdom of the Aurès was a Christian Berber kingdom in ancient times. It was founded in 480 AD by King Masties following Berber revolts against the Vandal Kingdom, which had conquered Roman Africa in 435. The kingdom remained independent until 703, when the Umayyads conquered North Africa, and the last ruler, Queen Kahina, was killed in battle.

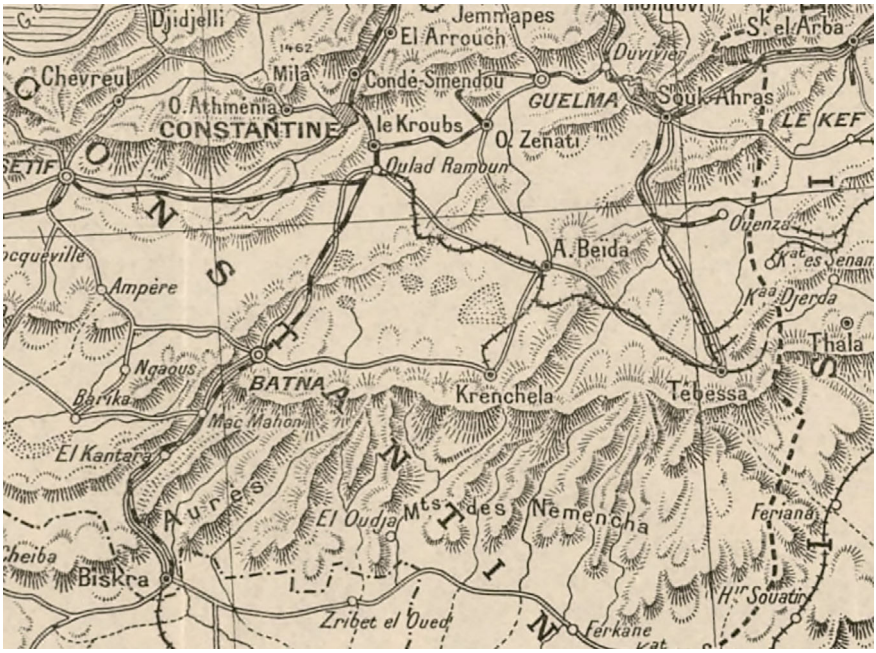

Fig. 1.1 The *wilayas* in the Aurès valley (Falck 1930)

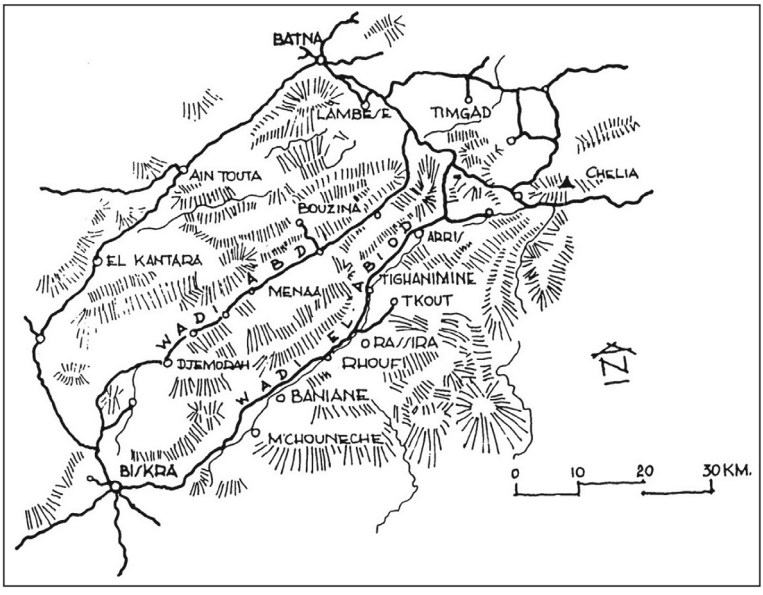

Fig. 1.2 The map of Aurès (Lebbal 1989)

As mentioned, in 2015, the first agreement, "Memorandum of Understanding" (MoU), was signed between Politecnico di Milano and the University Badji Mokhtar de Annaba, Algeria, with a term until 2025.

Since 2017, the research project "The recovery of the *genius loci* of the Ghoufi (Rhoufi) site Aurès Valley, wilaya of Batna in Algeria" has been directed by Bortolotto. This project, supported by the Ministry of Foreign Affairs and International Cooperation (MAECI, DGSP VI—Archaeological, anthropological and ethnological missions), focuses on collecting and analysing archival documentation relating to the Aurès Valley and the sites of Ghoufi and M'Chouneche (Fig. 1.3).

