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# Les techniques constructives des sites archéologiques dans le cadre du PPMVSA. Cas de Cherchell , Tamenfoust et Choba

Amina ABDESSEMED FOUFA*[1],

[1]University Blida 1, Department of Built Cultural Heritage, Algeria, aafoufa@univ-blida.dz

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Abstract

In Algeria, numerous archaeological sites are in a state of deterioration or have suffered numerous damage. Several factors contribute to this degradation, including the age of the remains, inadequate maintenance, natural hazards such as earthquakes, landslides, and floods, as well as, in some cases, abandonment. Since 2003, Law No. 98-04 on the protection of cultural heritage and its implementing regulations have been enforced. Article 30 of this law establishes the Protection and Enhancement Plan for Archaeological Sites and their Protection Zones (PPMVSA). The first protection plan implemented in Algeria concerned the archaeological site of Tipasa, a UNESCO World Heritage Site. Subsequently, several PPMVSAs were developed and applied in various regions across the territory. This paper presents the methodology adopted in the elaboration of the PPMVSA, with particular emphasis on identifying the construction materials and constructive typologies that characterize the archaeological resources. Three archaeological sites are examined in order to assess their significance and to diagnose the current state of preservation of their archaeological heritage. The first site is Cherchell, the second site is Tamentfoust, and the third site is Choba. The various actions undertaken, including emergency interventions, proposed protection measures, and enhancement strategies aimed at highlighting and preserving these archaeological remains, are discussed in detail in this paper. The projects developed by several institutions, have addressed all archaeological sites concerned.

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## 1. Introduction

Le plan permanent de protection et de mise en valeur des sites archéologiques (PPSMVSA) de Cherchell, Tamenfoust et Choba ont été élaborés respectivement par le CNERU d'Alger, le BET BETIB d'Alger et le BET CNT de Djelfa avec notre collaboration en tant qu'architecte agrée par le ministère de la culture entre les années 2010 et 2014. La démarche adoptée pour l'élaboration de ces plans a été effectuée conformément aux textes de loi régissant ces études [1]. C'est-à-dire un rapport de présentation mettant en relief l'état actuel des valeurs archéologiques, les références au plan directeur d'aménagement et d'urbanisme (PDAU), un règlement qui fixe les règles d'utilisation des sols ainsi que les servitudes mais aussi les opération de protection envisagées et enfin les documents graphiques qui comportent non seulement le diagnostic et les mesures d'urgence, mais aussi tous les relevés archéologiques et topographiques effectués sur les sites, l'avant projet du PPMVSA contenant les différents axes de développement et enfin le rapport final qui synthétise l'ensemble de l'étude.

Du point de vue scientifique, l'approche adoptée à été particulière du fait que Cherchell était capitale de la civilisation romaine *Césarée de Mauritanie* fondé en 25 av J-C qui ne nous a hélas légué que quelques vestiges ; non des moins importants tels que les thermes de l'ouest, le théâtre, le forum à travers son territoire. Le reste est enfui sous la ville médiévale et les extensions de la ville. Ces vestiges sont parsemés sur 230,13 ha que couvre le périmètre de protection. Cherchell est d'une part une ville connue pour sa richesse patrimoniale non seulement archéologique, mais aussi architecturale et paysagère. Ses vestiges sont parsemés à travers le tissu urbain. D'autre part son patrimoine archéologique n'a pas été protégé il s'est trouvé alors dans un état de dégradation, sans mise en valeur. Par ailleurs le patrimoine architecturale datant des périodes arabo-musulmane, ottomane et coloniale a subit des destructions car se trouvant dans un état de vétusté très avancé. De ce fait l'étude a eu pour principal objectif l'identification des caractéristiques de ces ressources ainsi que leurs facteurs de vulnérabilité. La superposition et corrélation entre les résultats obtenus ont permis l'élaboration de l'avant projet du PPMVSA. Le diagnostic a été fondamentale non seulement pour évaluer l'état de conservation de la ressource archéologique mais aussi pour évaluer les potentialités socio-économiques qui sont sous jacentes à ce double constat.

Tamenfoust, l'antique cité de *Rusguniae* fondée au 1er siècle av J-C dont les rares vestiges sont des mosaïques, des colonnes et des portions de murs des thermes Sud-Est et Sud-Ouest et une basilique Chrétienne datant du IV è siècle [2, 3, 4,5] a aussi le reste de son patrimoine archéologique enfouis sous les terres et parsemés sur plus de 330 ha que couvre son périmètre de protection. Sa problématique est moins complexe que celle de Cherchell. La ressource archéologique visible n'est pas importante du fait de sa démolition et de son enfouissement. Tandis que le patrimoine ottoman et colonial sont dans un été de conservation moyen à relativement bon. De ce fait les potentialités socio-économiques évaluées ont contribué à la mise en valeur du potentiel archéologique malgré sa rareté.

Tandis que Choba, connue par *Chobae Municipium* , ancienne ville de la capitale *Césarée de Mauritanie* puis de la capitale *Sétifienne de Mauritanée* est située dans l'ancienne *Igilgili* (Jijel- Djidjel) dans la région de Ziama Mansouriah. Fondée le dernier quart du 1er siècle av J-C [6,7,8] son patrimoine archéologique s'est dispersé il ne subsiste qu'une portion de muraille subdivisée en deux portions. La plupart des matériaux de la ressource archéologique ont été utilisés dans la construction des maisons de cette région ainsi que démolies par les travaux de la route qui relie Djidjel à Béjaia. Les éléments architectoniques tels que les chapiteaux et les plaques d'inscriptions décorent les commerces alignés sur la corniche Djidjelienne (route nationale n° 43) au niveau de la commune de Ziama Mansouriah. Par conséquent la problématique de Choba réside uniquement dans la protection et la mise en valeur de la portion de muraille qui se trouve à l'entrée d'une cité de logements collectifs.

## 2. Méthode d'élaboration des PPMVSA

Ce travail opérationnel réalisé dans un cadre professionnel s'est basé sur une démarche scientifique de part la discipline patrimoniale auquel il se rattache. La méthode adoptée pour l'élaboration de ces plans a été effectuée conformément aux textes de loi régissant ces études [1]. Il s'est basé sur le décret exécutif n° 03-323 du, 05/10/2003 [9] qui régis les points suivants:

Délimiter la zone du secteur archéologique et sa zone de protection périphérique.

Réglementer l'occupation des sols et l'architecture des nouvelles constructions à proximité du site.

Concilier le développement urbanistique local avec la sauvegarde des vestiges historiques.

Le présent article présente les relevés archéologiques effectuées *in situ* pour mettre en évidence les matériaux utilisés et les diverses typologies constructives. Donc on se réfère pour cela à l'article 18 du chapitre III du décret exécutif n° 03-323 du 05/10/2003 [9], c'est à dire, le diagnostic et les relevés topographiques et archéologiques du PPMVSA.

### 2.1 Diagnostic et mesures d'urgence

Le diagnostic effectué dans un premier temps a concerné toutes les ressources objet des études, afin d'évaluer leur état de conservation. Les résultats se sont soldés par des mesures d'urgence ayant surtout trait au nettoyage (désherbage, déblai des détritus) des sites archéologiques à la mise en place de clôture

provisoires de protection et à la mise en place de certains étayement (uniquement pour Cherchell) afin de stopper la dégradation. Les secteurs de protection ont été identifiés afin de mieux cerner les problèmes liées à l'état de dégradation de la ressource archéologique ainsi que celle des autres potentialités. Le diagnostic s'est effectué sur la base de fiches d'évaluation de la ressource archéologique et patrimoniale. Ceci nous a conduits à produire deux types de cartes l'une localisant l'ensemble des sites archéologiques classés ou sur liste complémentaire de l'inventaire national "Figure 1" et une carte des valeurs architecturales localisant l'ensemble de la ressource patrimoniale en particulier à Cherchell "Figure 2" et Tamenfoust . Afin de mieux cerner la problématique de Cherchell et Tamenfoust un diagnostic des autres ressources telles que les ressources culturelles, touristiques et socio-économiques a été réalisée. Le résultat s'est soldé par la production de plusieurs cartes dont celles liées aux potentialités touristiques et culturelles, celles du cadre bâti (état de conservation, gabarits, état juridique), celles des voiries (territoriale, régionale et locale, leur état de conservation), et celles des servitudes. Ce diagnostic a permis l'identification des facteurs liés à la gestion des sites archéologiques c'est-à-dire à leur protection, conservation et leur mise en valeur. Et enfin une délimitation du secteur à protéger à Cherchell et Tamenfoust a été établi.

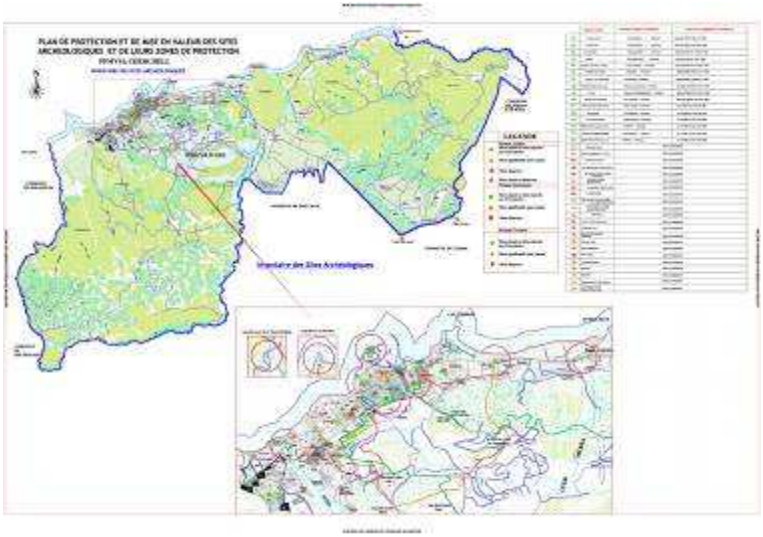

**Figure 1**- Ressource archéologique de Cherchell © CNERU 2011

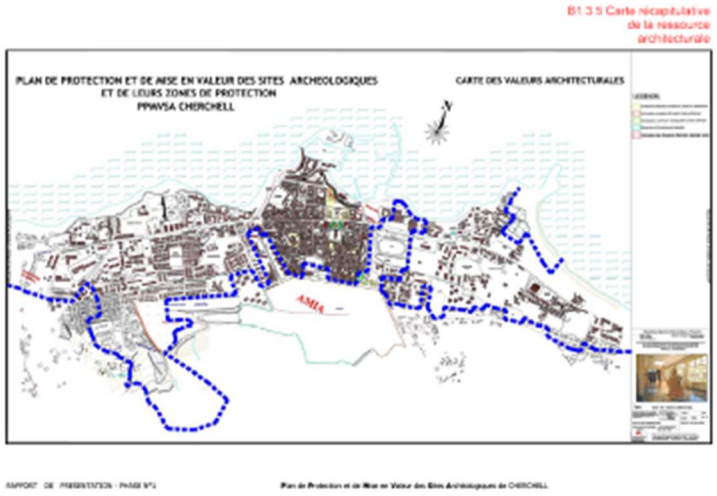


**Figure 2**- Ressources architecturales © CNERU 2011

### *2.1.1 critères de délimitation des secteurs archéologiques et leurs zones de protection périphériques*

Toute étude de plan sous-tend à une délimitation de l'aire d'étude. Dans le cas de Cherchell et Tamenfoust, les limites de protection ont été déterminées en fonction de la consistance et la répartition de la ressource archéologique sur le territoire de ces deux communes. En effet suite à une étude historique du processus de formation et transformation du tissu urbain, il a été démontré l'étendue des deux territoires

antiques auxquels se sont superposés les autres civilisations arabo-musulmane puis turque et coloniale pour Cherchell et Ottomane puis coloniale pour Tamenfoust. La délimitation du périmètre de protection a également tenu compte de six critères dont : la loi n°04-98 portant protection du patrimoine culturel en son article 17, qui détermine les zones de protection des monuments et sites archéologiques classés ou en instance de classement à travers une « *…relation de visibilité entre le monument historique et ces abords…* » . Le champ de visibilité est fixée à *« ..un minimum de deux cents (200) mètres… »* qui peut, le cas échéant, être étendu afin d'éviter la destruction des perspectives monumentales comprises dans cette zone. Outre le critère de visibilité décrit ci-dessus, d'autres critères aussi importants ont été également pris en considération, ressortis après élaboration du diagnostic, tels la stratification historique urbaine et architecturale, le parcellaire, les valeurs patrimoniales existantes et les paysages significatifs situés aux abords des monuments et sites archéologiques; pour ne pas se trouver dans des situations de division de parcelles et / ou d'édifices, difficiles à gérer par la suite, cette délimitation a été rectifiée, au cas par cas, pour inclure la totalité de la parcelle. Lorsque les zones de protection des monuments et sites archéologiques sont très proches, on a carrément procédé à leurs fusions. Dans le cas contraire on a laissé des zones de protection autonomes telle celle à titre d'exemple de site archéologique dit « les trois îlots » à Cherchell et les citernes à Tamenfoust. Enfin, on a exclu de ces zones de protection les propriétés appartenant au domaine de la défense nationale, conformément à l'article 25 du décret exécutif n°03-323 du 5 octobre 2003 portant modalités d'établissement du plan de protection et de mise en valeur des sites archéologiques et de leur zone de protection qui stipule que « *les sites archéologiques et leur zone de protection relevant du ministère de la défense nationale sont régis par des dispositions particulières » Lesquelles disposition ne sont pas encore ,à ce jour ,codifiées.* Pour une meilleure efficacité de gestion ultérieure du PPMVSA avec les autres instruments d'urbanisme en vigueur ,nous avons déterminé les différents secteurs du périmètre de protection par rapport aux territoires affectés par les PDAU de Cherchellet et Tamenfoust et aux différents POS réalisés, en cours ou programmés. Donc le périmètre final de Cherchell a atteint 230, 13 ha "Figure 3" et celui de Tamenfoust 330 ha "Figure 4". Chaque point des périmètres de protection élaborés sont géo-référencés.


