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Conservation Methods of Historic Gardens and the Adaptability to Contemporary Challenges

The revival of the royal palace Bardo garden in Tunisia

Ph.D. dissertation

by

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1. INTRODUCTION

1.1. Preamble

Throughout history, humans have developed an in-depth relationship with landscapes and the overall ecosystem. They have attempted to harness landscapes and natural resources for various purposes, starting with basic human needs such as agriculture, safety, and burial spaces. This has evolved into a more social and cultural aspect, creating pleasing environments that reflect artistic values, promote culture, and provide spaces for leisure and luxury.

Across the ages, civilisations showcased various gardens embedded in their given social system and cultural fundaments, and based on their own beliefs and interests; for instance, some cultures considered gardens a representation of paradise, while other civilisations regarded them an art form and an exhibition of power through the quality, design and metaphor of architectural elements within the garden. Moreover, all civilisations agreed that besides social and natural values, gardens hold more symbolic and spiritual values and are not only for physical pleasure.

Certainly, humans' relationship with gardens in contemporary times has changed vastly. It is indisputable that we still consider gardens as artistic spaces to showcase social and cultural values; however, nowadays, gardens are no longer considered as ~~an~~ additional outside space for pleasure and entertainment but more a necessary tool to adapt to the consequences of the modern environmental challenges we are facing in our daily lives.

Consequently, this human/garden relationship change also affects historic gardens. Indeed, historic gardens are considered places of artistic value, holding significant cultural values and being our inherited patrimony. Additionally, they hold a strong benefit for the ecosystem and are a great addition to the natural environment, especially if they are in a large and condensed urban environment.

These values only emphasize the importance of historic gardens' preservation and their adaptation to the contemporary challenges we are facing to firstly cherish the inherited artistic, cultural, and social values of the open spaces, secondly to benefit from the existing ecosystem and, the most importantly, to preserve the heritage site to the future generations.

1.2. Importance of the topic

Gardens, in general, are considered the intersection of human-made art and nature; in fact, by taming the natural elements and gaining horticultural skills and knowledge, we can even consider gardens as fully man-made creations based on using both natural elements and artistic/architectural

approaches and techniques. As a consequence of the art and nature combination, historic gardens have been recognised as living heritage by the International Council on Monuments and Sites (ICOMOS) in the 2nd article of the 1981 Florence Charter. Furthermore, as the main constituents of these heritage sites are mainly vegetation, thus, they might be impacted by the cycle of seasons and hence are changeable and should be renewable (ICOMOS, 1981). Generally, gardens are characterised by their fragility and constant change and growth; the green elements will certainly grow, age, and die much like any living organism which can lead in extreme cases of neglect and low maintenance to the loss of the garden's identity or even full disappearance and merge with wild nature (Obad Šćitaroci, Marić, Vahtar-Jurković, et al., 2019).

Moreover, historic gardens hold significant cultural values for societies, as they were established over a long period of time and therefore reflect a historical significance. Throughout their lifetime, they have hosted different owners with various tastes, they have accommodated diverse historical events and a variety of plant species and ecosystems, but most importantly, they display various architectural styles from specific periods, artistic elements such as statues, fountains, gates and garden furniture as examples. Furthermore, historic gardens demonstrate the perception of nature and gardens in past times through the activities and events held within the garden. The identity of historic gardens is eventually equal to the identity of the society and their artistic and horticultural heritage; the preservation of such patrimony is crucial for the current and future generations.

In the 20th century, historic garden conservation witnessed a lot of achievements and new elaborated recommendations, starting with the Florence Charter created and published by the ICOMOS and IFLA to advise on the conservation of historic gardens and to emphasise their significance as heritage sites. Besides the Florence charter, historic gardens have been recognised by several international associations and organisations as a public heritage that should be preserved and maintained, such as UNESCO. These organisations had a major role in improving the perception of professionals about historic gardens and are still helping to raise awareness about their values as heritage sites through the published Charters and recommendations that included direct definitions and recommended conservation actions.

However, this might be only the beginning of a more efficient garden heritage conservation field. In fact, due to the constantly changing circumstances like climate change, urban heat island effects, mass tourism, land usage, finances and management, historic gardens are at a greater risk nowadays of losing their value and identity.

This research focuses on the adaptation of historic gardens to the various contemporary challenges they are facing by determining sustainable solutions that might be applied in a conservation process to match the environmental, cultural and historical requirements for such heritage sites.

1.3. Problematic

With the adoption of the Florence charter by the ICOMOS and IFLA in 1981, the awareness about historic gardens and their environmental and cultural significance has risen, in addition to several other international and national organisations joining the historic gardens conservation movement. The field has witnessed many significant achievements of conservation and restoration activities on an international level. Despite the recognition of their cultural significance, historic gardens are still facing the risk of deterioration and heritage loss. Being a living heritage, these sites are indeed fragile, tangible heritage that also holds intangible significance for societies. They are worth the efforts of preservation and passing over to the upcoming generations to protect the identity, firstly and for educational and environmental benefits as well.

It is undeniable that our current environment is facing a fast paste change because of the many challenges, starting with the dynamic urbanization, the impacts of climate change, the mass consumption and the mass tourism, to the growth of the world population; all these symptoms are indexes that the consumption of our environment is raising to higher levels. Furthermore, the mentioned factors are not only impacting our ecosystem and its biodiversity but also influencing our fragile tangible heritage despite the conservation efforts.

However, historic gardens have been impacted significantly by several contemporary difficulties in different aspects: ecological, cultural and social. These impacts might potentially accelerate the deterioration of these heritage sites and can lead to identity loss. This research will focus on identifying the potential risks and proposing sustainable solutions to minimise the negative effects by adapting the historic gardens to our contemporary times.

1.4. Study hypothesis and research questions

The philosophy of heritage conservation lies in the ethics of protecting a cultural heritage because of its value for society, firstly, and secondly, because these sites are considered a fragile non-renewable resource that might be destroyed and lost if not treated accordingly. (Holtorf, 2020).

Recognising the value of the cultural heritage and the environmental benefits of historic gardens, and recognising the complexities of the heritage conservation field, this research's main

objective is to achieve scientific solutions that ensure the adaptation of historic gardens to the contemporary challenges we are facing nowadays.

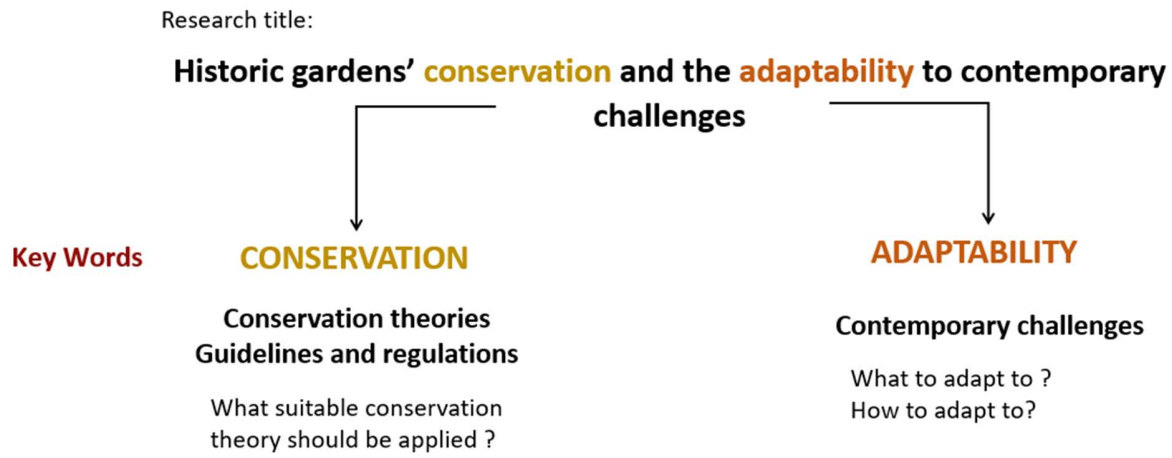


Figure 1Research title interpretation (Made by the Author)

1.5. Hypothesis

Historic gardens often struggle with remaining robust in the face of contemporary difficulties, starting with the changing climate and the impact of urban heat islands and reaching social and administrative challenges. However, because of the significance of such spaces, efforts to preserve historic gardens for future generations are necessary. This doctoral research aims to first, by collecting and investigating a large database of previous conservation strategies, and secondly, by evaluating the strategies on their results, the author will be able to formulate sustainable adaptation and ecologically beneficial practices together with heritage perspicacious actions.

This research attempts to:

1. Analyse the published international recommendations, charters and guidelines for historical gardens' conservation and preservation to study their main objectives, recommended actions and their adaptability to the heritage sites nowadays.

2. Identify the potential contemporary issues that historic gardens encounter nowadays and the possible risks that may accelerate heritage deterioration.

3. Outline a holistic approach that identifies the most efficient solutions for historic garden preservation and adaptation that might be applicable in future cases and ensures a sustainable solution that covers both the ecological and social aspects of the heritage site.

This research raises several questions.

1. What are the benefits of preserving historic gardens on the social, cultural, ecological, natural and economic aspects?
2. What are the threats that might accelerate the deterioration of historic gardens?
    a. What are the contemporary challenges that historic gardens are facing?
    b. How did these issues impact historic gardens?
3. What strategies and principles may help the historic gardens' adaptation to contemporary environmental and social issues while maintaining their historical authenticity and cultural values?
4. How can regulations and recommendations be developed within the sustainable conservation programs of historic gardens?

2. MATERIALS AND METHODS

For further understanding of the living heritage conservation subdiscipline, the author initiates the research with an in-depth literature review to study historic gardens' conservation principles, referring to ICOMOS charters as a focal point. The author studies multiple international recommendations and guidelines and follows the alterations and amendments throughout time for a better understanding of the new needs for heritage sites and to examine their compatibility with the contemporary challenges that historic gardens are facing.

After establishing a clear vision of the international regulations and recommendations, the author elaborates an analytic approach to examine and analyse several historic gardens as case studies for conservation and adaptation theories and practices, and to extract the implemented solutions, the lessons learned, and their potential results, for the present time and the projected goals.

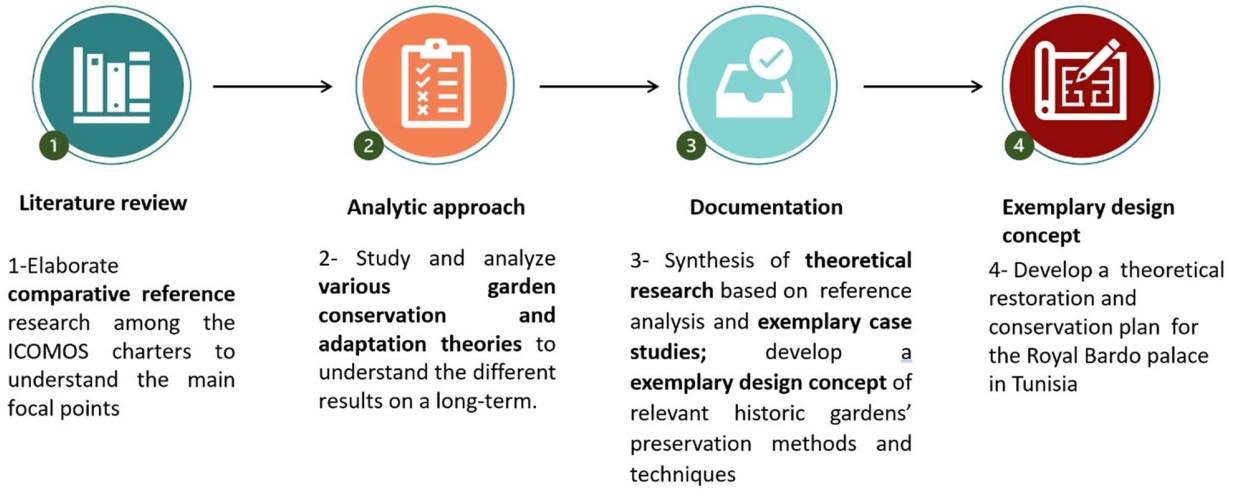


Figure 2: Methodology diagram (Made by the Author)

For this purpose, the author chose to work with precedents of conservation projects and strategies implemented in various gardens. The author is interested in historic gardens that are more or less exposed to the same challenges, but the conservation solutions, the steps of these projects, and their potential results were different.