The objective is to support a project for the protection, restoration, reuse and valorisation of the historical and cultural heritage of the region. The Ghoufi Project, supported by MAECI, has included several field missions in Algeria. The first mission occurred in December 2017, with training on desks in Annaba and Biskra universities and research activities in Ghoufi.

The subsequent missions occurred in September and October 2018, December 2019, and June and October 2022. During these missions, Bortolotto and Augelli collaborated with Algerian universities for workshops and on-site research activities. 2018 another agreement was established with the University Mohamed Khider of Biskra, valid until 2028.

The first opportunity to present the research work and scientific edition of the data on Ghoufi was in the communication during the conference organised by the Politecnico di Milano entitled: "International Milan: The Territorial Fragility of Archaeological Contexts", held on 13 March 2019 at Palazzo Greppi, Sala Napoleonica in Milan. The conference—presenting international experiences in archaeology and restoration—drew attention to the value of "expertise" and the ability to work with an interdisciplinary method, impacting contemporary national and international cultural policy. In addition to this, of interest for today's debate, the criticality of archaeological contexts was highlighted and how the multidisciplinary approach—which aims to conserve and respect "fragile" resources—is a valid tool for a targeted reading, capable of understanding and managing the complexity inherent in cultural landscapes and reading the relationships with the context, identifying risk and potential factors connected to the use of the territory for a conscious intervention strategy (Bagnasco Gianni et al. 2020) (Fig. 1.4).

In the same year, one of the most significant workshops was organised in December at the University Mohamed Khider in Biskra on the international conference "Rediscovering Sustainability: Architecture Heritage in the Aurès Area".

The collaboration between Politecnico di Milano and Algerian universities has been further strengthened through the Erasmus + programmes. From 2019 to 2022, the "Erasmus + KA107 project" funded students and faculty mobility of professors and staff between Politecnico di Milano and the Mohamed Khider University in Biskra, with Bortolotto and Augelli as referrers.

Fig. 1.3 Ghoufi (Rhoufi), Abiod Valley in the Aurès region (Authors photos)

In December 2020, due to the Covid-19 situation during the activities of Erasmus+, an online Conference with Biskra and Annaba University was organised by Politecnico di Milano and attended by many scholars and students, with the title: "Architectural and Landscape Cultural Heritage. Knowledge, Research, Preservation and Reuse in the fragile vernacular territories" (Fig. 1.5).

In this book, several papers by speakers who had participated in the conference were selected because they were relevant regarding methodological issues, similar problems, and/or related areas.

Fig. 1.4 The flyer of the conference "International Milan: The Territorial Fragility of Archaeological Contexts", March 2019

Fig. 1.5 The flyer of the Webinar "Architectural and Landscape Cultural Heritage. Knowledge, Research, Preservation and Reuse in the fragile vernacular territories", December 2020