**Figure 3**- Délimitation du secteur protégé géo-référé de Cherchell © CNERU 2013

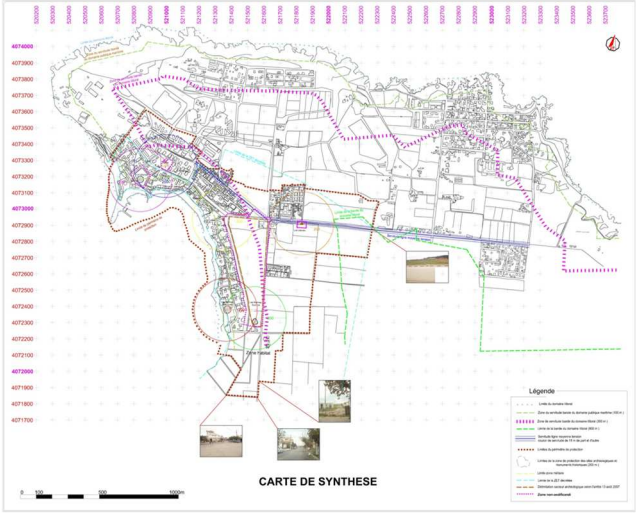


**Figure 4**- Délimitation du secteur protégé géo-référé de Tamenfoust © BETIB 2012

## 3. Relevés topographiques et archéologiques

Cette phase consiste en l'élaboration des relevés archéologiques de tous les sites classés et non classés. Ce travail s'est déroulé avec une équipe pluridisciplinaire se composant d'architectes, archéologue, ingénieurs, topographes et techniciens. Le résultat s'est soldé par l'élaboration d'un atlas des sites archéologiques traitant de relevés d'état des lieux, de matériaux de construction et de typologies constructives. Ce travail constitue un inventaire complet de la ressource archéologique. C'est une production d' informations concernant l'état de conservation du patrimoine archéologique de Cherchell, Tamenfoust et Choba mis à jour par rapport au travail déjà réalisé par Ph. Leveau [2]. et Gsell [3]. Il est à noter que chaque site a utilisé les matériaux locaux, et a développé des techniques constructives qui répondent aux contraintes et aléas naturels locaux.

Les sites de Cherchell sont construits avec plusieurs matériaux assemblés selon des savoir faire. Il est à noter que *l'opus mixtum* utilisé dans les thermes de l'Ouest est un assemblage de pierres auxquelles sont intercalées des tables de terre cuite disposées à intervalle régulier. Cette disposition de matériaux différents intercalés assure une sismo-résistance aux murs. Cherchell a été sérieusement endommagée par un séisme en 365 apr J-C. La violence du choc a fissuré et abîmé les grands édifices romains (théâtre, thermes, remparts). Ces techniques ont probablement émergées lors de la reconstruction des monuments. On trouve également des murs entièrement maçonnés en briques cuites du type murs de commandes dont l'épaisseur est importante et dont l'assemblage des briques correspond à l'*opus testacum*. L épaisseur 45cm de ces murs leur assure une stabilité et solidité structurelle "Figure 5".

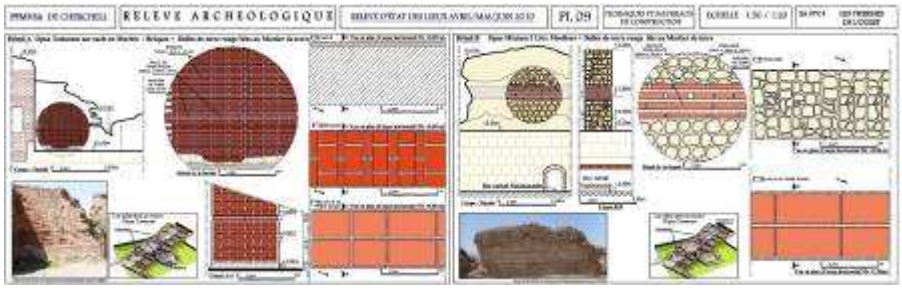


**Figure 5**- Relevé des matériaux et techniques constructives Cherchell © CNERU 2011

Les matériaux utilisés à Tamenfoust sont les moellons de pierres avec des blocs qui renforcent les angles. La typologie constructive est en petit appareil appelé *opus incertum*. Dans ce cas il est renforcé par le grand bloc afin de lui assurer un contreventement et une stabilité "Figure 6" .

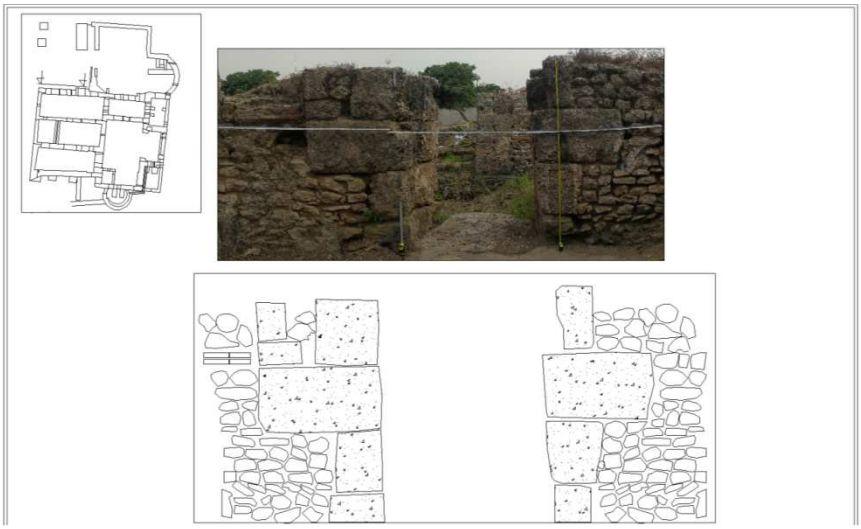

**Figure 6-** Relevé des matériaux et techniques constructives Tamenfoust © BETIB 2012

Ce qui subsiste de la ressource archéologique à Choba est juste une portion de muraille entrecoupée constituant deux partie séparées par un espace vide. Les murs sont réalisés en petit appareil, avec des moellons de pierres dont l'assemblage et la mise en œuvre sont connus sous le nom *d'opus incertum* "Figure 7". La pierre étant disponible dans cette région montagneuse donnant sur le littoral de Ziama Mansouriah.

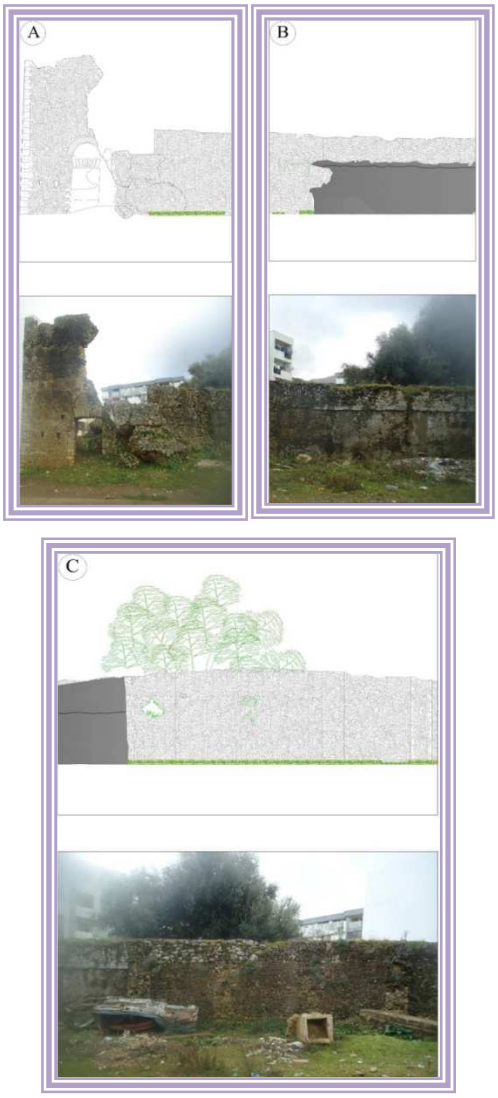


**Figure 7-** Relevé des matériaux et techniques constructives de Choba © CNT 2012

## 4. Conclusion

Après un diagnostic de la ressource archéologique couplée aux autres ressources potentialités des villes de Cherchell et de Tamenfoust, il a été mis en évidence les matériaux et les typologies constructives enregistrés dans des documents graphiques. Il en a été fait de même pour Choba malgré le peu de ressources archéologiques. Dans ce cas les matériaux ont été utilisés par les résidents de la région pour construire leurs maisons. Chaque site a puisé dans son territoire les matériaux visibles sur les vestiges archéologiques. Les typologies constructives ont été développées selon les savoir faire de l'architecture romaine. Lorsqu'il y a des aléas naturels nous avons observé une typologie constructive sismo-résistante à Cherchell. L'élaboration des PPMVSA s'est réalisée conformément à la loi 98-04 et au décret 03-323. Les projets de mise en valeur sont basés sur la richesse de la ressource archéologique identifiée. Par conséquent les mises en valeur et les mesures de protection diffèrent d'un site à un autre.

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# Acoustic Performance Assessment of Reused Archaeological Monuments: The Western Roman Thermae of Cherchell (Algeria)

CHENNAOUI Youcef[*1], BELLAHSENE Amira [2]

[1]Ecole Polytechnique d'Architecture et d'Urbanisme, Alger, Algeria, y.chennaoui@epau-alger.edu.dz
[2]Ecole Polytechnique d'Architecture et d'Urbanisme, Alger, Algeria, amirabellahsene@gmail.com

Keywords
heritage reuse, archaeological monuments, acoustics, music concerts.

Abstract

This study examines the adaptive reuse of ancient structures, including a case study of Roman thermae in Cherchell, Algeria, as performance venues for Andalusian music. The research explores the possibility of including musical activities in cultural places without compromising its architectural and historical integrity. In this work, the case study methodology has been used to undertake acoustic measurements and normative assessments to establish the compatibility of these ancient buildings with the present criteria of performance. The findings demonstrate that with appropriate spatial and acoustic modifications, these monuments can serve as effective cultural venues, fostering both heritage preservation and active cultural enhancement. The study emphasizes the importance of harmonizing architectural conservation with contemporary cultural functions to ensure sustainable heritage management.

## 1. Introduction

Heritage monuments are significant representations of ancient civilizations, embodying cultural identity and historical continuity. Roman thermal baths (thermae) are notable architectural and cultural properties, exemplifying ancient engineering prowess and social customs [1]. The vestiges of Roman thermae at Cherchell, Algeria, reflect this legacy, however its potential for modern use remains underutilized.

The difficulty is in reconciling heritage preservation with practical modification to satisfy contemporary cultural requirements. Utilizing historical sites as event locations, such as music concerts, presents a viable approach to rejuvenating ancient monuments, enhancing cultural tourism, and encouraging community engagement [2-3]. However, these innovations must respond to the technical constraints of acoustics, spatial arrangements and the maintenance of architectural integrity.

Normative frameworks and technical assessments have been highlighted as crucial elements in the guidance of heritage reuse in previous studies [4,6,7]. The Venise Charter (1964) encourages adaptive uses that respect the integrity of the monument, while acoustical regulations give specific requirements to ensure sound quality in performance spaces [10]. The Western Roman thermae of Cherchell are a complex that has a rich cultural heritage and has special acoustic features that might enhance musical performances. Recent studies show that various acoustic approaches stress the importance of sound transmission in ritual spaces, thereby underlining the need to alter archaeological sites [4,8,9]. Furthermore, research on sites such as Stonehenge and the theatre of Paphos shows the complex relationship between designed spaces and acoustics, confirming that ancient structures have special sound qualities that are useful for public meetings [5].