2.1. Precedents and case studies

The studied gardens are considered significant cultural sites with rich history and high artistic values. The precedents' sites represent various locations and different historical period, and obviously different landscape architecture styles, still they share the same threats and difficulties. Because of their large green spaces, these sites are home to valuable and vulnerable micro-ecosystems, and historic elements that are a direct subject to the impacts of climate change and several contemporary challenges.

Furthermore, different strategies were implemented for the historic gardens conservation and working on decreasing the negative impacts caused by contemporary challenges. The author studies in full depth these conservation solutions and their impacts on historic gardens be either positive or negative.

- **KEW Royal Botanical Gardens:** Studying the "Climate positive by 2023" program published by the garden-management and analysing the sustainable solutions that the program proposes as well as the measuring methods for the carbon emissions within the garden.

- **Alhambra Gardens:** Studying the master plan for the preventive conservation proposal by the garden's management to protect the heritage site from potential threats on different levels: ecological, mass tourism, environmental, risk management, etc.

- **Royal Park of Moncalieri Castle**: Studying the theoretical and holistic conservation proposal realised by researchers and professionals based on the Burra Charter heritage conservation strategy.

- **Royal Botanic Gardens Victoria Melbourne:** Studying the landscape succession strategy realised in the Melbourne Botanic Gardens in order to align with the projected climate and average temperatures.

Building on the literature review and the analytic research, the author should have understood the history and precedents of historic gardens' conservation principles, the relevant terms, and also learned the most suitable practices for the common contemporary challenges that most of the gardens are facing nowadays. Furthermore, the Author gathered and recorded the best conservation strategies to improve the condition of a historic garden, protect heritage, preserve its cultural values, and adapt the heritage sites to contemporary challenges.

The documentation will ensure the presence of different aspects of the heritage conservation matter (Climate change, mass tourism, maintenance issues, administrative protection, site material deterioration, etc), moreover, the documentation will be theoretical and mutable to fit with different climates, locations, landscape architecture styles, historical periods, type of usage, legal status, etc. Lastly, the Author will develop a theoretical restoration and conservation strategy for the Royal Palace of Bardo in Tunis, Tunisia, based on the documentation developed in the previous phase.

The **Bardo Palace** in Tunis, Tunisia, holds significant historical and cultural importance. It has been a focal point for showcasing the national history of Tunisia through its collections, reflecting the country's heritage. The palace has witnessed transformations over the centuries, serving as a symbol of power and governance, and still exhibits the rich Tunisian culture nowadays. The palace was well known and mentioned in poetry and travellers' books for its large green spaces and rich vegetation that sadly vanished due to the severe space and functional changes that occurred within the palace perimeter.

3. LITERATURE REVIEW

The following chapter aims to explore and better understand terminologies and heritage conservation concepts, more specifically in the field of historic gardens conservation. To achieve the objective, the chapter starts with studying the definition of the term "historic garden" from different sources with several points of view. Additionally, it highlights the social, cultural and environmental/ecological aspects of a historic garden that increases their significance as a common human heritage. Finally, the chapter addresses the conservation of historic gardens, the types of interventions in different cases and lastly, the international organisations that participate in heritage conservation.

3.1. Historic garden

- **Definition**

It is always crucial to understand the terminology and definitions in every field of study. The term "historic garden", as simple as it seems, is a complex entity to identify and categorise. Originally, historic gardens were not included in the definition of historical monuments in the Venice Charter in 1964 (Dreija, 2012). Later on, the ICOMOS and IFLA published their official "historic garden" term in 1981 as the Florence Charter, where they have dedicated nine articles for the definition to cover every aspect of the historic garden phenomenon including their architectural and horticultural composition, their cultural significance, their ornamental elements, their scale and design nature, etc. (ICOMOS, 1981). Based on the Florence Charter combined articles, a historic garden is a designed entity with architectural and horticultural composition, hosting both a living heritage and architectural structures of artistic value, making it an interesting intersection between nature and art, and these sites are usually of cultural and social significance and require continuous preservation.

"Article 1. "*A historic garden is an architectural and horticultural composition of interest to the public from the historical or artistic point of view". As such, it is to be considered as a monument*." (ICOMOS, 1981)

"**Article 2:** "*The historic garden is an architectural composition whose constituents are primarily vegetal and therefore living, which means that they are perishable and renewable." Thus, its appearance reflects the perpetual balance between the cycle of the seasons, the growth and decay*

of nature and the desire of the artist and craftsman to keep it permanently unchanged ". (ICOMOS, 1981)

"Article 6: " *The term "historic garden" is equally applicable to small gardens and to large parks, whether formal or "landscape* ". (ICOMOS, 1981)

In fact, from a lexicographical perspective, if we divide the term "historic garden" into two terms, the term "Garden" is a noun that only refers to "*a small piece of land where vegetables or plants are grown*" according to the Oxford Dictionary, however, when the term "historic" is added, the definition becomes wider and more precise. John Sales stated that the definition of the term "garden" must also include designed landscapes and their purposes, whether it is educational or entertainment. Moreover, he stated that gardens are determined by separate elements such as buildings and landforms, environmental factors, and plant selections. In conclusion, Sales acknowledges gardens as not only designed and built objects but also as continuously changing processes. (Sales, 1995).

Figure 3: "Historic Garden" definition after Oxford Dictionary (Made by the author)

- **Difference between "cultural landscape" and "historic garden"**

Cultural landscapes express a wide range of relations of humankind with their territory and its natural elements, providing a setting for their daily lives and livelihood activities (Aplin, 2007). In 1992, the World Heritage Convention defined cultural landscapes as the "*Combined work of nature and man*" as they illustrate the development and evolution of humanity and their interactions with

their environment for economic, social and cultural purposes. (UNESCO World Heritage Centre). Moreover, UNESCO has set three different types of cultural landscapes:

- **Designed landscapes:** created intentionally by humans, including gardens and parks established for aesthetic, religious or monumental purposes.
- **Organically evolved landscape**: these landscapes present the process of evolution of humankind, and they can fall into two categories, the fossil landscapes where the process of evolution ended or the second category where the process of evolution is continuous and linked to contemporary societies.
- **Associative cultural landscape**: these landscapes are valued for their intangible heritage more than physical or monumental elements; they might be associated with religious, artistic or spiritual aspects (UNESCO, 2011).

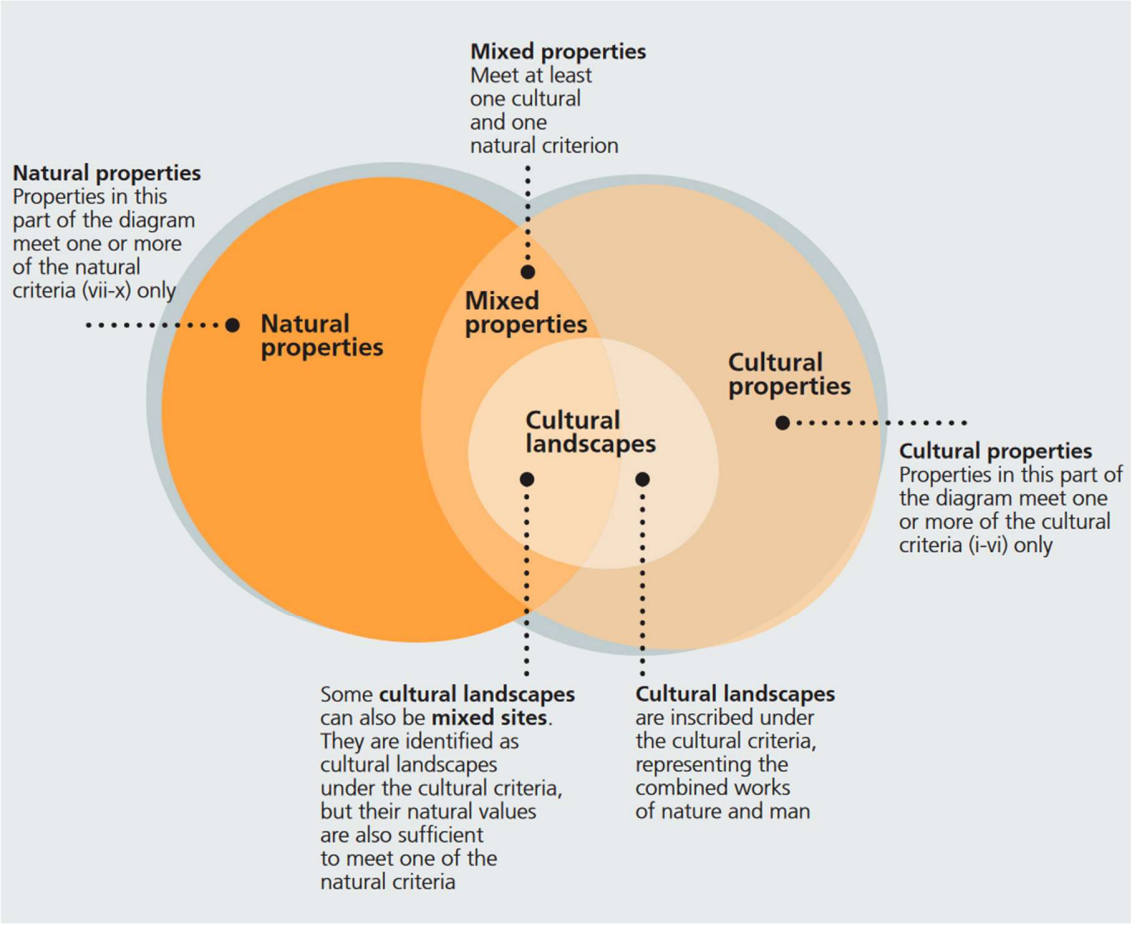


Figure 4: Cultural landscapes by UNESCO (Source :(UNESCO, 2011))

In conclusion, historic gardens are part of cultural landscapes due to their cultural and historical significance, however, the term "Cultural landscapes" includes a variety of categories which are all characterised by the fact that they are a combination of nature and man's work.

- **Cultural, environmental and social aspects of historic gardens**

Historic gardens are cultural assets with a set of notable monuments that were inherited from past generations. These sites are the concrete representation of the transformation from the past to the future, they display centuries of traditions and customs, not only in terms of landscape design and artistic interests but also in religious, spiritual, and social interests. Gardens in general have always symbolised human and civilisation development, artistic interests and tastes, and the cultural traditions of a period; for instance, Italian Renaissance gardens symbolise the balance and harmony between man and nature, while French Baroque gardens portray the ultimate power and wealth of their owners (Plumptre, 2007).

Furthermore, historic gardens hold valuable tangible and intangible heritage that must be passed on to future generations (Funsten, Borsellino, Schimmenti, 2020). The gardens are not only historic architectural structures that should be preserved, but also the intangible heritage that includes the horticultural practices, traditions and major historical events, the landscape design style, the beliefs and symbolism, and the given artistic movement. Because of the mentioned reasons, it is compulsory to preserve these sites for generations to come (Silva, Carvalho, 2022).

Florence Charter stated:

"***Article 8***. *A historic site is a specific landscape associated with a memorable act, as, for example, a major historic event; a well-known myth; an epic combat; or the subject of a famous picture*." (ICOMOS, 1981)

"Article 18. *While any historic garden is designed to be seen and walked about in, access to it must be restricted to the extent demanded by its size and vulnerability, so that its physical fabric and cultural message may be preserved."*(ICOMOS, 1981)

Besides its cultural and historic significance, historic gardens host rich and diverse ecosystems. Several historic gardens are home to unique plant selection that can be considered as part of their heritage identity, and also the cultivation methods, tree placements, and in some cases, the species might be part of the tangible and intangible heritage of a historic garden. Moreover, historic gardens ~~that are~~ located within an urban settlement are in fact a massive contribution to the biodiversity and ecosystem of the area (Olivadese, Dindo, 2022). However, the green elements of a historic garden can evolve with time as they are fragile entities that might grow old and age; they can be impacted by diseases or pests and can face destruction, and generally they constantly change over time. The

permanent change in the state of the vegetal element is actually a main characteristic of a historic garden; therefore, continuous and high maintenance is mandatory to preserve the historic vegetation (Olivadese, Dindo, 2022).