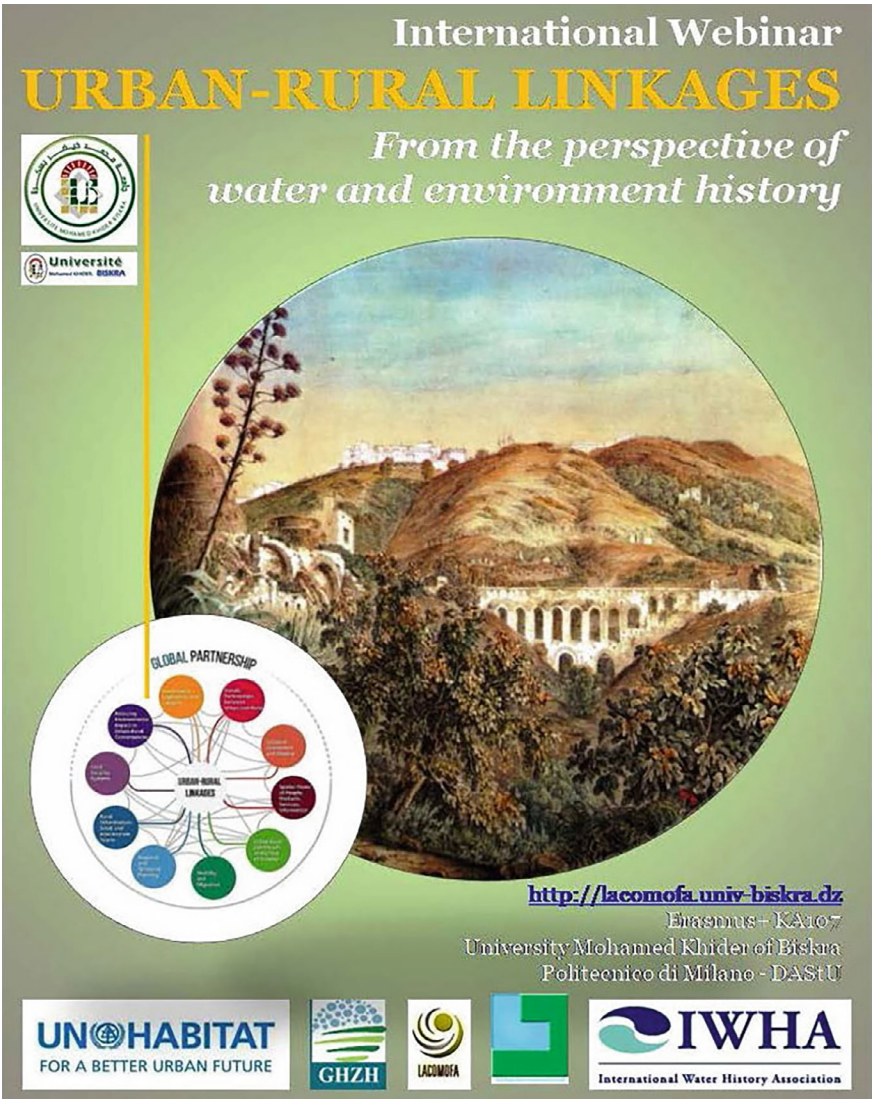

Fig. 1.6 The poster of the International Webinar "Urban–rural Linkages. From the perspective of water and environmental history", May 2021

The following year, in May 2021, the International Webinar "Urban–rural Linkages. From the perspective of water and environmental history", organised by the LaCoMoFa Laboratory Department of Architecture, Biskra University in collaboration with Habitat, Water History Association, Groupe d'Histoire des Zones Humides, Larhyss International Journal (Fig. 1.6).

In June 2022, during the mission in Algeria, the international conference "Cultural Heritage Diagnostics, Preservation, Consolidation and Reuse" was organised at the University of Biskra (Fig. 1.7) and in November was accomplished a workshop focused on the rehabilitation operation of Si el Haoues Museum of M'Chouneche. This workshop is organised in partnership with the Politecnico di Milano (Italy), LaCoMoFa Architecture Laboratory (University of Biskra), the Architecture Department of the University of Biskra, LGM Mechanics Laboratory (University of Biskra), EM Mechanics Laboratory (University of Biskra) and the Architecture Department of the University of Annaba.

In November 2022, thanks to previous activities, in particular with the workshop held in M'Chouneche (Fig. 1.8), the Italian and Algerian research group the project "AMAZING—Atlas Mountains, Aurès Zone: INterconnecting local sciences and Global challenges" won the Polisocial Award (Polisocial website) 2022, aims to analyse the global challenges of abandonment, desertification and loss of traditional knowledge in the Abiod Valley, Algeria. The project, coordinated by Porta as a Scientific Referent and Bortolotto as Project Manager, aims to recover the economic and social identity of the territory through an interdisciplinary approach and the combination of local sciences and polytechnical knowledge (AMAZING website).

This collaboration between bilateral projects saw a new phase, with the cooperation between Politecnico di Milano, MAECI, and Algerian universities. Training activities and workshops were held at the Université Mohamed Khider in Biskra and the Abiod Valley between June and November 2023. The missions focused on archaeological surveys and the preservation of cultural heritage.

As part of the AMAZING project, three participatory sharing events have been planned corresponding to the moments in which the AMAZING partner universities meet the local community to collaborate in achieving the project objectives on the conservation and reuse of the building annexed to the House Museum of Colonel Si el Haoues, a well-known partisan who dedicated his life to the fight for freedom.