The aim of this research is to evaluate the possibility of using the Western Roman thermae of Cherchell as a space for Andalusian music concerts. The project intends to propose an integrated approach via field measurements, normative analysis and architectural appraisal to combine historic preservation with new cultural functions [11].

This study is important for its contribution to sustainable heritage management, showing that archaeological sites may be revitalised as cultural locations, by means of purposeful interventions, and foster local identity and tourism while protecting their historical integrity [9-12].

## 2. Material and Method

### 2.1 Historical background of the western thermae of Cherchell

The Western Thermae of Cherchell derives from the architectural legacy of the Romans and are a testimony to the significance of public baths in the social life during the ancient era. Constructed in the 2nd century AD, these thermae are more technically advanced than their functional nature would imply, with aesthetic and aural aspects to enhance the user experience. This thermal complex is characterized by its nearly flawless symmetry and its imposing construction. It is planned in an orderly way and measures 115 meters by 70 meters. This is the large hall, in the center of the structure, 20 m. by 12, with two niches on the south wall. There are two entrances to the west leading to this hall. In opposition is a cold bath with a circular shaped basin, on top originally a statue of a famous, a symbol of the funds for the building. The main hall is surrounded by annexes, although their walls are now almost invisible. These rooms were formerly ornamented with marble plaques and painted plaster.

Concerning heating, the complex was provided, much like any Roman thermal institution, with heating pipes beneath the floor and in the walls, which made it possible to change the temperature of the rooms in accordance with the bathing practices of the period. But in the 4th century, there was a big alteration: the structure was transformed into a storehouse of sculptures coming from the temples, a considerable change in the usage of these locations owing to the religious and administrative history of the area. The archaeological excavations have found a sophisticated structure, including rest rooms and areas for social activities, showing that the acoustics of these sites were intentionally planned to foster communication and conviviality [4-9]. **(**See figure 1)

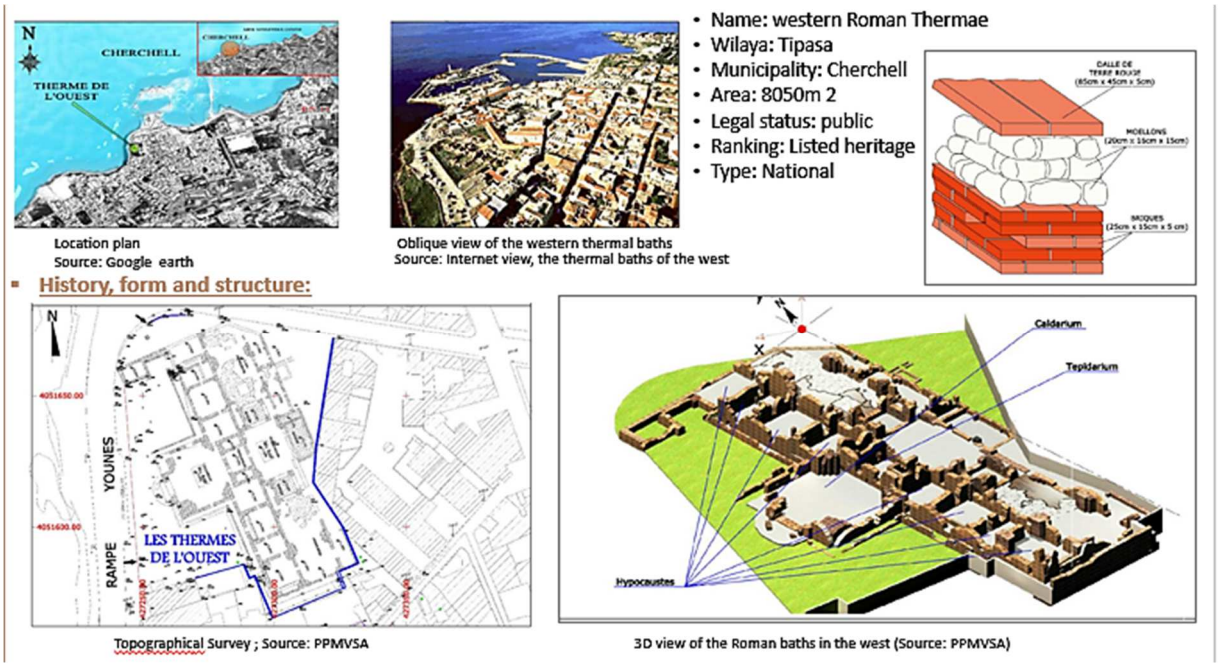


**Figure 1.** Case study application: The Western Roman Thermae of Cherchell. Sources [21].

The study of the Western Thermae of Cherchell gives important insights into the way in which soundscapes have changed with changes in sociopolitical situations, particularly the change from Roman to present days. The significance of these historical structures is furthermore explained by the application of modern acoustic analysis, as the spatial characteristics can evoke parameters comparable to those of contemporary concert halls, supporting the elaborate architectural design choices made by ancient builders [5,9,12]. Ultimately, the history of the Western Thermae reminds us that archaeological sites may sustain the test of time, functioning as a platform for musical tradition development and continuing to have cultural relevance in the collective memory of Cherchell. A visit to the Roman ruins at Cherchell reveals that thermae represent a historical narrative that transcends its original purpose, offering a complex tapestry of cultural and aural legacy that remains a subject of contemporary scholarly discourse. (See figure 2)

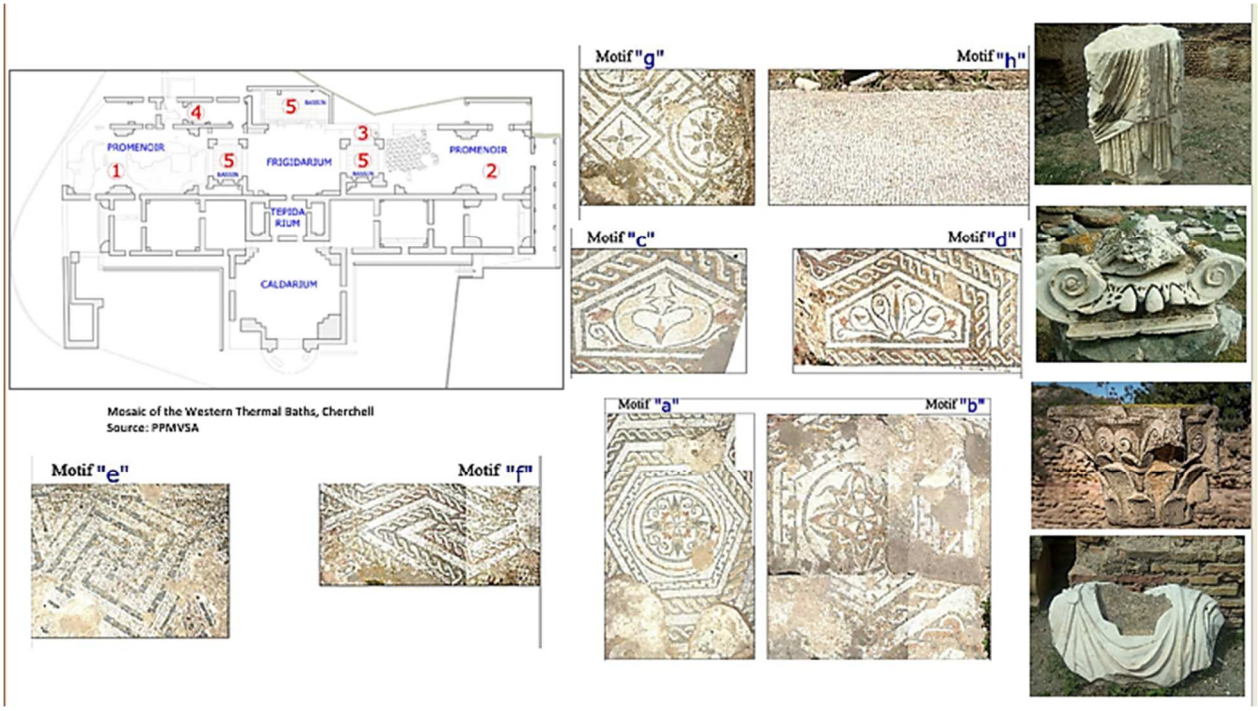


**Figure 2.** The architectural and aesthetic attributes of Western Roman Thermae. (Source: Authors (2020)

### 2.2 Acoustic characteristics of archaeological sites

The acoustic qualities of old buildings, especially those adapted for modern purposes such as music performances, are crucial for understanding how sound was purposely altered to improve the ceremonial and social experiences of previous societies. Historical studies show that acoustics were frequently a part of the design of important buildings, architects using certain geometric arrangements and materials to get the best sound quality. For example, in their study of sites such as the ancient caves in Spain and the Paphos Theatre in Cyprus, scientists discovered that the shape and composition of these structures had a significant impact on sound propagation and clarity that were essential for oratory and performance in communal spaces [4,5,6] .

Acoustic examination of such locations results in a varied spectrum of acoustic environments; for instance, the underground components of caves allow for unique reverberation effects, generating a soundscape that harmonises with the accompanying visual art of ancient rock drawings. Similarly, investigations of Stonehenge have shown that shifts in acoustics are due to changes in spatial arrangements and constructions throughout time, contributing to the potent aural experiences that must have defined rituals inside that site [5-14]. This relationship of natural acoustics to architectural design suggests the importance of sound in the lived experience of ancient peoples. These buildings may improve sound. It was not an accident of their design. In many historic constructions, such as temples and theatres, the designs and materials used were chosen not merely for aesthetic reasons but also played an important role in enhancing sound quality. The room's architecture was such that it amplified the sound of voices and sounds, causing them to reverberate within, which was important in rituals and performances [15]. This intentionality highlights the role of sound as a kind of community relation, connecting those who participated in the transcendent experiences. In the context of contemporary musical performances in archaeological sites – such as the Andalusian concerts in the Western Thermae of Cherchell – the acoustic characteristics of these ancient edifices are re-evaluated to fit modern

sound practices and at the same time to pay tribute to the original acoustic intentions. Therefore, an acoustic standardisation following a methodical approach to the historical data is necessary to preserve and improve auditory traits that belonged to the cultural roles of those ancient locations. Bridging the gap between ancient acoustic practices and modern-day applications, we can better appreciate the pivotal role sound played in shaping social and ritualistic identities across different epochs, and ultimately, enrich our understanding of architectural heritage and its contemporary revitalisation [12-14].

Acoustic features, such as those documented at the Western termae of Cherchell, may provide crucial insights on the former functions and community activities of archaeological sites. Recent research, notably by UNESCO World Heritage sites [10-16], makes it feasible to study aspects like as reverberation time and voice intelligibility to determine the feasibility of these monuments for modern music performances. Research into painted caverns and renowned monuments such as Stonehenge shows acoustics are crucial to the ritual experience with clear differences according to the architectural setting [4-5]. In the case of the Western thermae of Cherchell, the integration of these acoustic concerns in the design of concerts would not only provide a new life to the site but would also give a new dimension to its social significance throughout.

### 1.3. Overview of Andalusian Music Traditions

One of the most deep aspects of the region's historical identity is the complex tapestry of Andalusian-Maghrebian traditional music traditions, formed by a confluence of numerous cultural influences. Andalusian-Maghrebian traditional music (also known as Andalusi or Arab-Andalusian music) is a classical urban art style that originated in mediaeval Muslim Iberia (al-Andalus) and subsequently evolved throughout North Africa (especially Morocco, Algeria, Tunisia, and Libya). This style fuses Arab musical theory with Berber and Iberian elements and complex types of Arabic poetry, such as muwashshaḥ and zajal, to create a refined, sometimes sad sound that is well-suited to aristocratic salon audiences, religious venues, and public festivals. The music is modal, based on maqām (or ṭabʿ), and employs intricate rhythmic cycles (mīzān), usually presented in long multi-movement suites called nūba or nawba.

The characteristic core instruments of this style are the ʿūd (Arabic lute), violin or kamanja, qānūn (zither), and nay or ney (reed flute), accompanied by a variety of frame and goblet drums, including bendir, darbouka, and raqq. Today Andalusian-Maghrebi music is a symbol of high culture, played at concerts, festivals, and celebrations across the Maghreb, typically symbolising both secular elegance and Sufi spiritual expression.
The main melodic instruments include ʿūd, rabâb (a two-stringed bowed instrument), violin, qānūn and nay. Traditional percussion instruments include the riqq (tambourine), darbouka (goblet drum), and naqarat (tiny striking drums).