3.2. Historic garden conservation

- **Heritage conservation**

As a consequence of the industrial revolution in Europe in the 19th century, major changes occurred impacting directly the major cities and the majority of the society, starting with the significant population increase, fast urbanisation and the industrialisation of daily activities including agriculture (Jokilehto, 1999). In fact, according to scholars, there is a theory that the Western European World has been struggling with the feeling of "dissatisfaction" due to the fast changes during the 19th century, hence, they turned to heritage conservation as a mean to return to the old predictable times and stimulate the feeling of nostalgia (Poulios, 2010).(MacCannell, 1999).(Lowenthal, 1994).

The concept of heritage conservation originated initially in Europe and expanded later on an international level; in fact, the movement of modern heritage conservation occurred simultaneously with the evolution of information and news systems, leading to larger involvement of the public in heritage topics and debates through national and international associations (Jokilehto, 1999). Nowadays these non-governmental international organizations are deeply impacting the field of heritage conservation by providing definitions and guidelines and insuring the preservation of tangible and intangible cultural heritage (HASHİMOVA, 2022).

- **Historic garden conservation**

Garden heritage conservation is certainly a highly complex field that always deals with sensitive and mutable heritage sites. The elaborated conservation and preservation strategies are based on the site in question and on its initial state. Hence, there is no static formula that can be applied to multiple case studies. Moreover, besides the initial state of the historic garden, the professional background behind the work is taken into consideration too, more precisely, the conservation strategy might be influenced by professional's mindset and background, this will impact pathway of the conservation process and decisions.

Historic gardens conservation might be a complex area in landscape architecture, as these sites are considered aesthetic green spaces, where art and nature intersect, and a significant part of society's

history and culture, meaning that historic gardens benefit both the ecological system and the environment, and the cultural aspects of societies. Jacques David states that historic gardens are multiperiod creations that might have changed many times through time, and each change has its specific historical values (Jacques, 1995). According to Jhon Sales, "*Conservation is a continuous process that involves assessing the full significance of what exists, and arranging for the more important features, qualities and processes to be retained in the long term*." (Sales, 2000). This statement explains the philosophy of historic garden conservation, stating that the significance of elements can vary from one person to another, and hence, there would be various proposals and solutions. However, this statement does not give an ultimate freedom to decide the significance of elements only on a personal level.

Moreover, several studies suggest that before the Florence Charter in 1981, the conservation of historic gardens was less standardised, often involving a historically eclectic approach focused on the most important period of the associated house, rather than the comprehensive principles and long-term retention strategies that were later established by the Charter (Sales, 1995).

Types of interventions within the conservation strategy

Term	Definition	Source
Conservation	"Measures taken to extend the life of cultural heritage while strengthening transmission of its significant heritage messages and values. In the domain of cultural property, the aim of conservation is to maintain the physical and cultural characteristics of the object to ensure that its value is not diminished and that it will outlive our limited time span"	International Centre for the Study of the Preservation and Restoration of Cultural Property (ICCROM), Risk Preparedness: A Management Manual for World Cultural Heritage, 1998 and; UNESCO, Traditional Restoration Techniques: A RAMP Study, 1988.
Preservation	"The aim of preservation is to obviate damage liable to be caused by environmental or accidental factors, which pose a threat in the immediate surroundings of the object to be conserved. Accordingly, preventive methods and measures are not usually applied directly but are designed to control the microclimatic conditions of the environment with the aim of eradicating harmful agents or elements, which may have a temporary or permanent influence on the deterioration of the object."	UNESCO Institute for Statistics, 2009, UNESCO Framework for Cultural Statistics and UNESCO, Traditional Restoration Techniques: A RAMP Study, 1988.

Reconstruction	"To remake a design, sometimes with the benefit of good archival and visual information, and archaeological investigation of subsurface features) with accuracy, but without the inclusion of sufficient historic fabric to claim authenticity"	(Jacques 1995)
Restoration in spirit	"It has the primary aim of realizing the presumed original design intentions afresh, being based on the landscape designer's understanding and intuition."	(Jacques 1995)
Maintenance	"Means the continuous protective care of the fabric and setting of a place, and is to be distinguished from repair. Repair involves restoration or reconstruction."	Burra Charter 1999
Restoration	"Returning the existing fabric of a place to a known earlier state by removing accretions or by reassembling existing components without the introduction of new material. "	Burra Charter 1999
Reconstruction	" Returning a place to a known earlier state and is distinguished from restoration by the introduction of new material into the fabric. "	Burra Charter 1999
Adaptation	" Modifying a place to suit the existing use or a proposed use " The Burra Charter 1999 was developed when climate change was not yet widely recognized as a seriously challenging factor, while it advocates for adaptation, it states it in a context for compatible uses and focuses on modifications for functional or ongoing cultural significance.	Burra Charter 1999

Table 1: Types of interventions in historic gardens – (Edited by the Author)

3.3. International organisations

Several national and international organisations and associations of a non-governmental nature are participating nowadays in the field of cultural heritage conservation. The following section focuses mainly on the most significant organisations that operate on an international level and elaborates a comparison between the contribution of UNESCO and ICOMOS in the historic gardens.

The Council of Europe and the European Landscape Convention

Adapted by the Council of Europe on the 20th of October 2000 in Florence, however, the convention entered into force only in March 2004 (Council of Europe Landscape Convention, 2024). The convention acknowledges that landscape in general is a key factor in individual and social

wellbeing as it is a part of human development and identity (Déjeant-Pons, 2006). The convention includes all types of landscapes and is not only concerned with the cultural landscapes and heritage sites. It sets several direct and clear objectives to promote, protect and manage landscapes across Europe. It aims to achieve several purposes by firstly raising awareness and encouraging citizens and authorities to value better the cultural, economic, and ecological significance of landscapes; secondly, to include more regional regulations within the urban planning policies that ensure their economic and cultural management. Lastly, they aim to encourage the active participation of stakeholders and citizens in the sustainable management and development of European landscapes (Council of Europe Landscape Convention, 2024).

The European Landscape Convention helped improve the landscape management and exploitation across Europe, mainly by elaborating legal instruments to protect the landscapes across Europe, and also promoting the idea that landscapes are a shared responsibility and thus improving the cooperation among European nations (Déjeant-Pons, 2006).

The United Nations Educational, Scientific and Cultural Organisation (UNESCO)

UNESCO was founded in November 1945, and according to Poul Duedahl, "*The establishment of UNESCO was a direct response to the violent actions during World War II*" (Duedahl, 2016). Their initial main goal was to improve peace and security around the world through mental support after the war (Duedahl, 2016). Originally, UNESCO had prioritised fighting against illiteracy, which they considered as "incompatible" with human dignity; they have promoted education, science and culture and attempted to change mindsets on an international level (Valderrama Martínez, 1995). Furthermore, in 1950 UNESCO launched a project titled "History of Mankind", emphasizing the fact that we as humans have a common history as we belong to the same world, during this project they shared several academic publications promoting cultural heritage, and at the same time initiated the safeguarding of common heritage that has been affected during the second world war (Valderrama Martínez, 1995).

Overall, the UNESCO goals have evolved all along their history, starting with addressing the most urgent issues on a global level. At the beginning, they had the vision of spreading education and science, advocating for international peace and safety and ensuring the safeguarding of mutual human cultural heritage that has been affected by the war (Duedahl, 2016). Currently, UNESCO has expanded their objectives to match contemporary needs while still ensuring its initial goals currently

they are also working on improving scientific knowledge in order to tackle environmental and sustainability issues and creating goals and strategic plans for the future (UNESCO, 2017).

In regard to cultural heritage protection, UNESCO adopted in 1972 the World Heritage Convention, aiming to recognise cultural and natural significant sites globally and protect them. In fact the World Heritage Convention took the first step internationally to create legal instruments to protect cultural landscapes in 1992 (Rössler, 2006). Moreover, as their primary goal, the convention agenda had special attention to heritage and environmental protection. Recently, new terms have been added as they take into consideration sustainability, culture and climate change, expanding their vision and future agendas (Rodwell, 2012).

The International Council on Monuments and Sites (ICOMOS)

Founded in 1965 in Warsaw, Poland, in accordance with the 2nd conservators' meetings held in Venice in 1964, the International Council on Monuments and Sites (ICOMOS) is a non-governmental association of cultural heritage professionals on an international level. The assembly is working on the conservation and protection of heritage sites and monuments, it benefits from the professional and intellectual exchanges of its cross-disciplinary members. They have published multiple international charters specified for heritage conservation and preservation; these charters are considered as the fundamental base for the field of heritage conservation as they put together a set of definitions and guidelines to help heritage conservation around the world to be as harmonized and unified as it can be. Moreover, they have established partnerships with international and also national authorities all around the world for the sake of raising awareness about heritage and issue projects. (Grenier, Nutley, Cochran) (Burke, 2007).

Aspect	UNESCO	ICOMOS
Primary Mission	Advocate spreading human rights through education and peace, and encourages the protection of both tangible and intangible cultural heritage, including natural resources as well as cultural practices and traditions.	Works on the conservation and protection of tangible cultural heritage on an international level through regulations and charters.
Types of interventions	Promotes cultural awareness of cultural heritage throughout the world through the World Heritage Convention, which recognises and protects cultural heritage sites.	Develops heritage conservation standardised guidelines and recommendations throughout, providing technical and expert advice, research and education.

Areas of intervention	Historic monuments, historic cities, cultural landscapes, buildings, archaeological sites, intangible heritage such as traditions, handy skills, customs and traditions.	Buildings, archaeological sites, and cultural landscapes, ICOMOS might contribute indirectly to the safeguarding of intangible heritage by applying them in cultural heritage conservation projects.
Main Approach to Heritage	Comprehensive approach, integrating heritage with other sustainable development goals	Technical expertise, standards, and research specifically in cultural heritage conservation
Collaboration	UNESCO and ICOMOS work in close partnership due to the nature of their intervention works. ICOMOS is the official advisory body to implement the World Heritage Convention of UNESCO in 1972 and helps evaluate and manage the World Heritage Sites.	

Table 2: Comparison between ICOMOS and UNESCO – (Edited by the Author)

3.4. International charters by ICOMOS

To a deeper understand the ICOMOS's objectives and guidelines, of the ICOMOS, it is necessary to analyse several published multidisciplinary charters and recommendations on an international level. For this purpose, besides reading and understanding the articles of the charters, the author applied a numerical and statistical approach to understand the main direction of the charter and its main purpose. This approach is based on determining the dominant category of articles within the charter. Based on the highest dedicated number of articles to a specific category, the author can then conclude the charter's purpose, whether it is to set definitions, maintenance and usage, types of interventions, etc. Moreover, this approach will help the author detect the motivations behind publishing the charter and the objectives that the document aims to achieve. Moreover, this approach will assist in finding the conservation guidelines timeline within the ICOMOS through the timely order of the charters and the problems that should be resolved.

Since their establishment, the ICOMOS has published several charters setting guidelines and recommendations for heritage conservation; these charters cover various fields, mostly physical cultural heritage and their management (Historic buildings, historic gardens, historic cities, archaeological sites, etc). Besides the relevant charters, ICOMOS publishes declarations that state principles and address pressing cultural heritage issues; for instance, charters promote practical guidelines and standards for specific heritage areas, while declarations are often used to help raise awareness and advocate for heritage conservation by affirming principles and values concerning the field. Furthermore, the ICOMOS Charters are the result of extensive, long and formal research by the

ICOMOS General Assembly, while ICOMOS Declarations are responsive and emerging from specific urgent issues.