The study and research approach of the historical buildings of M'Chouneche, the Abiod Valley and the Aurès Park – evaluating the critical aspects and potential in the best possible way—focused on some specific themes in the workshops, namely: in June 2023 "Sharing places/sharing stories" (collection of local knowledge, stories and narratives of the territory under study); in November 2023 "Restoring houses/living stories" (enhancing vernacular architecture and combining it with contemporary housing needs). The project's final meeting finally focused on the "Sharing knowledge" workshop about how to allow future generations to gain experience and draw lessons from the traditional cultural landscape. Specifically, while the June mission took place with a workshop with the citizens of M'Chouneche aimed at creating a community map (Fig. 1.9), in the November mission, the community was once again involved with an invitation to participate in a survey by responding to a questionnaire "Sociological Survey - Museum Annex Si el Haoues, M'Chouneche" specially prepared by researchers from the Badji Mokhtar of Annaba University, to evaluate awareness/knowledge of the value of artefact and to express indications/preferences on its future intended use. Furthermore, an on-site exhibition was set up to raise awareness among the population on the issues addressed by the AMAZING project,

Fig. 1.7 June 2022. Poster of the international conference "Cultural Heritage Diagnostics, Preservation, Consolidation and Reuse"

Fig. 1.8 Workshop in M'Chouneche, November 2022

Fig. 1.9 The workshop with the local community in M'Chouneche, June 2023 (Authors photos)

Fig. 1.10 The participation of the local community of M'Chouneche in the Exhibition of the AMAZING project and in the survey concerning the future of the building annexed to the Museum, now abandoned, November 2023 (Authors photo)

in which the citizens could actively participate by expressing their considerations on specially dedicated posters (Fig. 1.10). Training activities aimed at students and doctoral candidates were also conducted on the building identified as a construction site/school.

The AMAZING project ended in 2024 with a last International Conference in Khenchela organised by the Politecnico di Milano and the three Algerian Universities in agreement (Fig. 1.11).

A second Erasmus+ project, KA171, with Biskra University, started in November 2023 and will end in 2026. Again, the primary referrals are Bortolotto and Porta. Both projects aim to promote academic mobility and international training between

Fig. 1.11 Poster of the last International Conference in Khenchela with the Politecnico di Milano and three Algerian Universities in agreement. October 2024

Italy and Algeria. In December 2023, they signed with Abbes Laghrour University in Khenchela and will be valid until 2028.

Over the years, Bortolotto has been invited to numerous conferences and cultural events in Algeria and other countries organised by the Italian Ministry of Foreign Affairs (MAECI), the Embassy of Italy in Algeria and the Italian Cultural Institute of Algiers. Her participation in the MAECI "IAM 2. Italian Archaeology in Egypt and MENA Countries" conference in Cairo in December 2018 highlighted the international dimension of work. On this occasion, he presented the Ghoufi project as a case study of archaeology for recovering local heritage. Also in 2018, she contributed to the archaeological exhibition "IAM 2", with a poster on the Ghoufi project exhibited at the Italian Institute of Culture in Cairo. Among the most significant are the "Heritage Day" in Algiers in 2018, where she presented the project to recover the *genius loci* of the site of Ghoufi and the webinar "Archaeology of Algeria" of 2021, but also the conference "Les missions archéologiques italiennes en Algérie" in Algiers, with an intervention on the recovery of the Berber sites of Aurès area: site of Ghoufi and M'Chouneche, with Porta participate in 2024. Lastly, in May 2023, Bortolotto participated in the first edition of the Italian Archaeology Abroad Days, organised by MAECI in Rome, presenting the Ghoufi project again.

In addition to research and international cooperation activities, S. Bortolotto has supervised several theses. In 2021, she was the lecturer of a first-level thesis on "Agadir: the granaries of Morocco", while in 2022, she supervised, together with Augelli, a Politecnico di Milano master thesis entitled "The Canyon of Ghoufi, Aurès, Algeria".

Finally, this book permits everyone to explore almost 10 years of collaborations, research, workshops, training and teaching activities in the amazing Country of Algeria.

The collaboration between Politecnico di Milano and Algerian universities, started in 2015, is an example of successful international academic cooperation and a good result of cultural diplomacy. Through a series of projects and field missions, Politecnico di Milano has contributed to enhancing Algerian cultural heritage, particularly in the Aurès region, demonstrating how the synergy between scientific research and local knowledge can be a powerful tool for sustainable development. The numerous conferences, workshops, mobility (professors, staff and students) and publications highlight the importance of these projects in the international landscape of archaeology and cultural heritage conservation (Fig. 1.12).

Fig. 23.9 Particular saprophyte fungi attack, well visible through cubic or brown rot (author's photo)

and big Coleopters like the Hesperophanes holosericeus (Fig. 23.10). Observed saprophyte attacks by fungi and insects in the same element (Fig. 23.11).