This reciprocal relationship has been recognised by scholars as a rich musical history and a fertile field for improvisation and creativity, which is essential to the development of Andalusian-Maghrebian traditional music [6-13]. Archaeological remains from Andalusian sites, including mediaeval buildings and artefacts, enable us to get insights into the soundscapes and musical practices of the past, and hence more nuanced understandings of the role of music in daily life and religious events. While current practice generally follows basic acoustical tenets, it is instructive to understand where they originated from, in traditional contexts where the experience of the performance was dictated by specific ambient acoustics. For example, the acoustic qualities of venues, as discussed in studies of ancient locations, show how the relationship of music and space affected the performance of rituals and community activities. This dynamic between the quality of the sound, the audience's participation and the appropriateness of the location is a hallmark of the heritage of Andalusian music [5-13], which suggests a conversation between past and present that continues to create the musical identity of the area.

### 1.4. Methodology

The feasibility of reusing the roman thermae of Cherchell as a concert venue for andalusian music is evaluated by means of a qualitative and quantitative case study technique in this research. The research approach is made up of several stages:

*Literature examination*: A full examination of international norms, charters and academic publications pertaining to historic reuse, acoustics and cultural tourism was undertaken as the literature review. The main sources are the UNESCO charter (1964), the ICOMOS charter (1997, 2007) and the current studies on adaptation of cultural sites [10-16]. This study established normative frameworks and good practices to support recommendations for intervention.

*Site Analysis and Architectural Evaluation*: The thermae were surveyed in situ, with extensive topographical and architectural surveys. Measurements and photographic records were taken of the historical buildings, materials, and proportions and spatial composition of the site [11-12]. Attention was paid to the preservation of mosaics, statues and structural features.

*Acoustic Measurements*: For our case study, to facilitate this assessment, we choose to reintroduce a musical ensemble of musicians who play several instruments, including string instruments (such as the violin and mandola) and percussion instruments (such as the darbouka).Field measurements of acoustic characteristics were performed on October 6, 2020, with the use of portable sound level meters and smartphones with specialized programs (Spectrum Analyze, Sonometer, Spectroid). Within the site, there were several measurements stations for sound strength, frequency and reverberation duration [4-9]. The purpose was to evaluate the present acoustic environment and to determine any alterations required for musical performances. (See figure 3)

photo of the site during the acoustic measurements
Photo credit: author (06/10/2020)

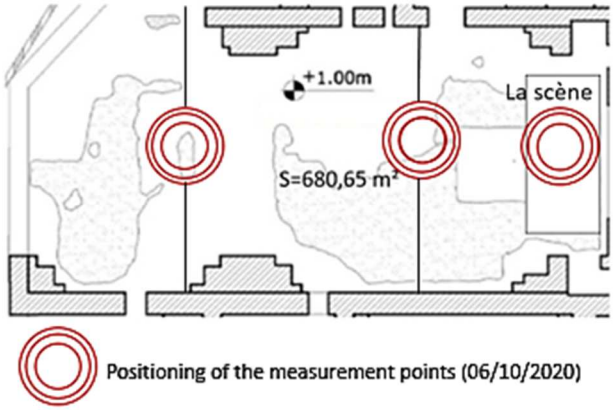


**Figure 3.** The acoustic measurement locations inside one of the wings of the thermal baths selected for the concert (Source: author, 2020)

**Acoustic Requirements:** Concerts need $RT_{60}$ 1.6-2.3 s, STI >0.6; isolation Rw ≥50 dB. Andalusian music (gharnati, malouf) favors medium frequencies (200-400 Hz). Norms: Algerian 70 dB diurnal; ISO 12345.

Exploratory: Theoretical review + in-situ (qualitative/quantitative). Site: West Roman Thermae of Cherchell (symmetric plan, caldarium/apodyterium). Measurements: 6 points (stage, rows), apps calibrated to 94 dB/1kHz; wind <5 m/s. Data: Intensity (dB), spectrum (Hz), analyzed via Sabine/ray-tracing simulations. (Table.1)

| Point | Position | instrument |
|---|---|---|
| 1-3 | Stage | Sound meter |
| 4-6 | Front | Spectroïd |

**Table 1 :** Measurement Protocol. (Source: authors, 2020)

*Normative and Technical Evaluation*: The measured data were compared with worldwide acoustic standards for concert halls including Sabine reverberation formula [17] and recommended sound pressure levels (European and Algerian rules). The spatial design was investigated in terms of the compatibility of existing architectural features with the practical needs of a concert hall as suggested by Neufert [16-17]

*Design and Proposal Development:* Preliminary design suggestions were produced using the architectural elements and acoustic results of the location. These ranged from stage, seating, lighting and acoustic spatial layouts with a focus on maintaining the authenticity of the landmark. To show the intended improvements with little intervention and maximal protection of history, visualizations and plans were prepared.

*Data Interpretation and Application:* The data and normative judgements were synthesized into concrete prescriptions for spatial and sonic adaptation. These proposals were made to optimize sound quality, to

guarantee safety, and to conserve the historical integrity of the monument while responding to the demands of musical performances.

The technique is multidisciplinary, using principles of historic conservation, architectural analysis and acoustical engineering to assess and suggest a sustainable strategy for the adaptive reuse of Cherchell's Roman thermae.

## 3. Results

The complete examination of the roman thermae of Cherchell, along with in-situ acoustic measurements and normative assessment, provided many major findings:

*Architectural and Structural Suitability*: The existing architectural elements of the site, particularly its symmetrical design, large inner outdoor spaces, and high masonry masonry walls, are well-suited to the functional needs of a performance hall. Regarding the existing dimensions, the stage area (ca. 43 m2) and the open space of more than 680 m2 dedicated to performances provide appropriate space for stage setting and audience capacity according to normative criteria [17].

*Acoustic Environment Assessment*: Field measurements showed that the present reverberation duration in the location is roughly 2.4 seconds on average, which is appropriate for classical and traditional music performances. The sound intensity levels measured at different locations were between 85 dB and 90 dB, in compliance with both European and Algerian legislation for live music events [17-18].

| Parameter | Stage | Front | Rear | Norm |
|---|---|---|---|---|
| **Intensity (dB)** | 85 | 82 | 78 | <90 |
| **Freq (Hz)** | 250-350 | 200-380 | 196-381 | 100-5000 |
| **RT60 (s)** | 2.1 | 1.9 | 2.2 | 1.6-2.3 |

**Table 2:** Frequency Spectrum measurements of western roman thermae. (Source: authors, 2020)

*Material and Surface Analysis:* The materials used at the site, including stone and mosaic flooring, have low absorption coefficients, which favor the reverberant acoustics that are suited for musical performances. Lightweight, acoustic absorptive panels and strategically placed sound diffusers may be added to optimize sound clarity and prevent undesired echoes, without sacrificing architectural authenticity.

Acoustic measurements are characterized by three parameters: intensity, frequency, and timbre.

**1. Intensity:** contingent upon the acoustic pressure generated by the sound source.

Conclusion: The measurements obtained at each spatial position indicate that the averages conform to the intensity criteria for a musical performance, with a threshold not over 90dB.

**2. The pitch**: is determined by the vibrations of the sound-producing item. The greater the object's vibration frequency, the higher the sound pitch.

Conclusion: The measurements conducted at various spatial points indicate a frequency variation that maintains a normal audible level and a discernible speech range suitable for a musical concert, as it lies within the spectrum of 196 Hz to 381 Hz, denoting a medium sound according to established standards.

**3. The timbre:** is characterized by the many features that constitute it, enabling the identification of the speaker or the instrument being performed.

The data analyzed and compared to the standards indicate that the harmonic and timbral purity of each instrument, together with the human voice were satisfactory for our case study.

Acoustic tests and standard comparisons indicate that the archaeological site, namely the western thermal baths, is very suitable for musical activity. (See figure 4).

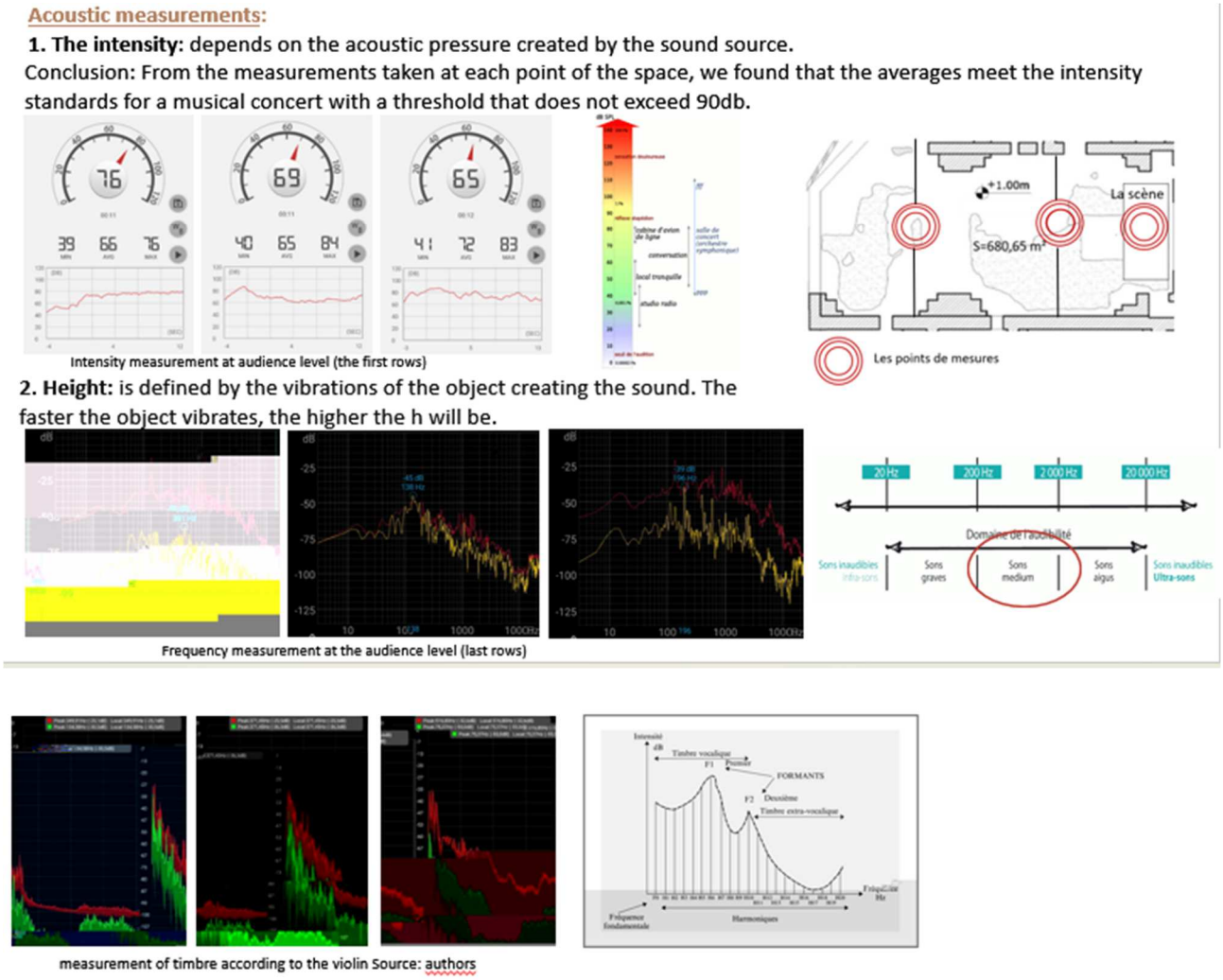


**Figure 4.** The acoustic measurement locations inside one of the wings of the Western Roman Thermae, selected for the concert (Source: authors, 2020)

*Preservation and Heritage Constraints*: Interventions such as the use of transparent glass flooring over mosaics and the use of limited, non-invasive acoustic treatments guarantee the preservation of precious archaeological elements. The spatial configuration makes it possible to preserve sculptures, mosaics, and structural components according to conservation standards [1-6].

*Design plans and functional adaptation*: indicate that the stage might be successfully placed in the middle or western wing of the thermae, with audience seating positioned to improve sightlines and sound quality. Lighting, sound systems and safety precautions may be included with few structural adjustments to preserve the uniqueness of the place.

*The structural and acoustic properties of space* are typically suitable to be used as a venue for the presentation of Andalusian music. The evidence confirms that the Roman thermae of Cherchell may meet the functional needs of contemporary musical performances while protecting their historical integrity via specific technological measures aimed at acoustic treatment, spatial organization and heritage protection.

## 4. Discussion

The acoustic investigation of the Western Thermae of Cherchell delineates a complex heritage environment where auditory performance is intrinsically linked to vaulted architectural typologies, spatial configuration, and the legacy of ancient construction materials [4-5]. The findings suggest that these constituent parts provide a reverberant field that, providing an auditory immersion and depth, also contributes a large spatial variance in sound dispersion. Thus, the site is not only a passive container, but an active audio participant whose shape substantially determines the listener's sensory experience.