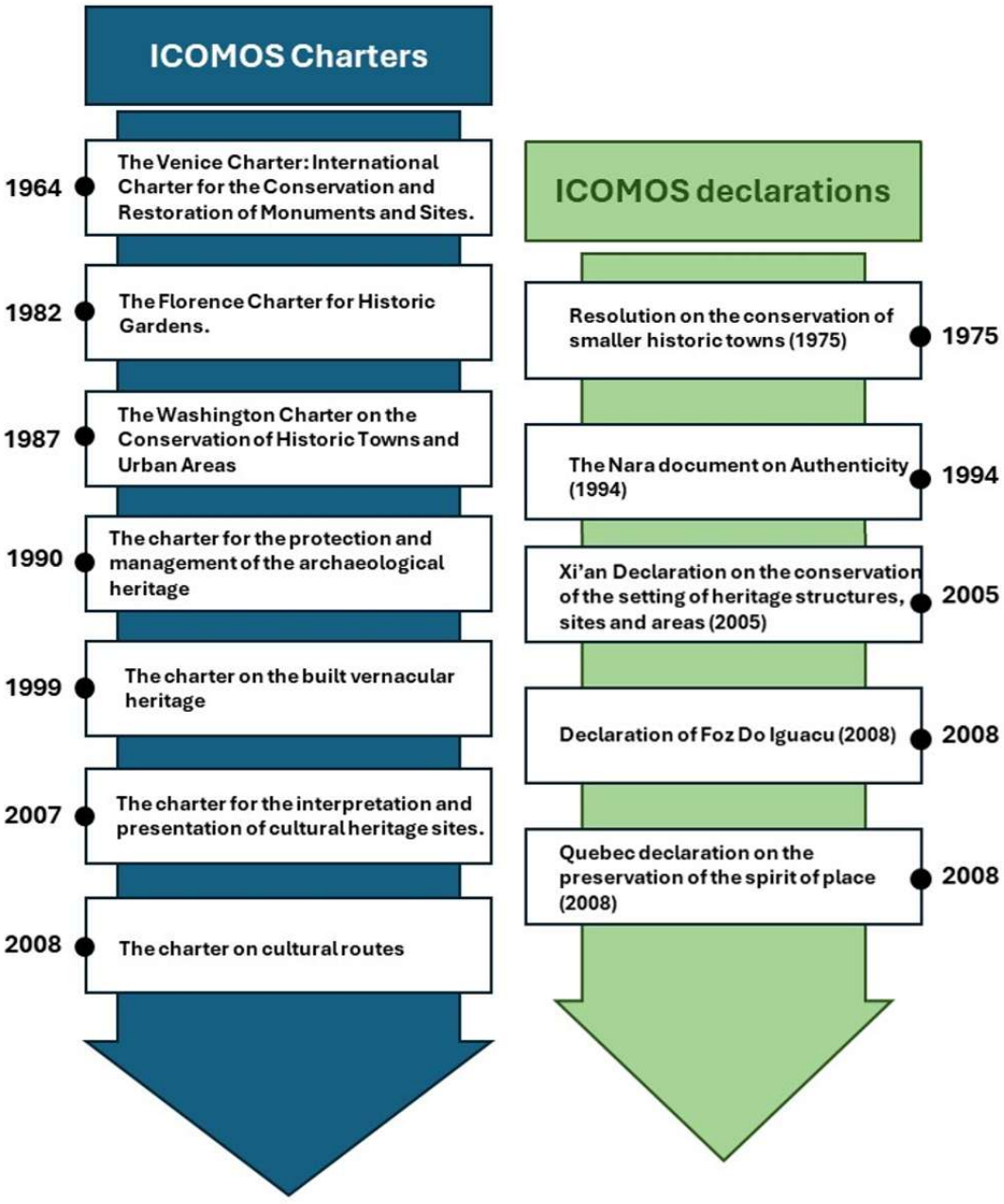


Figure 5: Timeline of ICOMOS published documents related to historic garden conservation (Made by the Author)

3.4.1. Venice Charter, 1964

The Venice Charter is considered the most significant guideline for monument conservation, published in 1964, previously to the foundation of the ICOMOS organisation. It has been the leading document of the fundamentals and principles for architectural conservation and restoration, and the

reference point for the development of several other international conservation documents. This charter helped to raise awareness of heritage conservation on an international level and to introduce several innovative concepts at that time, such as historic buildings conservation, the application of modern technology in conservation projects, and encouraging international corporations (Ahmad, 2006).

Being the fundamental document for cultural heritage conservation, the Venice Charter presented the critical points that might affect the success of the conservation procedure, that are: the guidance regarding the preservation of the site's original state, the respect of the periodic contributions to the site, relying on several experts techniques throughout the process, documentation and most importantly, stating the responsibility of planning the conservation strategy should be realized on a national level to ensure the correct implementation of cultural aspects and traditions (Hanna, 2015).

Figure 6: Venice Charter's articles analysis (Made by the author)

The charter has a total of 16 articles; analysing the percentage of articles dedicated to each category, the study reveals that 3 articles are dedicated to definitions in general, focusing on the definition of the concept of conservation and restoration for historic sites; these articles represent 18.75% of the total charter. The second and the third categories are equal in this case, focusing separately on the conservation and restoration principles; both categories represent 62.5% of the total from the charter. The conservation chapter is setting the basis and principles for a holistic conservation process, while the restoration chapter is discussing in detail the restoration work that could or should be implemented in historic buildings' conservation plans. Lastly, the charter also includes 3 separate chapters regarding the usage of historic sites, the archaeological excavations and the significance of documentation.

Overall, and based on both the literature review and the statistical analysis, it is clear that the Venice Charter is dedicated mainly to the types of processes that can be applied to historic sites in general, in addition to setting definitions to standardise some technical terms internationally (ICOMOS, 1964).

3.4.2. Florence Charter,1982

Following the successful implementation of the Venice Charter and the achievements in the heritage conservation field, ICOMOS, together with IFLA[1] published the Florence Charter for historic gardens in December 1982, and was considered as an addendum to the Venice Charter (ICOMOS, 1981).

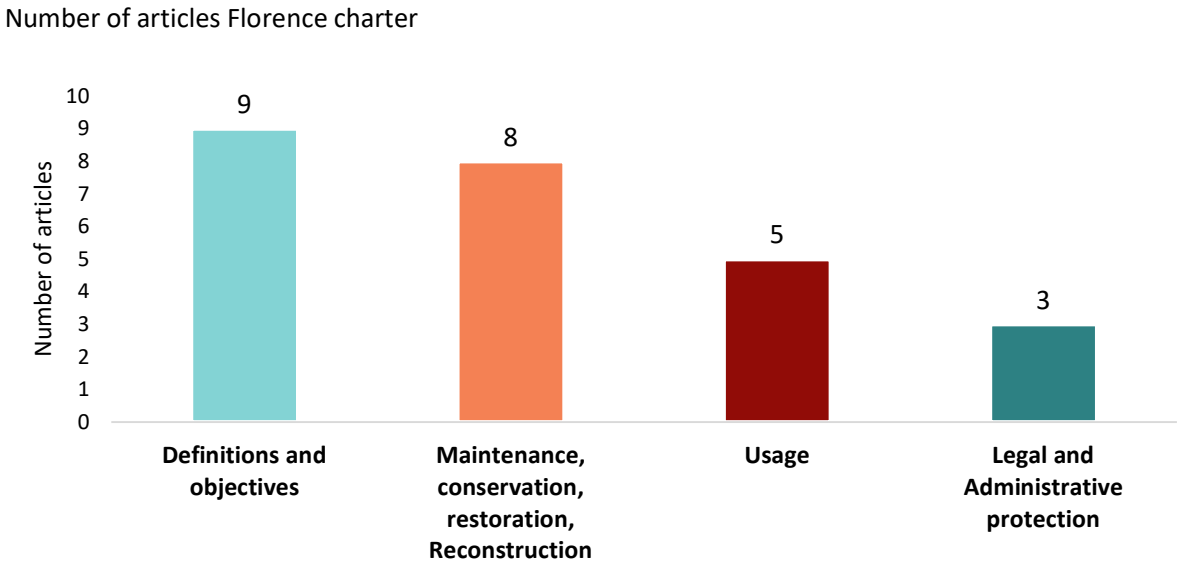


Figure 7: Florence Charter's article analysis (Made by the Author)

Despite being linked to the Venice Charter, since it is the main document for heritage site conservation, the Florence Charter has also been a successful implementation in this field mainly because of the recognition of historic gardens as living heritage which led to a set of specific conservation aspects that are suitable for the green elements of historic gardens.

In total, the Florence Charter is composed of 25 articles. Based on the graph attached, the document has 4 main categories. The largest percentage of the document, 36% (9 articles), is dedicated to definitions and objectives of the charter. Certainly, this chapter has led to a significant change in

[1] IFLA: International Federation of Landscape Architects

the historic gardens' conservation field. The chapter included definitions regarding the general structure of historic gardens, the size and scale, and the components, defining historic gardens as living heritage due to their primary vegetal composition.

Moreover, the charter includes 8 articles, dedicated to possible types of interventions in historic gardens. In this chapter, there was a significant emphasis on the continuous maintenance of these sites due to their main vegetal composition. Also, the chapters underline the essential research and field study tasks that should be conducted before any restoration or reconstruction works within the site.

Furthermore, the charter dedicates 5 articles to the "usage", emphasising the fragility of historic gardens, limiting and defining the types of activities that may not interfere with the preservation strategy of such sites. Finally, the last 3 articles in the Florence charter are dedicated to underlining the legibility of historic gardens for legal and administrative protection, and the continuous responsibility of authorities to take into consideration the vulnerability of the space, and the essential efforts that should be implemented for the preservation of the site.

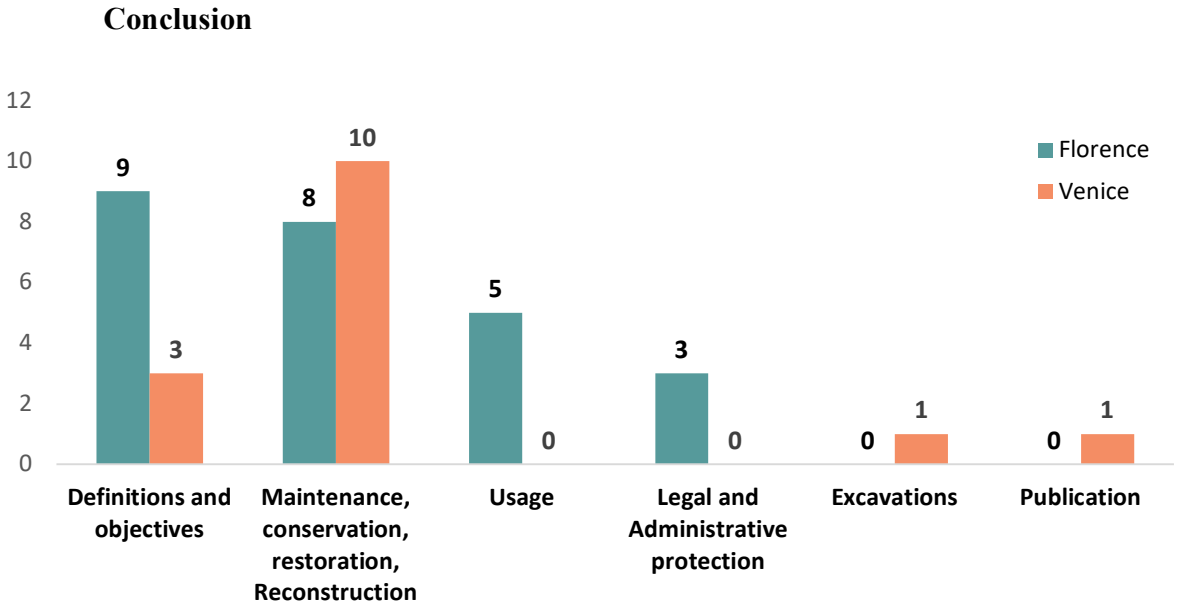


Figure 8: Combining the Venice Charter and the Florence Charter (Made by the Author)

Both charters are considered the main base for heritage conservation. Although the Florence Charter has been published as an addendum of the Venice Charter, the comparison has shown that the documents have different approaches because of the different types of sites. The Venice Charter has

a wider scope as it focuses on monuments and sites generally, which also includes historic gardens, whilst the Florence Charter focuses specifically on historic gardens. Moreover, the Florence Charter focuses on setting definitions and labelling the historic gardens whilst the Venice Charter focuses on the types of interventions that might be applied in a historic building which will not affect the building's authenticity, The Florence Charter limits the type of possible usage within a historic garden and emphasize the necessity of legal administrative whilst Venice charter only advises about the publication and documentation of the process (ICOMOS, 1981).