It is also impossible to exclude the presence and damage provoked by termites (Fig. 23.12).

However, research regarding the saprophyte attacks is lacking, and proper scientific research should be necessary and urgent.

Fig. 23.10 Particular saprophyte insect attack, visible through big exit holes on the surface (author's photo)

Fig. 23.11 Particular saprophyte insect attack along the core of the beam, well visible through small exit holes on the surface. Probably, the insect attack also occurs with fungi attack (author's photo)

Fig. 23.12 Particular termites attack along the core of the beam, well visible through the condition inside the canals and by typical tunnels around the deeply damaged part. The particular termites' typical tunnels on a date palm beam are visible on the right (author's photos)

The lack of yearly maintenance intervention at the flat roof level provoked collapses of wood flooring systems after years and the lack of containment of horizontal elements for the masonries. And with it, the progressive collapsing of walls. Even in this severe condition, wooden elements seem more resilient than stone elements (Fig. 23.13).

Fig. 23.13 Even in severe conditions, wooden elements seem more resilient than stone elements in a lack of maintenance intervention (author's photo)

23.5 Research Activity Proposals

Due to insufficient information about the anatomy, physiology, chemistry, and mechanical behaviour of date palm wood, research in different fields and multidisciplinary methods, following the existing standards, is necessary. The University of Biskra "Mohammad Khilder" already has skills, a research laboratory, and testing equipment. Knowledge of Biskra Agriculture and Forestry University is also necessary for deep research.

The research should be diided into two main different steps. First, the research should start in the chemistry laboratory, achieving more precise data about cellulose, hemicellulose, lignin content and quantity of extractives, mainly about the toxic ones (i.e., tannins or others). Another valuable research could be conducted with the entomologists and biologists about the Algerian wood saprophytes (fungi and insects). Then, achieving many new and old beams from wrecks in the mechanical characterisation laboratory should be carried out loading test, following the standardised rules, in the dry lumber dimensions (3 m and more) and necessary to achieve enough comparable mechanical behaviour data, at the same humidity condition (equilibrium moisture of 12%). New and old dismantled beams could be subjected to computed axial tomography (TAC) to obtain helpful information to compare.

Loading tests must be conducted using progressive loading and unloading cycles, recording the behaviour of every beam in the field of elasticity without arriving at the breaking point. Before the loading test, all the beams must be inspected for dimensions, characteristics, alterations, and deterioration conditions. For the density of wood, it is necessary also to carry out transversal drilling tests in at least three positions: top, middle, and base of the beams. After obtaining this data, it will be possible to conduct tests directly on-site following the standardised survey methodology for

historical wooden structural elements and, after that, measure the environmental temperature, relative humidity, and the media moisture of wood using the electric method. The in situ instrumental tests will conclude with the drilling test to assess the condition inside the section and the inserted parts of the beams to the walls, evaluating the wood density. In-site loading tests will be desirable to conclude the research by obtaining valuable information about the reliability of date palm beams for the new buildings.

The main results and returns of this comprehensive research will be:

1. Obtain enough data on the behaviour of date palm beams.
2. Obtain first data about defects and deterioration problems of date palm trees in historic buildings.
3. Preserve the old beams in the historic buildings through a proper diagnostic and using the scientific data obtained during the research.
4. Avoid unnecessary replacements of authentic timber elements in the historical buildings.
5. Promote the proper use of date palm beams in the new sustainable construction.

23.6 Conclusion

The research demonstrated insufficient knowledge about the characteristics of date palm stems. On the contrary, papers and books about cultivation and using date palm waste for producing panels or mortar additives are already rich in research and experience. The research in the field of date palm timbers seems insufficient; the aim is not clear enough, the experiences and tests are carried out on specimens, and the results of specimens are different from the results of the tests in the beam dimension. Tests frequently do not use standardised methodology, and results are very little compared and commented on.

A more profound knowledge of "the state of the art" is necessary, and new rigorous tests should be performed widely, comparing numerous elements and final data. The writer has forty years of experience in the field of dicotyledons, and what has been summarised about defects and deterioration of date palm wood, consider the dicotyledons and not the monocotyledons. Regarding deterioration, papers and books are available about the trees and the parasites and not on the material used by the trees, which means there is a lack of research about the saprophytic organism's attack.

For this reason, a more specific survey on site should be carried out, recorded, and scientifically described after the laboratory exams.