When it comes to reverberation and its interaction with voice intelligibility, a complex performance profile emerges. The measured acoustic properties, although possibly favourable for musical types that privilege atmospheric resonance and spatial envelopment, provide clear obstacles for repertoire demanding high-fidelity articulation or temporal accuracy [5-7]. This dichotomy points to a fundamental tension about the site's fitness: the qualities that confer aesthetic distinction are also antithetical to the technical demands of modern concert performance and thus require a delicate calibration of artistic expectations against the monument's inherent acoustic character. The acoustics quality of such locations has a huge impact on the experience of the audience during music performances in historic places such as the Western Baths of Cherchell. In these old structures the sound propagation and resonance impact not only on the clarity and richness of the music heard but also the emotional engagement of the listeners [4]. Previous research has shown that places such as old caves have a changeable reverberation time which enables a unique immersive experience [6]. In addition, the acoustic study of the Stonehenge stone circle shows the effect of architectural adjustments on the perception of sound, stressing the relevance of design decisions [5]. In this perspective, it is of interest to investigate how the acoustic properties of the historic thermae might be improved to improve the audience's experience during modern events. (See figure 5).

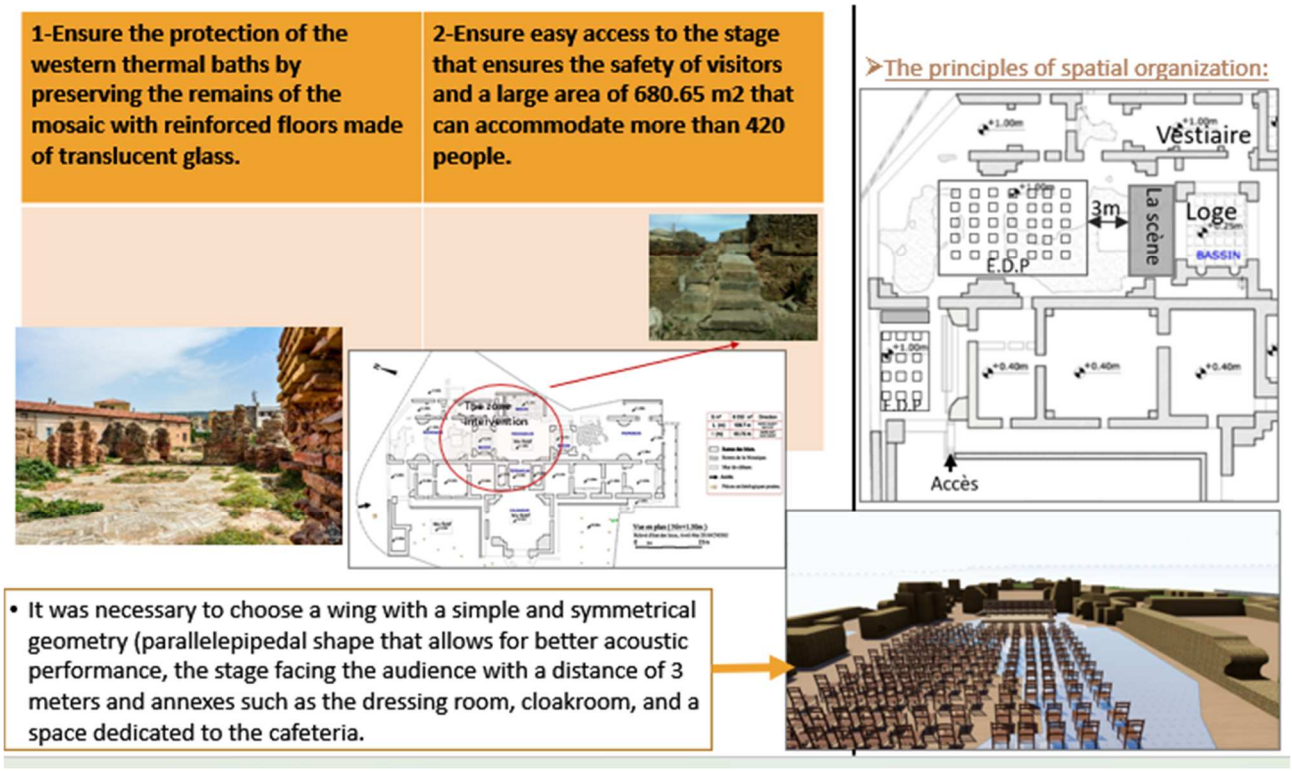


**Figure 5.** Rationale for the selection of venue for the orchestration of the music performance (Source: author, 2020)

- *Regarding the acoustic principles:* Recommendations to consider for our case study include the sound pathways from the performer to the audience throughout the performance, including reflections from the stage, walls, and direct waves.

- *The transmission of sound inside the performance venue:* a range of acoustic measures based on the sound source from 65dB to 75dB.

- *The audibility range in the concert area*: Acoustic tests indicate that the audibility range encompasses medium noise.

- *Isolation system concerning the walls*: The walls are constructed from dense and thick materials, facilitating the attenuation of airborne sounds, since airwaves encounter more resistance while vibrating a heavy element compared to a lighter one. (See figure 6)

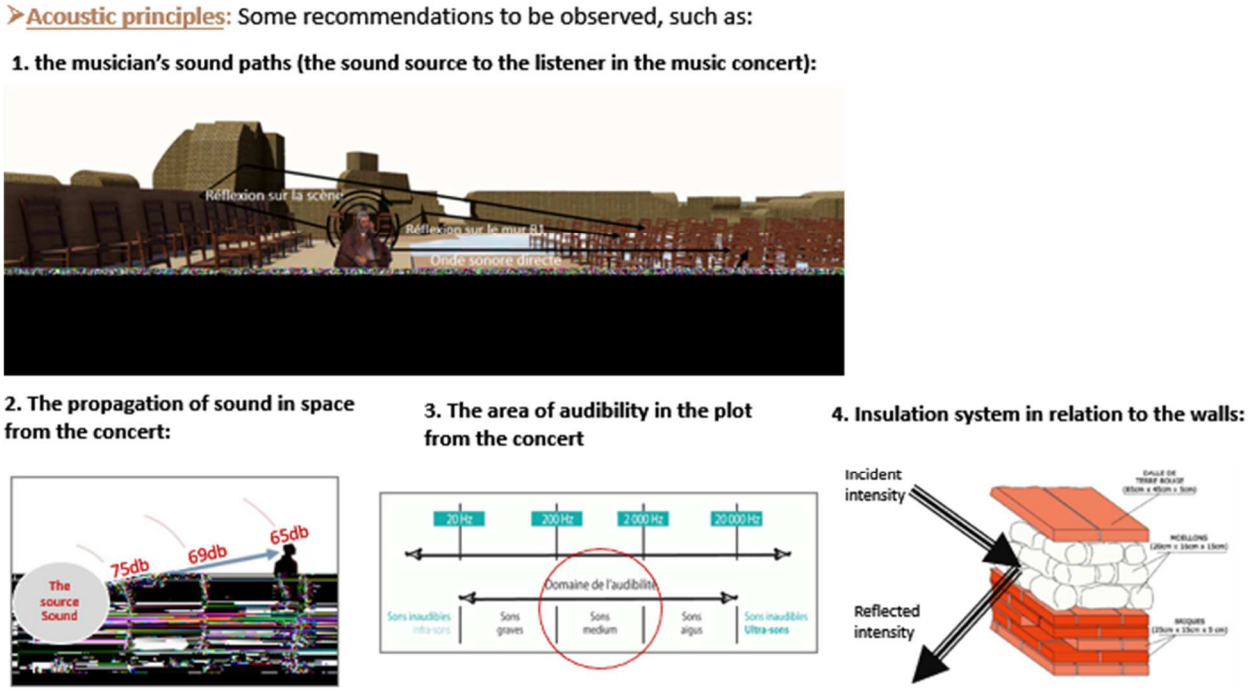


**Figure 6.** Acoustic Principles: Suggested Standards for Compliance (Source: author, 2020)

The architectural morphology of the thermae acts as the primary determinant of the site's acoustic output [9,11,12]. Large-scale thermal volumes, characterized by significant surface-to-volume ratios and stone-based materiality, promote extended sound decay durations, thereby generating a profound sonic envelope. However, the existence of varying archaeological remains causes non-homogeneous reflection patterns, which results in localized acoustic abnormalities that prevent a homogenous listening experience over the whole arena. This spatial variability suggests that auditory performance is inherently dependent on the location of both the artists and the listener.

To properly evaluate legacy acoustics, a multi-dimensional analytical approach is required that moves beyond single measures such as reverberation time. Clarity, early decay, speech intelligibility and frequency dependence must be combined to get a full picture of the venue performance [7-19]. This integrative view identifies the Western Thermae as a singular confluence of archaeological authenticity, heritage management and performative potential where quantitative acoustic data must be filtered via an interpretative comprehension of visitor experience. Comparative studies within the burgeoning field of archaeoacoustics provide a critical context for these findings [4-5]. By sitting the Western Thermae among esteemed historical sites like Stonehenge, prehistoric painted caves, and ancient theatres, constructed heritage has audio fingerprints that are historically meaningful and relevant today. Similar qualities indicate that the acoustic aspect of heritage is an inherent quality, enabling a deeper, embodied link between the place and contemporary audiences. The Western Thermae's re-vitalization via live music is a medium for increased public participation from a socio-cultural point of view [4]. By activating the architectural space with sound, the site turns from a static historical record into a dynamic cultural event, bridging the temporal and aesthetic gap between antiquity and the current period. This integration is responding to larger heritage valorization objectives, so that the monument remains a lively element of the soundscape.

However, the functional use of such locations for musical activity must be subjected to strict conservation imperatives [5,11,20]. Preservation requirements sometimes prevent structural work that is often necessary to optimize performance in a music venue. Therefore, the emphasis should turn to reversible and low-impact solutions, such as advanced temporary sound reinforcement and carefully curated concert programming, that preserve the architectural integrity of the space and address its intrinsic acoustic weaknesses. The findings unequivocally emphasize the necessity for a multidisciplinary methodology in the evaluation of heritage sites [4-7]. The convergence of acoustic physics, architectural history, conservation ethics, and human-centric perception studies is essential to establish a viable reuse strategy. This scholarly approach ensures that acoustic

optimization remains subordinate to the primary goal of material and historical preservation, thereby precluding any approach that treats the monument as a disposable resource. (See figure 7)

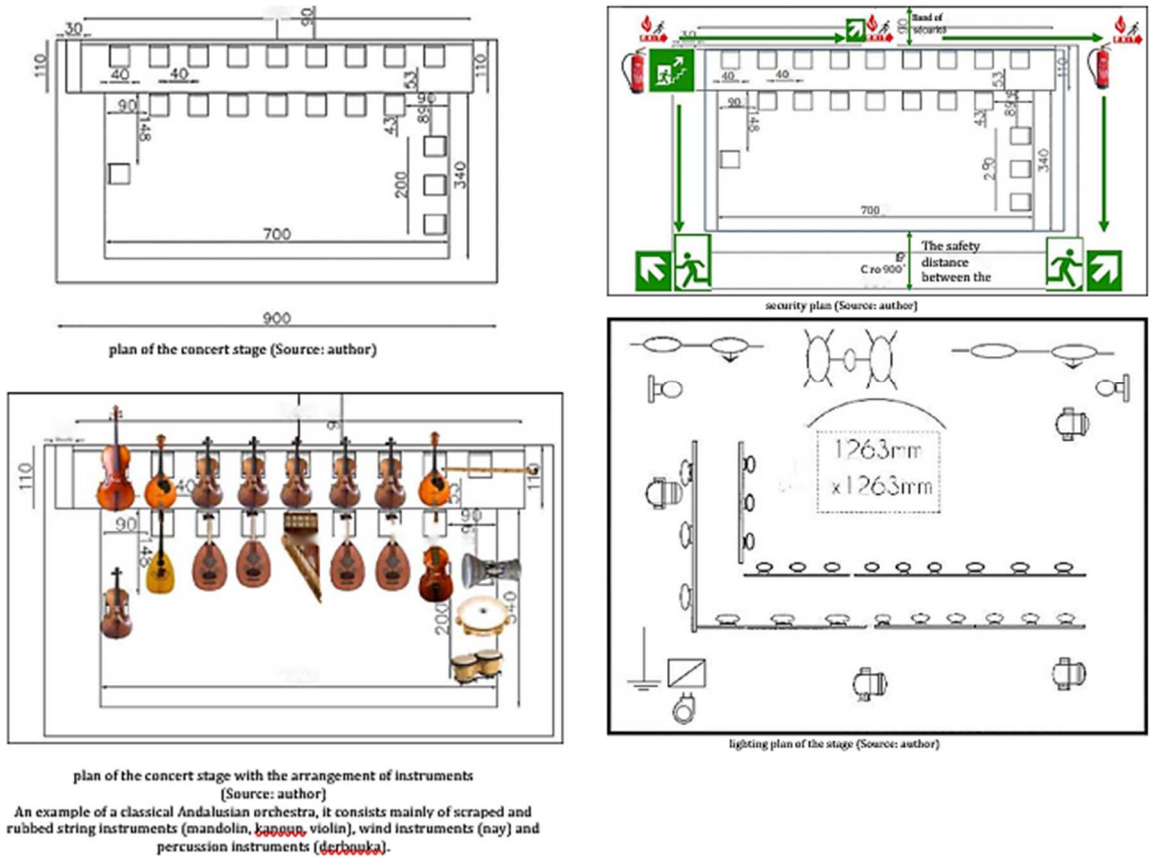


**Figure 7.** An Andalusian music event exemplifies a practical approach. (Source: author, 2020)

Overall, the sonic uniqueness of the Western Thermae provides a major, yet subtle possibility for cultural reuse [11-19]. The location has significant promises for immersive and atmospherically resonant concert experiences, but its operational viability is limited by the non-negotiable restrictions of conservation and the physical limits of its historical design. Ultimately, effective reuse requires a conscious mix of acoustic awareness, historical ethics and bespoke creative programming [9-20].