Venice Charter	Florence Charter
Monuments and sites	Specifically for historic gardens
Prioritise authenticity and minimal intervention.	Acknowledges the living elements of a historic garden
Focuses on the types of intervention that might be applied in a building and will guarantee the authenticity of the place	Focuses on the definition of historic gardens and underlines the changing aspect of the green, living elements of the site.

Table 3: Differences between Florence Charter and Venice Charter (Made by the Author)

3.4.3. Nara Document on Authenticity, Japan 1994

Firstly, it is essential to differentiate between a charter and a document, while both are official publications by the ICOMOS, and both are legitimate; however, they might not hold the same significance and influence among professionals due to the level of formality. The main difference is that charters are formal documents that establish guidelines and principles of the conservation and management of cultural heritage, whilst documents, being official too, have a narrower scope compared to charters.

The Nara document is also written in the spirit of the Venice charter with an additional emphasis on the spirituality and identity of a cultural heritage site:

"*The Nara Document on Authenticity is conceived in the spirit of the Charter of Venice, 1964, and builds on it and extends it in response to the expanding scope of cultural heritage concerns and interests in our contemporary world."* (ICOMOS, 1994)

The document mainly highlights the significance of the authenticity of cultural heritage sites, it promotes a broader understanding and acknowledgement of cultural heritage diversity, which might be present in many forms and hold a unique part of identity to different communities in multiple ways. The document explains that we should thoroughly comprehend this diversity in order to evaluate the

value and authenticity of a cultural site fairly and make decisions that respect the values and attributes of the given site.

The structure of the Nara document

1- Comprehensive definition of authenticity by emphasising the need for a broader understanding of cultural diversity within heritage conservation.
2- Advocate the significance of the concept of authenticity in cultural heritage conservation by explaining the concept of authenticity in cultural heritage and exploring.
3- Advises to engage the stakeholders and local communities in the decision-making process.
4- The document recommends the continuous and sustainable evolution of the conservation of heritage sites and explains that authenticity is not a static concept, and it can evolve.
5- Encouragement for international cooperation and exchange of knowledge and expertise in the field of cultural heritage protection.

3.4.4. The Burra Charter, Australia

As Australia overtook the British colonial legacy after the World War II, the society became interested in the conservation of both the built and the natural inheritance, hence the ICOMOS Australia carried out the publication of a national heritage conservation charter that responds to the social, cultural and natural needs adopting at the same time the same principles of the Venice charter (Lennon, 2014).

The Burra Charter, drafted by ICOMOS Australia in 1979, is a national charter that proved to be significantly beneficial and relevant on the international level too. The charter provides an in-depth framework for cultural heritage sites. The charter not only provides definitions and terminology, displays the conservation process and practice, and it also underlines the contemporary challenges that places of heritage might be facing. Moreover, in 2013, the Burra charter was reviewed and updated to clarify further its guidance by formalising the conservation process with a visual flowchart, expanding the understanding of cultural significance and including supplementary guidance, Practice Notes for detailed applications (ICOMOS Australia, 2013).

The structure of the Burra Charter is different from the international charters, as it has four main categories, while the logical structure is similar to the other documents. It follows the reasoning of the conservation process from the fundamental understanding of the philosophies and terminology

to the process of conservation and the potentially applied practices, and eventually the protection and maintenance of heritage sites.

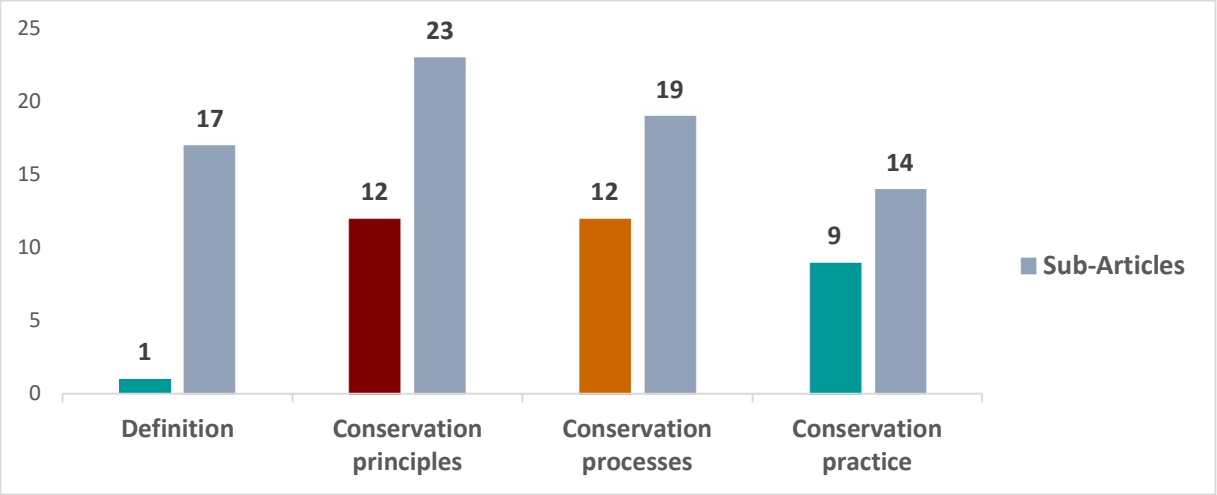


Figure 9: Burra Charter's article analysis based on articles and sub-articles (Made by the Author)

Overall, the Burra Charter has 34 articles and 73 sub-articles. A significant portion of the charter is dedicated to definitions and terminology as a basis for the following parts; however, the 'highest' part of the charter is the "conservation principles" which outlines the core and philosophies for an ideal heritage conservation process, is followed by a third chapter that translates the philosophy into actions, the "Conservation processes" is the second largest part of the document which includes the possible practices that can be applied in a heritage sites. Lastly, the Charter concludes with the "conservation practice", while this is considered the shortest part of the charter, it is indeed significant to the whole process as it outlines the principles of fair maintenance, adapting to the change, taking full responsibility for decisions and lastly, the importance of documentation (Australia ICOMOS, 2000).

Conclusion

Following the chronological order, this analysis of the ICOMOS charters' publications and studying the main interest and objective of each document proved that the foundation of heritage conservation practices has always been the Venice Charter. Moreover, the rest of the documents hold their weight in the field of heritage conservation. The Florence Charter has a more specific objective and dedicated recommendations, whilst the Nara Document emphasises the identity and spirit of the place. Lastly, the Burra Charter focuses on the contemporary conservation strategies that would have more efficient and sustainable results.

Conservation Management Plan: A strategic approach

A conservation management plan (CMP) is a site-specific strategic document that helps organise the management of a heritage site. It articulates the cultural significance of the site and advises the future usage, management, restoration works and alterations within the site (Institute of Historic Building Conservation, 2020). It is often referred to as "management plan" or "plan de gestion" and is a widely recognised tool in international heritage practice. In fact, the document is largely shaped by conservation guidelines from international organisations such as UNESCO (for World Heritage Sites), ICOMOS and ICCROM.

Together with ICCROM, M. Feilden and Jokilehto published in 1998 a book titled "Management guidelines for World cultural heritage sites". The book provides advice and recommendations to fulfil the intentions of the World Heritage Convention in 1972 (ICCROM, 1998). According to them, the Conservation Management Plan should be a living document regularly updated to reflect the changing conditions of the site. Moreover, it ensures the preservation and protection of identified heritage through (M. Feilden, Jokilehto, 1998):

- Ensuring the long-term preservation of a heritage site by safeguarding the cultural significance, fabric, and authenticity for future generations.
- Guiding the sustainable usage of the site by ensuring a balanced conservation and management strategy and appropriate use.
- Mitigating risks by identifying and addressing potential threats (natural disasters, neglect, human activities, climate change)
- Providing a clear framework for stakeholders to support decision making and make informed choices.

3.5. Fragility of Historic Gardens and the Contemporary Challenges

Being green, living heritage, and historic gardens combine the characteristics of built heritage sites and natural sites, and also points that are susceptible to the same vulnerability, namely fragility. They are always at risk of disappearance in case of neglect due to the natural process of decomposition (Obad Šćitaroci, Marić, Vahtar-Jurković, et al., 2019). In fact, the contemporary challenges we are facing nowadays are the main cause why the vulnerability and fragility of historic gardens is growing

and speeding up. Moreover, these contemporary challenges might be present in different aspects of historic gardens (Lahmar, Ben Salem, Benkaid Kasbah, et al., 2024)788.

3.6. Conservation strategies and historic gardens' authenticity

Historic gardens are always at risk of deterioration in case of neglect due to the natural changes of the vegetation, the ecosystem of the garden that might arrive at severe decomposition, while the main purpose of conservation strategies is to maintain the authenticity of a heritage site in all aspects (Rehman, 2011). Unfortunately, besides neglecting the historic garden, low-level or false maintenance might also be a major threat to a historic garden. To carry out a successful and authentic conservation strategy, in-depth research, investigation, and documentation are essential.

According to Abdul Rehman (Rehman, 2011) Authenticity has three different levels:

- **First degree:**
  Full respect should be given to authenticity; a minimum action will be taken in a historic garden, these actions should be strict to preservation, and complete documentation is a must to eliminate the possibility of deflection from the original design.
- **Second degree:**
  This category is a moderate level where restoration and rehabilitation fall, as an adaptive solution, some alternatives and changes might be considered, even if there will be changes in the original appearance of the design, in case of the lack of suitable material or craftsmanship.
- **Third degree:**
  In this category, there is a low consideration of authenticity, reconstruction works might be added to this degree, and the lack of precision when choosing materials and craftsmanship might result in a low standard of work that does not respect the authenticity of the heritage space entirely.

In the context of historic gardens, authenticity encompasses several dimensions and aspects, each dimension focuses on a specific aspect of the garden and aims for the protection of its original characteristics. According to Rehman (Rehman, 2011) authenticity can be categorised as below :

Aesthetic authenticity	Conservation work should be aesthetically accurate: Colours, textures, sizes of finishing materials and workmanship should be identical to the similar artwork.
Sensory authenticity	The environmental, thermal and sensory conditions should be like the original case, the usage of contemporary construction materials will not generate the same environmental compatibility as the original work.
Historical authenticity	The overall history of the garden should be taken into consideration and studied thoroughly, moreover, archeo-botanical studies might be required to identify the originally used plantation.

Scientific authenticity	Efforts must be made to conduct a scientifically correct construction that, at the same time, respects the original work in all aspects.
Socio-cultural authenticity	The social and cultural values must be preserved, and respected and remain unaltered.

Table 4: Respecting the authenticity aspects of historic gardens (by the author after Rehman 2011)

An unsuccessful historic garden conservation work:

Rehman has documented in his research a conservation project for the Shalamar Garden that has led to unsuccessful results, the lack of research and experience caused further degradation within the garden and the efforts regressed leading to loss of valuable garden elements.

Shalamar Garden is a royal Mughal Garden located in Lahore. It is also a case study where the conservation strategy had a negative result. The garden had severe damage in the 18th century and remained neglected until the 70s (Rehman, 2011). It is a typical Mughal Islamic Garden built in the 17th century, with a space structure that follows the spiritual quadripartite Islamic shape named *chahar bagh;* it has various terraces with a topographic difference, an advanced water system that includes canals, water surfaces and 300 fountains within a water system spreading over more than 16 Ha (Rehman, 2011).