## 5. Conclusion

This research has provided a comprehensive evaluation of the acoustic suitability of the Western Thermae of Cherchell for contemporary musical performance, bridging the gap between archaeological conservation and cultural revitalization. By integrating site-specific acoustic measurements with historical, architectural, and sociocultural analysis, this study has demonstrated that ancient structures possess inherent sonic signatures that can enrich modern cultural life while maintaining their status as invaluable artifacts of antiquity.

The results show that the Western Roman Thermae of Cherchell presents a unique, immersive acoustic environment, shaped by the symmetrical architecture, large open spaces and original materials. This study also highlights, however, that such sites are not a substitute for purpose-built concert halls but represent a distinct category of performance space where acoustic performance requires negotiation through sensitive management, reversible interventions and careful repertoire selection. The research emphasizes that the primary task of heritage management is to preserve the physical fabric of the monument and that contemporary culture should be utilized to supplement, not diminish, the historical narrative.

Outside of the Cherchell context, this research contributes to the wider theme of archaeoacoustics by offering a multidisciplinary approach for the repurpose of cultural assets. The study suggests a sustainable approach to the integration of historic locations into current cultural heritage, proposing a hybrid approach that combines technical acoustics with preservation ethics and phenomenological interpretation. This sets a precedent for future research on other archaeological sites, demonstrating the acoustic potential of the past is

a tremendous, underutilized resource for strengthening local identity, public participation and cultural continuity.

The study concludes that the future of constructed heritage is its capacity to adapt to the requirements of the present without losing the integrity of the past. As our investigation of the sonic dimension of our shared past continues, the Western Thermae have taught us the vast potential of archaeological spaces to be active spaces of community encounter, where the convergence of ancestral architecture and contemporary art can thrive in a balanced, sustainable and culturally meaningful manner.

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# The Architectural and Urban Quality of the Built Environment in Algeria: Challenges and Issues

Ammar BOUCHAIR

Professor of architecture
Department of architecture, University of Jijel Research laboratory « CBE »
Email: abouchair@univ-jijel.dz

Keywords

Architectural and urban quality, patrimonial architectural and urban development, vernacular buildings, architectural and urban identity.

Abstract

Demographic growth and migration movements have led to uncontrolled urban expansion and significant deterioration of the urban environment in Algeria. This has led to a loss of identity and decline in architectural and urban quality, despite the presence of laws and regulations that are often inadequately enforced, resulting in lossof This study explores the current state of architectural and urban quality on a broader regional scale. The article illuminates the profound transformations, challenges, and issues associated to the development of the built environment over recent decades. It elucidates the process of unplanned urbanazition, uncontrolled expansion, and profiliration of illegal constructions, which have affected both traditional and colonial architectural heritage. This article provides a qualitative analysis of urbanization dynamics, exames architectural design practices, and explores the impact of modern design flaws on the built environment. Particular attention is given to traditional and patrimonial architecture by highlighting its advantages and qualities through key features such as, the courtyards, local material, windcatchers, compacity and the use of colors known for their climatic adaptativity and ecological sustainability. The analysis underscores the importance of reviving principles of traditional building practices and incorporating them into contemporary contexts. Modern design errors, often poorly suited to local conditions, are identified as significant contributor to architectural and urban decline. Relevant solutions were sought, including the integration of heritage protection legislation, the adaptation of modern projects to climatic realities, and the enhancement of traditional and patrimonial architecture.

## 1. Introduction :

Over the last decades, Algeria's architectural and urban landscape has experienced significant transformations. Recent shifts in social, cultural, and political spheres have greatly impacted both planned and spontaneous architectural and urban development. Form and space are not architecture. Architecture only happens when there is a person to experience it (William Wayne Caudill, 1971). Architecture is defined as the art of transforming, designing, and constructing buildings, interiors, cities, landscapes, and outdoor spaces according to specific aesthetic, technical, economic, social, and environmental criteria. Architecture creates protective volumes that shelter human beings, in the various aspects of their lives, from all natural and artificial disturbances. Architecture is a multidisciplinary field that cannot ignore geometry, physics, mathematics, philosophy, sociology, law, politics, and technology. It is a discipline that combines the art and science of constructing terrestrial or naval buildings and structures. The classical definition of architecture, as found in the writings of Vitruvius (Fleury 1990) is based on a harmonious and balanced combination of three fundamental principles: utility, solidity, and beauty. Utility involves functional, practical, and economic aspects. Solidity encompasses structural strength and ecological durability. Beauty and attractiveness refer to the qualities of buildings and the built environment, which must now be given a more precise meaning than before. Architecture is linked to time and place. Time connects buildings and their environment to our cultural heritage and history. Place connects architecture, environment, and nature (Schulz 1980). Architecture is important because the built environment is the physical framework of human activities,

and architecture plays a crucial role in the quality of this framework. Many strong meanings are associated with architecture, and it is one of the components of national and local identity (Giedion 2009). The cultural environment of cities and countryside represents part of our wealth. Different historical periods must be respected (Choisy 1899). An architect (from the Greek arkhitektôn, meaning "master builder") is often a creative professional whose job is to design (through drawings and plans) and oversee the construction of buildings (Hanrot 2002). More broadly, the architect works with space and creates spaces: surfaces (facades, floors, areas…), like a painter; volumes (spaces of connection and

perception), like a sculptor; atmospheres (light, color, texture effects), like an artist (Ching 2023). The profession of architect as it is understood today—as a liberal discipline (non-mechanical and closer to arts and sciences than to manual building trades)—is relatively recent in the Western world. It dates back to the Renaissance, 16th century. In most societies before the Renaissance, "architects" already existed, more precisely called master masons or master carpenters. They combined the roles of what we now call architects, engineers, and contractors, but were mainly responsible for the technical aspects of major constructions ; prestigious public or private buildings (Avermaete and Teerds 2016). Outside these exceptional cases, buildings were constructed by their occupants using patterns developed over centuries through experimentation, without the need for specialists. This process is known as vernacular construction or typological building (Burr and Jones 2010). Urban planning is both an academic and professional field concerned with the study of urban phenomena, the process of urbanization, and the organization of cities and their territories (Scott and Roweis 1977, Taylor 1998). Depending on academic traditions, this discipline is associated either with architecture or geography, but it also draws on sociology, economics, and political science. Thinkers such as Le Corbusier strongly influenced an architectural vision of the city, while scholars such as Henri Lefebvre developed a more social and critical approach to urban space (Stanek 2011). Urban planning focuses on the design, organization, and transformation of urban spaces, taking into account social, economic, environmental, and political dimensions (Benevolo 1971, Benevolo 1977). Historically, modern urban planning emerged in the 19th century with industrialization and major urban reforms, such as those led by Georges-Eugène Haussmann in Paris (Benevolo 1977, Jordan 2004). These interventions aimed to improve hygiene, circulation, and control in rapidly growing cities (Levin, Forgan et al. 2010). Today, urban planning faces new challenges, including urban population growth, socio-spatial inequalities, and climate change. Organizations such as UN-Habitat emphasize the importance of promoting sustainable, inclusive, and resilient cities (Gupta 2025). The urban landscape refers to the totality of visible urban forms as perceived by inhabitants or observers. It results from the combination of built elements such as housing, buildings, and monuments; infrastructure such as roads and transport networks; and public spaces such as streets, squares, and parks. It also includes nature in the city, such as trees, gardens, and waterways, which help structure and enhance urban space. The form of the city, studied through urban morphology, plays a key role in shaping the landscape. Some cities have a regular layout, such as New York with its grid plan, while others, such as Paris, combine an old historic core with newer developments. The urban landscape also reflects the different functions of the city: living, working, consuming, and leisure, with each district often having a dominant function that shapes its appearance (Frampton 2020). However, the urban landscape is not limited to its physical aspects, as it also depends on perception. Urban theorist Kevin Lynch showed that inhabitants understand their city through visual landmarks, paths, and boundaries that structure their mental image of space (Lynch 1960). Finally, the urban landscape is constantly evolving due to urbanization and planning policies, which gradually transform neighborhoods, for example by converting former industrial zones into modern and attractive spaces. In the absence of appropriate strategies and cultural and environmental reflection, the rapid expansion of suburban areas has led to a decline in quality and an insufficient response to basic needs. Despite the richness of Algeria's architectural heritage—Arab-Islamic, Amazigh, and colonial—the

current built environment seems to be evolving without clear reference points, gradually losing identity, coherence, and quality. It has become imperative—if it is not already too late—to initiate a debate on the future of architectural and urban quality in Algeria. In this context, many questions arise, both practical, political, and aesthetic.

Does architecture in Algeria fulfill its role in shaping identity?
Does it reflect the level of culture of its creators?
Does it project a sense of quality, and to what extent?
Can we truly speak of architectural and urban styles specific to and meaningful in Algeria?
What are we doing?
Architecture or "ANARCHITECTURE": anti-architecture?
Urbanization or de-urbanization?
Building or deconstructing?
How can we save and transform the Algerian architectural and urban landscape in crisis?
How far can we go in transforming the architectural and urban product?
What solutions should be adopted in the face of an already critical situation?

## 2. Architectural quality: Criteria, issues, and evaluation tools

Except for the Modern Movement, which conceives architecture as an "isolated object," every architectural project must take into account the environment, materials, climate, as well as the cultural and economic context. In this way, each building contributes to shaping the identity of the territory in which it is located. Architectural quality is the result, throughout the design and implementation process, of a coherent relationship between the program, its economy, its use, its siting and orientation, the site, materials, volumes, colors, and its cultural context (architecture is an expression of culture). High-quality architecture is architecture that reduces energy needs and creates a comfortable environment in occupied spaces, with pleasant temperatures, sufficient natural lighting, reduced noise, controlled ventilation, and respect for local culture. Quality seeks harmony between the function of the building, occupant comfort, and environmental respect, by making extensive use of architectural principles. This involves taking into account, during the design process, the environmental elements most influential on the future project. Project design should incorporate the positive aspects offered by the environment and eliminate those that are harmful to occupants' well-being.

***Two categories of elements can be distinguished:***

-elements related to human factors

-elements related to the physical environment

Human-related elements include culture, history, etc. Physical elements are thermal, acoustic, visual, aerodynamic, and spatial. Thermal aspects concern solar radiation (sun exposure), ventilation (air circulation), ambient temperature, and humidity. Acoustic aspects concern noise from various sources. Visual aspects concern vision, natural lighting, and preferred views. Spatial aspects concern the site and its elements: topography, vegetation, and the surrounding built environment.

## 3. Current situation : overview and critical analysis

### 3.1 Deficiencies in architectural and urban spaces :

Blinded by the enthusiasm and urgency of rebuilding a modern independent state, and by the need to respond to the demands of a rapidly growing urban population, the built environment in Algeria is deteriorating and gradually losing its identity, heritage, and qualitative values. Uncontrolled urbanization, shortcomings in urban management, and the insufficient consideration of environmental issues are causing serious damage to the environment, as well as the degradation of natural resources and spatial quality. The city thus becomes synonymous with discomfort, insecurity, and poor living conditions for its inhabitants. Urban spaces are experiencing strong disintegration and a degradation of the built environment, characterized by arbitrary and standardized forms that are poorly adapted to climatic, cultural, and environmental contexts. This uncontrolled urban expansion leads to spatial dysfunctions, environmental deterioration, and a decline in residents' quality of life.