The many years of neglect, during the Sikh period and the British colonisation period, resulted in the raise of the surrounding ground and in a seepage of water, and even the property walls were damaged which led to storm waters causing more damage to the garden and the water system pipes. The fountains were blocked due to the accumulation of silt and the damage of the original pavement bricks. Surely as a listed world heritage site, the Department of Archaeology and UNESCO engaged a group of experts to prepare a conservation master plan for the Shalamar Garden, however, the lack of experience of the majority of the hired group lead to an adequate conservation strategy that did not include several elements from the gardens such as planting design (Rehman, 2011).

The conservation process was not as successful as it should have been, because of the significant damage caused to the water supply system and the complexity of the restoration; the group decided to add a new water system in parallel to the older version that only lasted 40 years before showing signs of damage. Even though the department of archaeology attempted to restore the water system for a second time, the restoration was not sustainable, as they used contemporary materials. The process will be repeated every 50 years. To improve the quality of the grass cover, instead of adding fertiliser, the more than 15cm deep ~~of~~ topsoil layer was replaced with a new one and several existing plantations

were cut down in the process leading to the loss of archeo-botanical pieces of evidence. Furthermore, during the conservation of the pathways' pavements, a contemporary material that lack of the correct workmanship resulted in challenging the authenticity of the garden (Rehman, 2011).

In conclusion, conservation strategies might cause more damage to a historic garden if not conducted with full respect to its authenticity, cultural aspects, engineering solutions and the history of the place, therefore, detailed research is needed for the history and workmanship of the region is mandatory to realise a master plan for historic garden conservation.

3.7. Climate change

Besides their artistic, aesthetic and cultural aspects, historic gardens are living, human-made and maintained creatures and special ecosystems too, and thus, they are a complex intersection of culture, society and nature. In fact, historic garden conservation is directly related to nature conservation, the gardens reflect the climatic changes of the past and present, and as a result, the natural elements of the space are endangered too (Hüttl, David, Schneider, 2019).

According to Richard Bisgrove and Paul Hadley, the information relating to climate change and gardens is anecdotal, they believe that in order to establish scientific research on this matter, it is necessary to use data from horticultural crops, forestry and nature conservation research. Moreover, three different phenomena need to be studied to a better understanding of the possible impacts of climate change on landscapes. Firstly is the climate change itself and the projected changes in the future, secondly, the increased frequency of extreme weather events such as floods, storms, heatwaves and drought, and lastly, the dramatic and continuous changes in the earth's surface and land use system as a result of the human activities that are directly responsible for climate change (Bisgrove, Hadley, 2002).

Since 1950, several changes have been observed in long-term trends, and the frequency and intensity of extreme weather and climate events, which have always been linked to human influence and activities. According to "The Climate Change 2014 Synthesis Report" published by the Intergovernmental Panel on Climate Change[2] (IPCC), over the 21st century, the surface temperature has increased, and more heat waves will occur, and they will last for longer periods; extreme precipitation will become more frequent and more intense, in addition to the unpredictable

[2] The Intergovernmental Panel on Climate Change is a United Nations body that advances scientific knowledge about climate change caused by human activities. http://www.ipcc.ch/

precipitation distribution. Moreover, anthropogenic greenhouse gas emissions have largely increased since the pre-industrial era; between the years 2010 and 2019, emissions were higher than any previous decade (Pachauri, Mayer, 2015).(Calvin, Dasgupta, Krinner, et al., 2023).

Moreover, the continuously increasing emission of greenhouse gases will result in warmer temperatures worldwide and long-lasting changes to the climate system. Climate change will inflate the currently existing risks and cause new risks for the environmental and human ecosystem (Pachauri, Mayer, 2015).

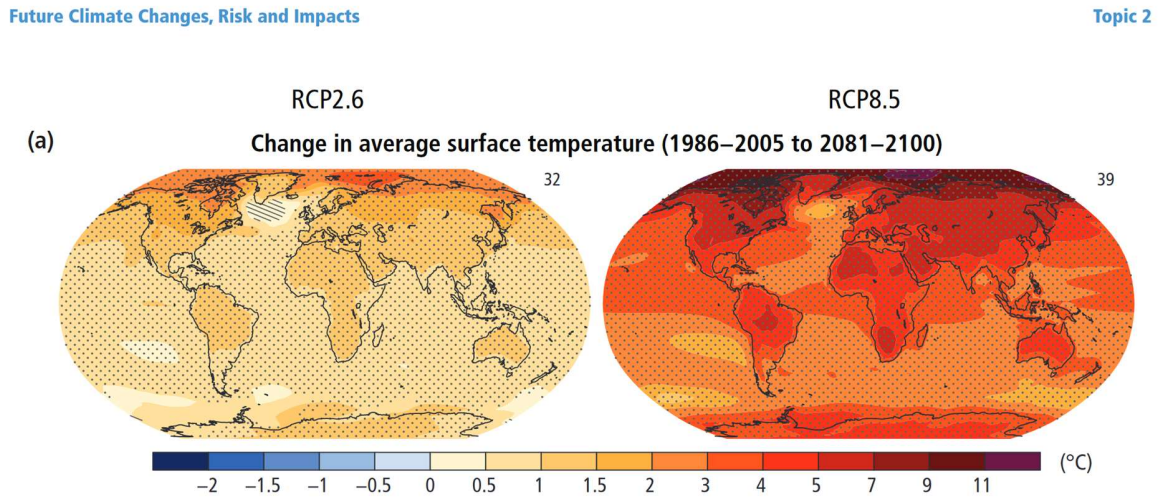


Figure 10: Change in average surface temperature (source: Climate change 2004/Synthesis report page 61)

3.8. The environmental and ecosystem impacts of climate change

Certainly, climate change has negative impacts on several components in historic gardens, affecting the micro-ecosystem, while the impacts will involve the soil, water, vegetation, built elements, and the visitors (Bisgrove, Hadley, 2002). Bisgrove and Hadley have released a technical report regarding the impacts of climate change on gardens in the United Kingdom, specifically, however, most of the general impacts might be common for different regions worldwide.

- **Climate change impacts on soil and groundwater**

Besides the temperature changes, the soil changes are holding a significant influence as well, primarily on plant growth, garden management and usage. The increased aerial temperature is predicted to hasten the loss of organic matter in the soil, which will affect the growth of vegetation.

moreover, the higher air temperature will result in reducing soil moisture because of the increase and speed-up of evapotranspiration by the vegetation. Furthermore, the loss of organic matter might decrease the soil structure and quality, hence, the soil is more vulnerable to predicted wind erosion and water erosion (Bisgrove, Hadley, 2002).

Moreover, climate change also impacts the groundwater significantly, both in direct and indirect ways. In fact, the increased droughts and irregular rainfall, together with the higher evaporation rates, due to higher air temperature, will lead to a decrease in water replenishment and eventually will cause lower groundwater levels. As temperatures rise, the water demand will increase to cover all aspects of modern human life, and agricultural and industrial demands are growing, which makes it more challenging to sustainability manage underground water resources (Taylor, Scanlon, Döll, et al., 2013).

- **Climate change impacts on the plantation and vegetation**

Being the most fragile and visible elements of a garden, plants are the most affected by climate change. The massive changes in the precipitation patterns, extreme weather events and rising temperatures are leading to favorable conditions for the spread of different pathogens (bacteria, fungi, and viruses) which result in increased disease infections in crops and natural systems as well (Egon, Oloyede, 2023).(Szabó, Doma-Tarcsányi, M. Szilágyi, et al., 2022). Moreover, climate change causes a biological change for the plants in particular, as a change in the lifecycle of the plants can be observed mainly by earlier than estimated blooming as a response to warmer temperatures (Willems, Scheepens, Bossdorf, 2021).

- **Climate change impacts on historic built elements**

Historic buildings and garden structures are also considered among the historic garden's components, as the Florence charter defined it (ICOMOS, 1981). Certainly, these historic buildings and constructions are not resistant to the new climate conditions and the risks associated with them, so the impacts might be observed in the aged and fragile materials of aged structures (Haugen, Bertolin, Leijonhufvud, et al., 2018).

Conclusion

According to Cassar and Pender, climate change is a major threat to all types of heritage sites. With the increase of the climate crisis, garden and landscape ecosystems become a more critical point

(Cassar, Pender, 2005). For historic parks and gardens, the threat is even more significant, especially to the mature vegetation. As a result, conservation and maintenance will be more challenging with the climate change impacts (Cassar, Pender, 2005).

3.9. Mass heritage tourism

In view of the growth of a new industry: Due to the heritage tourism industry, historic gardens have become a major tourist attraction based on their significant cultural, environmental, and social aspects; in fact, historic gardens are living heritage, linking the past, present and future, and hold sensation of a community past and continuous interest. These heritage sites hold not only the displayed tangible heritage but also the intangible heritage representing spirituality and beliefs. Nowadays, thanks to infrastructure development, remote heritage sites have become more accessible, and as international cultural tourism is rising, hence, the touristic pressure is increasing as well (Millar, 1989).

Heritage conservation and mass tourism have conflicting goals when it comes to managing historic gardens, especially when achieving economic benefits without planning simultaneous preservation policies (Millar, 1989). In fact, Serena Volo defined over-tourism as the overconsumption and overexploitation of touristic attractions and destinations, which carries negative consequences on the socio-cultural and environmental aspects (C Funsten, V Borsellino, E Schimmenti, 2020).

The Florence Charter has emphasised the fragility and vulnerability of historic gardens and ensured to align the intensity of the usage to the current state of the garden in Article 18:

"**Article *18.*** *While any historic garden is designed to be seen and walked about in, access to it must be restricted to the extent demanded by its size and vulnerability so that its physical fabric and cultural message may be preserved."*(ICOMOS, 1981)

Moreover, due to their fragility and cultural significance, for every heritage site a maximum capacity of visitors should be defined, whereby if the visitor capacity is exceeded the sustainability of the site will be at risk (Pereira, Martins, 2018). Pereira and Martins also put three (3) main categories that are impacted by over-tourism negatively:

Environmental: Higher vehicle congestion leads to overcrowding and noise, and air pollution, damaging the sustainability of the local and regional landscapes.

Economic: Higher living and service expenses for the residents, and higher property costs and taxes.

Cultural: unpredictable behaviour from the visitors, vandalism risk, and the appearance of "Phoney folk culture".

Moreover, the gains from tourism are also significant on a regional and national level, especially after differentiating between tourism and over-tourism. Certainly, tourism is an economic generator that should be implemented wisely through well-placed policies and regulations. Furthermore, the fragile state of the heritage site, its genius loci and its capacity are mandatory to ensure the sustainable preservation of a non-renewable resource. Assuming that all the above conditions are met, tourism certainly has positive impacts as well on the 3 categories (Pereira, Martins, 2018):

Environmental: safeguarding and preservation of natural and cultural resources and enhancing the aesthetic aspects of the region.

Economic: ameliorate the infrastructure, increase investment rate and employment opportunities.

Cultural: promoting cultural identity and, a better understanding of different communities through cross-cultural interaction.

Furthermore, Mass tourism has a direct impact on the ecological aspects of a historic garden; the large number of tourists can cause the destruction of the natural habitat and its population and disturb the ecosystem, especially in the case of historic gardens, as the ecosystem is already fragile. Moreover, the overuse of the site and the increased foot traffic will eventually soil compaction and harm the vegetation. Also, more stress will be placed on natural resources, and eventually their management will be more complicated. This includes the overuse of water resources, increased waste and further demand for maintenance and infrastructure (Taff, Benfield, Miller, et al., 2019).

On the other hand, under-tourism is also considered a threat to heritage sites, in fact, Gowreesunkar and Vo Thanh have explained that the new term refers to an under-visited tourist attraction site, and the causes are various and affect different aspects. For instance, under-tourism might be caused by the lack of reliable infrastructure, which makes reaching the site challenging for the tourists, the poor image in the media, especially places of conflict or natural disasters and diseases, poor leadership and management and lastly, the lack of financial support (C Funsten, V Borsellino, E Schimmenti, 2020).

Historic gardens have a complex relationship with tourism, due to their different structures, green elements and built elements. They attract tourists daily for different purposes. In many cases, people visit historic gardens to connect with nature and have a peaceful experience rather than visiting the historic site, which can lead, in some cases, to harming the site and not being aware of it because of the fragility of the site (Pouya, Demirel, Pouya, 2015). Furthermore, overcrowding a natural site will result in ecosystem degradation and the loss of biodiversity (Czałczyńska-Podolska, 2014). Therefore, strict and standard measures should be implemented to protect historic gardens from potential threats.

The list of World Heritage Sites by UNESCO prioritises heritage sites with outstanding universal cultural, natural and historic values. In fact, being registered in the list by UNESCO instantly elevates the site's recognition both nationally and internationally, it is actually a factor that increases the revenues of the site notably from tourism (Vecco, Caust, 2019). UNESCO recognises tourism as a factor to safeguard heritage sites and their improve their economic development (International Committee of the Red Cross, 1967), but they also acknowledge the potential risk of mass tourism, hence, they aim to realise the balance between sustainable conservation and development in the Budapest Declaration 2002 (Vecco, Caust, 2019).

Conclusion

Tourism is an essential part of heritage sites, it contributes to raising the awareness of communities towards the historic and cultural significance of the site and guarantees economic benefits and further advancement on a regional and national level, all the above can be only achieved if the balance between conservation and tourism is attained. In fact, several measurements and techniques are being studied worldwide in order to achieve sustainable tourism and the continuous preservation of heritage sites.

4- PRECEDENTS AND CASE STUDIES

To achieve optimal results, the author has selected a set of Precedents as case studies and references for studying and evaluating different conservation and preservation projects internationally, and analysing different conservation-related topics such as climate change, mass tourism, historic gardens and heritage conservation methods, etc. The author aimed to select various precedents with different conservation aims as an attempt to cover multiple subjects:

1. The first step is the fundamental historic gardens' conservation strategy represented by the theoretical conservation approach of the Royal Park of Moncalieri Castle. As it is based on the Burra Charter, the research presents a holistic approach to the historic garden's conservation inspired by the relevant international charter (Gullino, Pomatto, Gaino, et al., 2020).
2. Secondly, the author selected a preventive conservation strategy conducted in the Alhambra Gardens, Spain. The strategy focuses on identifying potential risk elements and attempting to eliminate them as a prevention for the sustainability of the heritage site.
3. Lastly, two different heritage sites with climate adaptation strategies serve for a comparative analysis. The applied solutions are, in fact, different on the site however, the goals remain the same. The author studies the climate adaptation solutions for the Royal Botanic Kew Gardens in the United Kingdom and the Royal Botanic Gardens Victoria Melbourne in Australia.

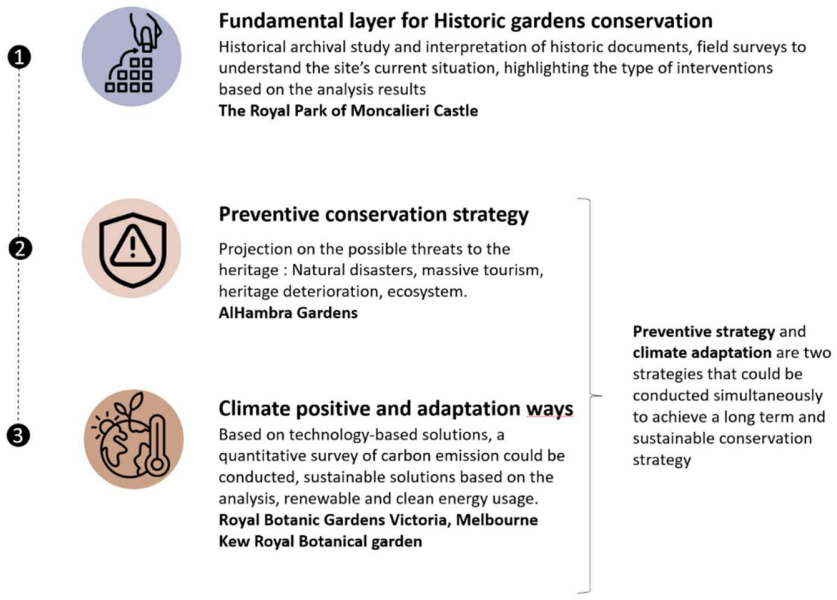


Figure 11: Precedents and case studies (Made be the Author)

4.1. Methodological and holistic approach for historic garden conservation - Royal Park of Moncalieri Castle

Being part of the Residences of the Royal House of Savoy, the Moncalieri Castle has been included in the UNESCO World Heritage List since 1997 (UNESCO World Heritage centre). The Moncalieri Castle was built initially as a military fortress in the 12th century; however, the site has been transformed into a royal residence and has entirely changed its function during the Savoy family dynasty in the 17th and 18th centuries. The castle and its garden are a significant representation of the late Renaissance and Baroque architectural styles in Italy and Europe. The gardens are divided into three parts: the formal garden, the rose garden, and the landscape park, which extends over 10 hectares. Due to its strategic location, the palace was transformed into a military base in 1945, hence, the site was unutilised and not accessible for a while (Gullino, Pomatto, Gaino, et al., 2020).

According to Gullino, currently there is a lack of scientific literature in terms of restoration approaches that cover all aspects of historic gardens simultaneously, historical, compositional and botanical elements of a historic garden. In 2020, researchers from the University of Turin in Italy published a research project titled *"New Challenges for Historic Gardens' Restoration: A Holistic Approach for the Royal Park of Moncalieri Castle (Turin Metropolitan Area, Italy)"*, The research aims to demonstrate a holistic approach for historic garden conservation covering all the necessary phases and to aim for more sustainable solutions that balances the contemporary needs with the historical and cultural significance of the garden, (Gullino, Pomatto, Gaino, et al., 2020).

Firstly, the research group emphasises the point that historic gardens are also part of the green infrastructure in a metropolitan context, hence the need to improve their sustainability as they provide several ecological benefits to their surroundings. Moreover, the research focuses on illustrating the significance of detailed site analysis to decision-making and its impacts on the results of the restoration project. The research group provided a holistic methodological framework that will be applied to achieve optimal results for the restoration of historic gardens in general.

Figure 12: Moncalieri Castel aerial view (Source: https://www.britannica.com/place/Moncalieri)

consists of three main stages, starting with identifying methods and collecting materials, which will firstly allow the researchers to analyse the garden's components' original state based on historic and archival documents, GIS tools, field surveys, etc. These investigations will secondly lead to identifying the level of permanence and sustainability of the site. Finally, the above-mentioned methods will lead firstly, to detect the priority elements that require urgent safeguarding, secondly, to the definition of the features that need conservation, and lastly, to realise the sustainable solution that should be applied for a long-term historic garden preservation (Gullino, Pomatto, Gaino, et al., 2020).

Methodology:

- Historical and archival study: analysing the historical documents, previous projects conducted on the site, historical cartography, historical documents, historical photographs and paintings.
- Evaluation of the site's structure: study the architectural structure of the site, the historic building and the pathway systems, the green compositions and water bodies, etc, through field surveys, photographs and plans.
- Geo-referencing and mapping: investigate the compositional features and structures of the site through GIS (Geographic Information System)

- Botanical studies: examine the biodiversity of the site, vegetal compositions and plant species through field studies, documentation and photographs.

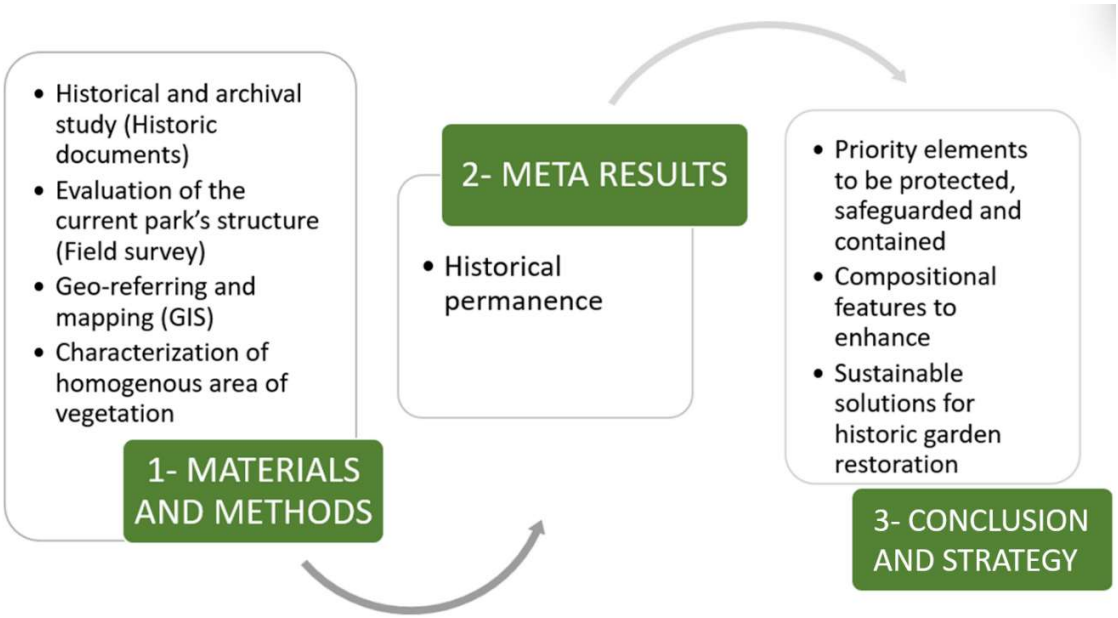


Figure 13: Methodological framework (edited by the author, after (Gullino, Pomatto, Gaino, et al., 2020))

The planned methodological framework:

- **Preservation of Historical and Architectural features:**

By comparing the current plan of the park with the archival documents and historic plans, the research group were able to find the lost parts of the park, as the usage of GIS mapping assisted in detecting the missing parts of the pathway systems. Moreover, the strategy also includes the aesthetic aspects and the visitor's landscape experience as efforts were put to study and re-establish the viewpoints and panoramic perspectives within the garden.

- **Botanic conservation strategy:**

The research group valorises the botanical and ecological aspect of the garden, they implemented technology-based solutions, GIS mapping and the usage of drones to identify the priority species and intervention zones. Moreover, the group proceeded to identify the invasive species and will actively align with the regional ecological guidelines to prevent the loss of native and historic vegetation.
In addition to that, the research group studies the historical vegetation records from the 19th century and are planning to reintroduce the previous species to the site as an attempt to improve the historical representation of the garden design withing the garden, also several measures will be taken to address the health and resilience of legacy plantation.

- **Sustainable management:**

  The group proposes to apply an adaptive management framework, which will be a monitoring program that will address several issues as climate change and its potential impacts. Additionally, the restoration project will include several stakeholders, local authorities, researchers and the public, aiming to promote educational and cultural initiatives, raise awareness and enhance visitor experience.

In conclusion, the research group emphasised that the first phase of site analysis, must include a deep understanding of the past, the present and the future of the historic garden. They explained that comparing the archival and historic documents with the new field study documentation might lead to identifying the long-lasting historic patterns in all aspects of the garden. Moreover, the research group emphasised the significance of the usage of technology-based solutions such as GIS tools in georeferencing the site as a means to determine the hidden spatial structure, the compositional features and the green or vegetal compositions (Gullino, Pomatto, Gaino, et al., 2020).