I must state here, with full objectivity, honesty, transparency, and clarity, that the situation is bitter and the assessment is negative. The situation is in an advanced stage of "illness," and there are no miracle solutions, at least in the short and medium term. There is, unfortunately, a tendency—marked by disregard for the symbolic and identity values of our country and at the expense of the sacrifices of Algerian society—to repeat, for many years, the same patterns of architectural and urban production, with the same mistakes, across the north and south, east and west, in urban and rural areas alike: mass housing estates, dormitory towns, illegal constructions, non-environmental subdivisions, and a lack of any national or local strategy. The use of generic solutions reflects a disregard for reference or original approaches drawn from our historical heritage.

#### *3.1.1 From an architectural perspective*

1- Low quality façades enhanced with expensive materials in various forms and styles, without providing thermal comfort. Lack of harmony and integration (figures 1-2). High-quality architecture is architecture that reduces energy consumption and creates a sense of well-being in occupied spaces, with comfortable temperatures, sufficient natural lighting, reduced noise, controlled ventilation, and respect for local culture. It seeks harmony between the building's function and the comfort of its occupants.

**Figure 1.** A façade composed of various styles and materials in Mila city (left). Two buildings owned by the same person with façades combining different styles and materials in Jijel (right).

(a)

(b)

**Figure 2.** In the city of Jijel : two juxtaposed buildings (on the same street) with non-harmonized architectural styles (a). Illegal individual construction in Ayouf Est featuring an exaggerated number of balconies at the expense of comfort; four air-conditioning units are installed to ensure comfort (b).

2- Large-scale housing developments with buildings of contradictory volumes and different architectural styles within the same neighborhood, which erode the urban landscape like unsightly “growths,” or extend into a bleak accumulation of stacked cubes (Figures 3-4).

**Figure 3.** On the same street in Jijel, buildings with different volumes and architectural styles are found side by side. There is a clear lack of integration and continuity in terms of style and scale: a five-story building (R+5) stands next to a two-story individual dwelling (R+2).

**Figure 4.** On the same urban frontage, individual and collective dwellings are juxtaposed without any sense of integration or harmonization, in El-Milia -Jijel.

3- Excessive vertical extensions without compliance with the urban planning regulations set out in the Land Use Plans (P.O.S.) result in the piling up of multiple storeys, which prevents sunlight from reaching neighbouring buildings during cold seasons (Figures 5a-b).

(a) (b)

**Figure 5.** Excessive vertical extensions of building overshadows the surrounding low building levels in (a) 40 Ha, and (b) Village Moussa districts in Jijel city.

4- Design of large housing complexes without taking into account climatic factors, such as solar exposure during the cold season. A blank façade receives good morning sunlight, while the façade containing the openings remains in full shadow. This indicates arbitrary orientation (Figures 6a-b).

(a) (b)

**Figure 6.** A newly constructed six-storey collective building casts morning shadow over a school (a), and open façades (b), located in the 40 Ha district in the city of Jijel.

5- Use of non-ecological and non-sustainable materials, which degrade the environment and reduce comfort (Figure 7). The use of poor-quality materials or defective workmanship in a collective building leads to the rapid deterioration of exterior wall finishes.

**Figure 7.** A façade in a deplorable condition due to poor-quality materials and substandard workmanship in Ayouf district (Jijel city).

6- Non-compliance with the construction standards for cavity wall systems is frequently observed in contemporary building practices. In some cases, walls are executed with a (10 + 15 + 10) cm configuration instead of the recommended (15 + 5 + 10) cm assembly. This deviation eliminates the required 5 cm air cavity intended to ensure proper thermal insulation performance. Such modifications are often motivated by cost reduction or construction speed, but they compromise the building's thermal efficiency. As a result, occupants experience increased heat loss in winter and excessive heat gain in summer, leading to higher energy consumption for heating and cooling systems. Ultimately, this practice reflects a short-term economic approach that undermines long-term comfort, durability, and environmental performance (Figure 8).

**Figure 8.** A poorly executed cavity wall in the Herraten district, in the suburbs of Jijel, constructed for cost-saving reasons but at the expense of thermal comfort and overall building performance.

7- Spatial anarchy is widespread; no one seems able to stop this proliferation of illegal constructions, the degradation of the natural environment, and the disregard for regulations. Electrical pylons are poorly positioned within an informal settlement, placed directly in the middle of the street. Advanced balcony structures extend dangerously close to electrical pylons, creating a risk of electric shock, reducing visibility, and further degrading the aesthetic quality of the façades (Figure 9).

**Figure 9.** Unsafe proximity of extended balconies to electrical pylons, causing safety hazards, reduced visibility, and visual degradation of façades in « Camp Chevalier » district (Jijel city).

**Figure 10.** Spatial appropriations (modifications) of public building façades (balconies) without authorization in 400 housing district (Jijel city).

(a) (b)

**Figure 11.** Extended balconies obstructing pedestrian circulation on the sidewalk (a). Concrete flower boxes positioned at very low heights (b), causing inconvenience and sometimes leading to accidents in « Camp Chevalier » district (Jijel city).

**Figure 12.** Poor execution of a foundation in Herratene: the reinforcement bars of the ground beams are placed directly on the soil, without a blinding concrete layer.

### *3.1.2 From urban planning perspective*

Urban extensions on the fringes of Algerian towns and villages, extending and encircling the old cities and colonial urban centers, have created residential areas that are dysfunctional with these existing structures. The old cities are characterized by a compact and dense urban fabric. The colonial urban centers are characterized by more open, regular, grid-like, and hierarchical layouts that follow a defined geometry. These are important features that the new urban extensions have been unable to replicate and integrate (Figures 13).


(a)


(b)

**Figure 13.** Urban extensions of the city of Mila (a) and Jijel (b).

The floods that occurred in Ghardaïa on October 1st, 2008, triggered by severe and dramatic weather conditions, illustrate the consequences of poorly planned urbanization on unsuitable land. The ancient Mozabites demonstrated great wisdom by avoiding construction on the wadi bed of the Oued M'zab (Figure 14).


(a)

(b)

**Figure 14.** New urban extensions : Ghardaia, Melika and Beni-Izguen).

We are witnessing the emergence of true dormitory towns or "planned housing estates" — such as the "200-unit housing estate," the "400-unit housing estate," etc. — which degrade the urban landscape, as well as the quality of our living environment and overall well-being. The built environment in which we now live increasingly forces us to adopt a defensive stance, if not

to live in a state of anxiety. Should we speak of errors to be corrected, or at least not repeated?

In reality, the situation is not that simple. Urban sprawl, the rapid increase in urban populations, and the profound transformations of landscapes, mindsets, and production modes imposed by industrialization have led to a restructuring and functional reorganization of urban space. This process is difficult to control because it involves multiple interconnected issues, requiring a combination of expertise, political action, and administrative measures. High-rise buildings (R+6) with flat roofs that disrupt the silhouette of the village of Belghimuz, which is traditionally characterized by single-storey (ground-floor) houses with pitched, tiled roofs (Figure 15).

**Figure 15.** Degradation of the urban landscape of the former agricultural village of Belghimouz through the scattered development of collective housing buildings – Jijel.

The amount of land consumed by urbanization since independence has been very significant, despite the existence of legal texts aimed at protecting agricultural land and formally prohibiting its conversion to other uses. Pressure on agricultural land has intensified the already existing strain around urban areas, where villages and rural centers are weakened by the poorly planned expansion of peri-urban housing. Rather than fostering and stimulating rural development, this process has reinforced the divide between rural and urban areas. As an illustration, the urban expansion of Mila has taken place mainly on land with the highest agricultural potential (Figure 16a). In Jijel, planned and unplanned urban extensions are spreading over agricultural land, tourist sites, and sometimes into valleys and protected or restricted areas (Figure 16b).

(a) (b)

**Figure 16.** Boussouf housing subdivision developed on agricultural land in Mila (a), and Herraten in Jijel (b).

(a) (b)

**Figure 17.** Social housing project of 1,173 collective dwellings in Harratene (a) – Jijel. Chemaiem Hill (b) in Jijel, a tourism potential site, is being urbanized and occupied by construction.

(a)

(b)

**Figure 18.** Uncontrolled urbanization on Laakabi (a), and Romane Riverbed (b) in Jijel.

## 4. Responsibilities: Key actors, roles, and levers for action

***The responsibility for this unfortunate situation is widely shared and falls particularly on:***

-The legislator, who enacts laws that are often ill-adapted to the cultural, social, and environmental context. Building legislation is a fundamental tool. Its purpose is to define the framework and create the necessary conditions for balanced community development and for construction in general. It should foster a high-quality architectural and urban living environment. When building regulations fail to achieve satisfactory outcomes, alternative strategies must be explored.

-The State, which bears a multiple and extensive responsibility in shaping the built environment. It must ensure the strict enforcement of existing regulations. However, legislation alone is not sufficient. Decree No. 94-07 of 18 May 1994, relating to the conditions of architectural production and the practice of the architectural profession, clearly states that the quality of construction, its integration into the surrounding environment, respect for natural and urban landscapes, and the preservation of heritage and the built environment are matters of public interest.

However, an Architecture, Urban Planning and Built Environment Committee has been established in each province (wilaya) to provide advisory opinions on the issues mentioned in the decree, but only when it is referred to by local authorities.

We are witnessing a lack of initiative and political will among decision-makers and professionals to confront this bleak and critical situation, as socio-economic concerns tend to prevail over rational planning. We are experiencing a “forward escape” policy that results in powerlessness in the face of crisis.

-Architects and construction professionals, who often lack sufficient creativity and in-depth knowledge of the environment in its broadest sense.

-Citizens, who do not respect the regulations governing building construction.

The absence of knowledge of identity-based architectural culture rooted in tradition and heritage among builders, citizens, and decision-makers further worsens the situation.

## 5. Solutions : Does Traditional and Heritage Architecture Offer Models of Quality?

In the past, most designers fully took environmental factors into account, particularly the local climate, when designing buildings. They were well aware of how to benefit from its advantages and avoid its constraints, while remaining within the limits of their available resources and means. Traditional architecture illustrates a wide diversity of methods and techniques for responding to the physical environment and often harsh living conditions, while ensuring comfort at both urban and architectural levels It demonstrates how the site is used to provide protection, promote natural ventilation, facilitate drainage, and offer shelter from the sun, while adapting to a challenging local climate (Bouchair and Dupagne 2003, Bouchair, Tebbouche et al. 2013, Bouchair 2014, Bouchair 2015).

### 5.1 The Courtyard House

The principle of the courtyard house is often associated with hot and dry regions; however, it is also found in temperate climates, particularly in the Mediterranean region. This internal courtyard, sometimes referred to as a patio, constitutes the central element around which the house and its social and family activities are organized.

***Its physical functions include:***

- thermal regulation and ventilation
- natural lighting

***Thermal regulation operates in two main ways:***

***Chimney effect ventilation:***

The upper, sun-exposed part becomes warmer. Air in contact with these surfaces, due to its lower density, tends to rise and creates an upward airflow. Fresh air enters from lower openings located in cooler areas (basements, cisterns, shaded zones). The efficiency of this thermal pumping can be enhanced through evaporation (fountains, water flow, pools, vegetation, sprinkling or irrigation).

***Heat deficit storage through nocturnal radiative cooling:***

The mass (soil, walls, water) at the bottom of the courtyard heats up only slightly during the day and radiates heat at night toward the clear sky, especially when it has a high emissivity (light-colored surfaces, marble, etc.). This creates a sustained thermal deficit compared to the warmer external environment. Cold air masses, due to density differences, remain in spaces with only high-level openings, allowing the creation of distinct microclimates within open-air spaces. This method is widely used in M'zab architecture. These courtyards collect, through density differences, the cool air produced by contact with the ground surface when it has released its solar heat back into the night sky through radiation.

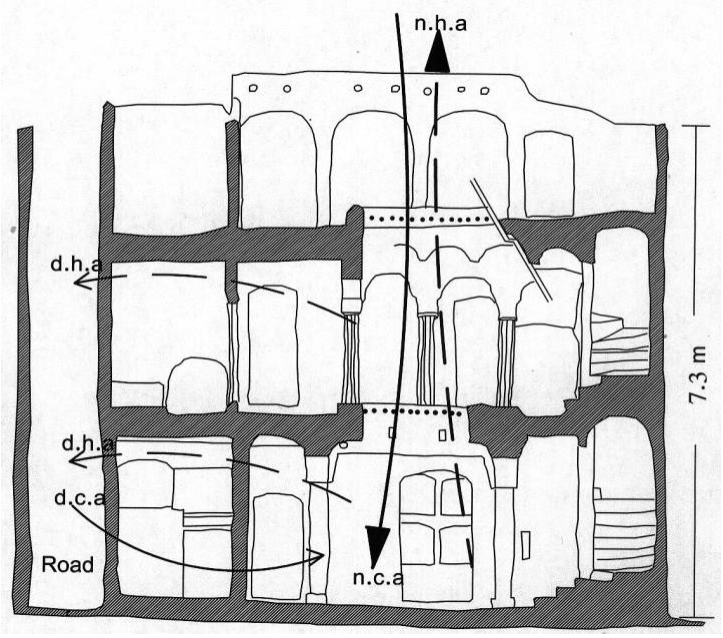



**Figure 19.** Schematic diagram for a typical courtyard used in M'zab architecture (Bouchair 2004). (d = day, n = night, h = hot, c = cool, a = air).

**5.2 Wind towers :**

In vernacular Arab-Islamic architecture, particularly in arid regions, buildings are often equipped with wind towers designed to capture cooler winds and channel them inside the structure (Bahadori 1985, Bahadori 2018). This passive system helps reduce indoor air temperature and improves thermal comfort by promoting natural ventilation (Figure 20).

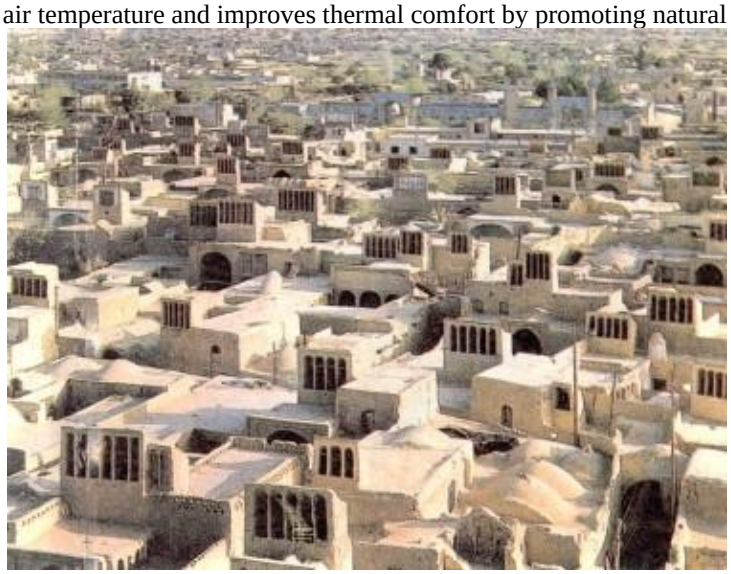


**Figure 20.** General view of unilateral wind towers in Meybod, Yazd Province, Iran ((Lukhi 2018).

**5.3 Building envelope using local materials with high thermal inertia**

The external walls of a building envelope form its "skin," through which a large portion of heat exchange occurs. High thermal inertia allows walls to store heat, thereby reducing the amount of heat retained in the air (Li and Xu 2006, Reilly

and Kinnane 2017). This is why old houses with thick stone walls remain cool during summer. In the hot regions of Algeria, vernacular architecture is distinguished by the use of locally available materials adapted to climatic conditions, including lime, natural stone, palm branches, and raw earth. These materials help ensure thermal comfort while also promoting the integration of buildings within their natural environment (Figure 21a). During the day, the building envelope acts as a thermal reservoir (Figure 21b). During the night, the heat stored in the envelope is partially released inside and largely dissipated outside (Figure 21c). Roofs are also constructed with thermal thermal insulation properties such as palm brances and adobe (Figure 22).

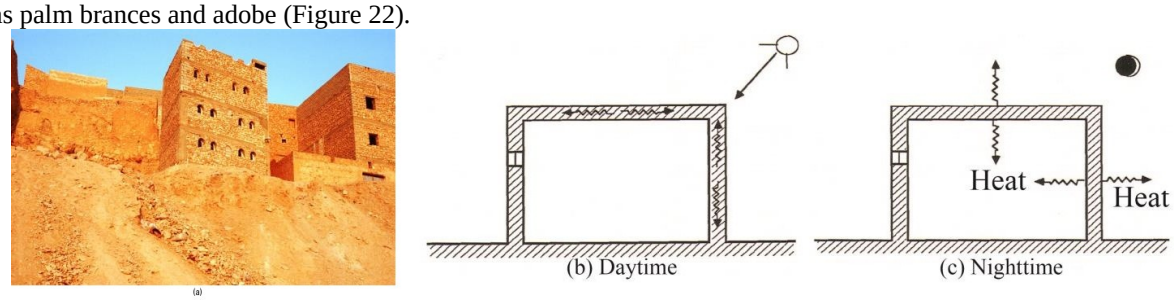



**Figure 21.** The use of high inertia material. (a) General view for a building in Melika, Ghardiaia. (b) Heat performance during the day. (c) Heat performance during the night .

**Figure 22.** Use of palm braches as insulating materials in roofing in Ghardaïa (Bouchair 2004).

### 5.4 Use of bright colors adapted to the climate

The use of bright colors adapted to the climate is an important architectural strategy in hot and sunny regions. Light-colored surfaces reflect a significant portion of solar radiation rather than absorbing it, which helps reduce heat gain within buildings and improves indoor thermal comfort (Pal, Goyal et al. 2020). By limiting the accumulation of heat on walls and roofs, bright colors contribute to lowering surface temperatures and reducing the need for artificial cooling (Yuxuan, Yunyun et al. 2020). In traditional architecture, especially in arid and Mediterranean climates, white and light earth tones are commonly used because of their high reflective capacity and their ability to respond effectively to intense sunlight. Beyond their environmental function, bright colors also enhance the aesthetic quality of urban spaces by creating visually pleasant and luminous environments (Figure 23).

**Figure 23.** Traditional use of bright colors for climatic adaptation in the Ksar of Ghardaia.

### 5.5 Exploitation and adaptation of settlement sites

Certain architectural practices, such as those found in the cities of the M'zab Valley, clearly demonstrate a long evolution of styles, materials, site adaptation, orientation, and the integration of all these elements within a hot and arid climate. The inhabitants adapted their dwellings to the environment by selecting the most suitable sites. They built their homes on hills overlooking the M'zab Valley in order to intelligently preserve the fertile agricultural land along the wadi, avoid flood risks, and facilitate the drainage of wastewater and runoff water (Figure 24) (Bouchair and Dupagne 2003, Bouchair 2004, Bouchair 2014).

(a) (b)

**Figure 24.** Position of settlements on highlands and hills. (a) Melika Ksar, (b) Ghardaia Ksar.

### 5.6 Minimizing surfaces exposed to direct solar radiation or wind

To protect themselves from direct solar radiation, desert inhabitants construct their buildings in a compact manner by reducing the façades exposed to the sun (Figure 25) (Bouchair 2004, Bouchair, Tebbouche et al. 2013).

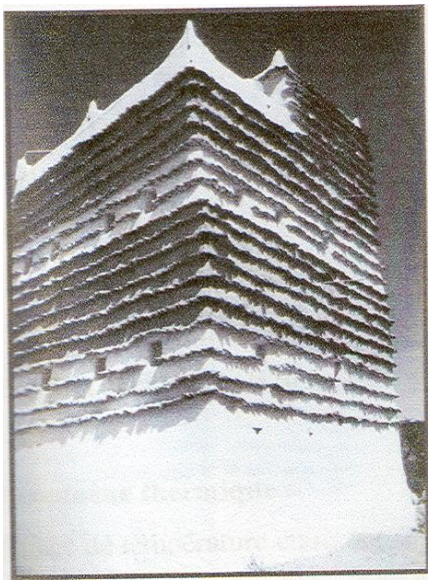
(a)

(b)

**Figure 25.** Clustered buildings in Ghardaia Ksar (a) and Ben-Izguen Ksar (b).

### 5.7 Providing shade and aesthetic value on façade

Architectural features are included into façades for both practical and decorative reasons. In addition to providing shaded areas that lessen direct solar exposure, inclined flat stones set into the façades aid in shielding structures from heavy downpours (Attia 2022). In a similar vein, the placement of bricks or stone masonry on façades enhances the architectural style and improves thermal comfort by creating shading effects. These strategies show how conventional building practices integrate architectural expression with environmental adaptability to improve both look and performance (Figure 26).



(a)

(b)

**Figure 26.** Façade design techniques for shading and climatic protection. (a) Flat stones embedded in an inclined manner for protection against torrential rain and for shading (b) Brickwork on facades to provide shade (in Yemen).

**5.8 Use of small openings facing the exterior to avoid excessive heat**

**Figure 27.** Building façades with small openings in El atteuf Ksar, Ghardaia.

**5.8 Use of vegetation**

Vegetation modifies the microclimate. The ideal species for hot, dry desert climates is the palm tree. Vegetation reduces the warmth of the ground and building surfaces by offering shade. It also lowers evaporation and soil erosion while using evapotranspiration to chill the surroundings. Additionally, vegetation produces timber for construction. It improves environmental comfort and safeguards constructed structures by acting as a natural filter, capturing dust and sand particles and creating a barrier against winds carrying sand. In general, vegetation contributes to the biological stability of desert areas, improves climatic conditions, and supports conventional building methods (Figure 27).

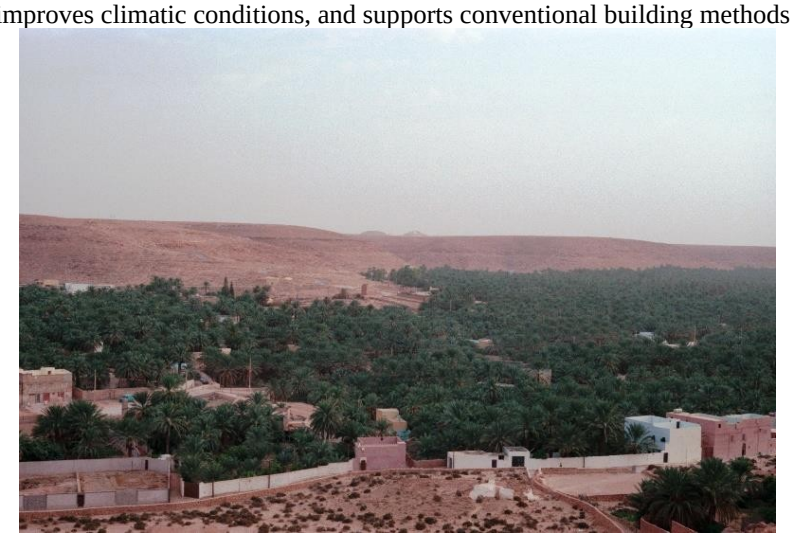


**Figure 28.** Palm grove of Beni Isguen in the M’zab.

**5.9 Colonial heritage**

Colonial towns and urban centers present a variety of physical settings and a diversity of architectural and urban landscapes, where public spaces contribute to the atmosphere of the city and enhance its visual identity. Colonial urban planning is well integrated into the site and is based on a strict cadastral layout, where street patterns are geometric and regular, and building façades are carefully ordered to define and structure the streetscape. Today, this form of urban design often appears more refined and coherent than that found in newer urban extensions, whether planned or informal, which are frequently less visually harmonious and less pleasant to the eye (Figure 29).

(a) (b)

**Figure 29.** Typical colonial towns and urban centers (a) Jijel triangle, (b) Mila square.

The urban architecture of colonial cities can serve as a lesson for future urban transformations and changes. It represents a particular historical era that needs to be read, comprehended, and conserved. Both political commitment and extensive interventions targeted at its conservation are necessary for the preservation of this historical legacy. Regretfully, entire colonial-era cities have been destroyed to provide space for communal housing projects. The building forms of colonial architecture

in the city of Jijel display more rational and refined aesthetic and functional qualities than many contemporary buildings. They feature a limited number of balconies with shallow depths, onto which French windows open, while still respecting alignment and urban planning regulations. Sometimes French windows have no balconies and are just shielded by railings that line up with the façades. In addition to improving the openings and façades, simple ornamental features also contribute to the structures' overall architectural character and visual coherence. Large amounts of balconies are typically constructed on façades that face public areas (Figures 30).

**Figure 30.** Colonial buildings with adapted balconies located on 1st November Avenue.

## 6. Conclusion

Achieving high-quality architecture requires a thoughtful appreciation of history as a source of inspiration, insight, and depth rather than as a retreat or a rejection of modernity. In order to create contemporary architecture that is based on our social, cultural, identity, and environmental values, this approach entails utilizing, appreciating, and analyzing prior experiences. Architectural creation, the quality of buildings, their harmonious integration into the surrounding environment-both natural and cultural-and the respect for natural and urban landscapes, as well as for heritage, must be the subject of a national consensus and culture. High-quality architecture helps create a better environment for all citizens. Every individual has the right to a healthy living environment and to high-standard architecture. It is the responsibility of every person and public institution to ensure that this right is effectively respected.

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