4.2. Preventive strategy - Alhambra Gardens

In the remaining ancient Arabic quarter of Granada stands the Alhambra Palace, which was built during the 13th and 14th centuries by the Nasrid Dynasty. It has been registered as a World Heritage site by UNESCO since 1984, and it is the best-preserved example of Moorish art and architecture; moreover, the Alhambra complex constitutes a real urban system that integrates architecture and landscape architecture of the medieval times. The area was and still is best known for the richly irrigated gardens and plantations, helped by the existing irrigation engineering in Andalusia, and mainly inspired by irrigation systems for higher agricultural productivity (UNESCO, 2009). Throughout its history, the Alhambra Palace has been owned by owners with different backgrounds due to the continuous occupation of the area. The palace complex represents a hybrid Mediterranean Spanish landscape that merges agriculture, aesthetics and architecture, while it combines Islamic art and Western influences (de Klerk, 2001).

The Alhambra is considered an urban settlement containing a series of residential buildings in addition to several community buildings such as mosques, schools, baths, pavilions, cemeteries and a series of gardens. These buildings and open spaces are all enclosed by walls (Chisholm, Garber, 2018) in the style of most Islamic cities. Moreover, besides the variety of usage within the site, it is also famous for the complex combination of shapes, green, and built elements. From a design perspective, the Alhambra lacks symmetry among the buildings, yet symmetry is a strong space-forming way

within small areas; moreover, water is present in a variety of forms and geometric shapes as the Moors considered water one of the most significant design elements in their gardens. Therefore, the Moors have gained an advanced knowledge of hydraulics, which helped them to bring water from the surrounding mountains to the site. Besides the aesthetic role, water surfaces also hold and supply ecosystems within the gardens and serve as an adaptation element for the dry and hot climate as well (Chisholm, Garber, 2018).

The palace contains a series of small gardens and pavilions for political and personal purposes. The most famous are the Court of Lions and the Court of Myrtles, despite the simplicity of their designs; these smaller patios with their unique ornaments contributed to increasing the authenticity of the site as the best representation of Islamic gardens in Andalucia. Moreover, the second part of Alhambra, The Generalife, the summer house of the royal family, is a combination of beauty and functionality, as it has a less formal design ŧ presenting a great variety of plantations and water elements and offering a panoramic view from the hills to the city of Granada (Chisholm, Garber, 2018).

Throughout its history, the Alhambra has witnessed accumulated repair and maintenance attempts since 1492 due to its cultural significance and artistic character. Moreover, the Catholic monarchs preserved the palace as an award for the victory over the Muslim dynasty in southern Spain (de Klerk, 2001). In the 19th century, French troops occupied the citadel of the Alhambra complex. During the occupation period, the military engineers supervised several urgent architectural repair plans but also cultivated the gardens and supervised the renovations of the watercourses and several fountains around the gardens.

Figure 14: Court of Lions in 1910 before the restoration of the 20th century (Source: https://mdc.csuc.cat/digital/collection/afceccf/id/18092)

During the 20th century, the restoration and conservation processes focused mainly on the built elements of the site and the architectural artefacts, however, in the case of the Alhambra Gardens, the conservation strategy is quite different due to the complexity of the built fabric and the designed landscapes (de Klerk, 2001). Leopold Torres Balbás, the leader of "the scientific restoration" in Spain, carried an essential part in the Alhambra restorations in the 20th century. His interventions were for both built elements and gardens as well and he worked on the preservation of more than 20 patios in the palace (Satoh, 2020).

When working on the conservation strategy, Torres studied the Islamic gardens in Granada and their spatial features, and he set several criteria for the conservation of Alhambra under the names of "eclecticism" and "elasticity":

- To firstly preserve the previous ancient works in an absolute manner
- To avoid adding new elements to the site, as much as possible
- To make the new additions distinguishable from the old parts
- The new additions may not interfere with the artistic character of the site.

Torres suggested that both the artistic and archaeological aspects of the Alhambra complex should be respected whenever possible, in fact, in the 19th and early 20th centuries, the restoration and conservation practices were only focusing on the built elements of the heritage site and neglecting their surroundings. Ultimately, the strategy in the Alhambra palace was different based on a deep understanding of the various layers of the site, that was mandatory for a successful conservation strategy (de Klerk, 2001).

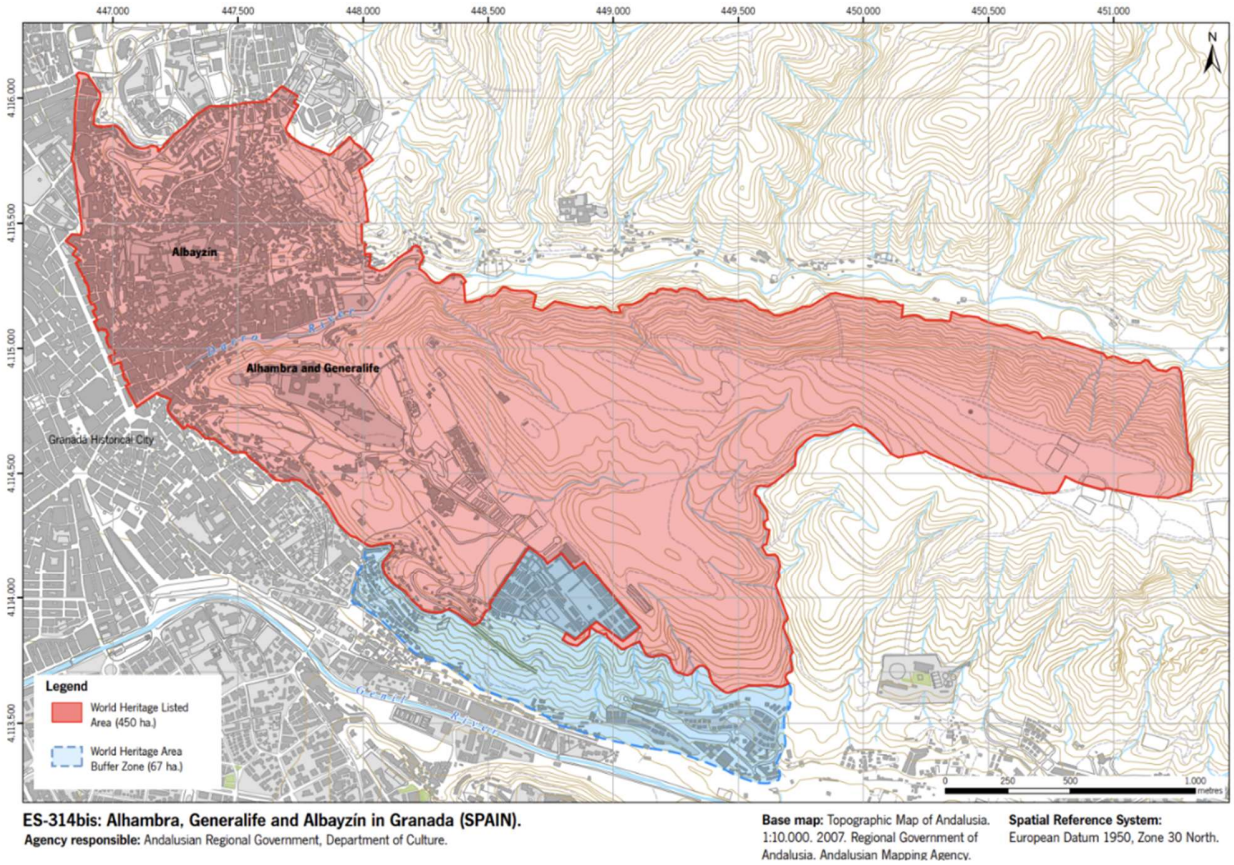


Figure 15: the Alhambra inscribed property and its buffer zone Source (UNESCO, 2009)

The Alhambra master plan for a preventive conservation strategy

Alhambra has been exposed to several risk factors throughout its history. Some of these factors have indeed left serious effects on the palace and currently present a significant challenge for the comprehensive conservation of Alhambra (Villafranca Jiménez, Gutiérrez-Carrillo, 2019). To realise a sustainable and continuous preservation plan for the Alhambra complex, the Board of Trustees of the Alhambra approved on strategic preventive master plan for 2007-2015 which was later extended to 2020 (Del Mar Villafranca, 2007).

The conservation plan was originally drafted by an external team of professionals from different disciplines led by the architect Pedro Salmeron Escobar in 2005, and an internal team of experts from the Board of Trustees of Alhambra. More than forty experts overall were invited to participate in the preparation of site diagnosis and contribute in the decision making of historic conservation approaches and strategies. The project focuses on a participatory approach where the main purpose is firstly, to fulfil the principle of democratization for cultural appropriation and social acceptance, and secondly, to have rich and creative suggestions for the new actions.

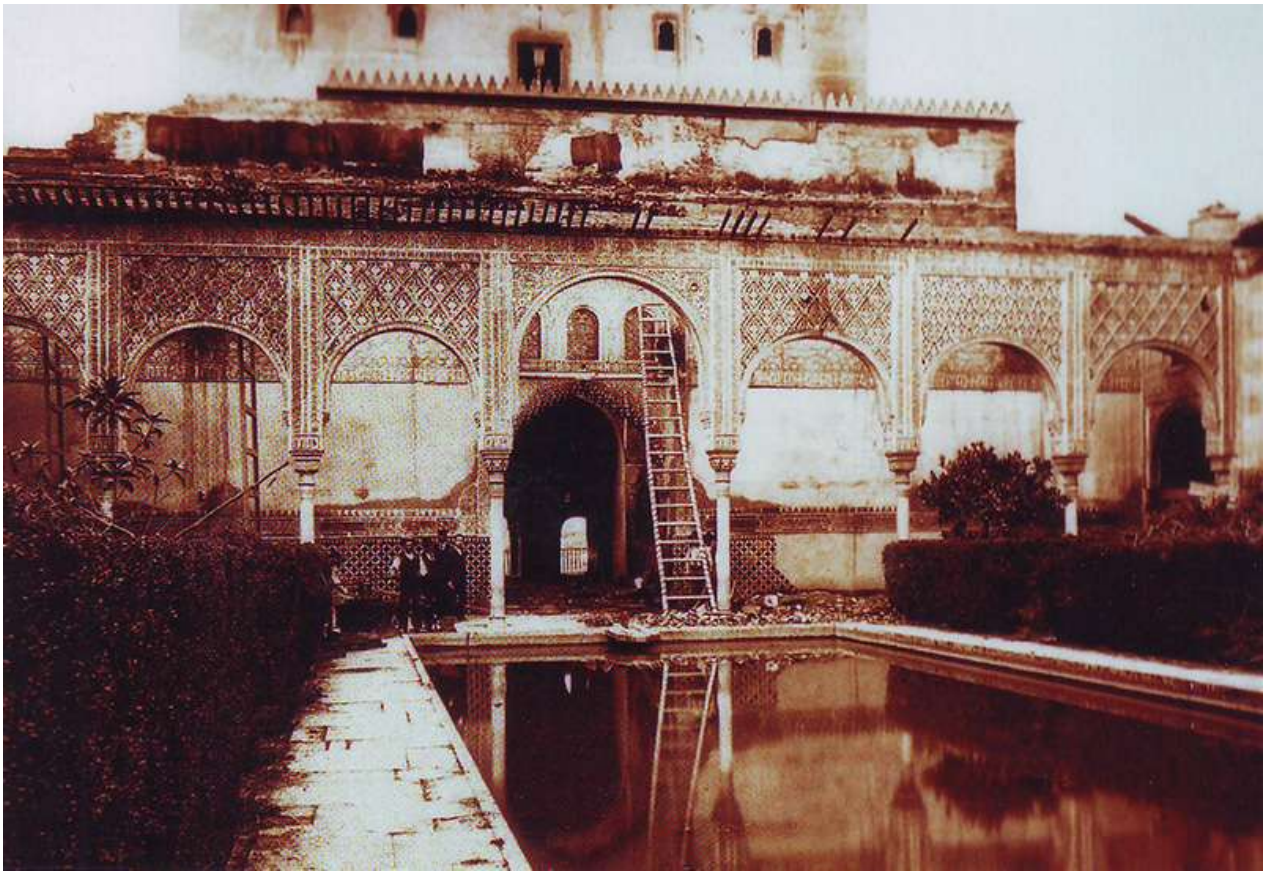


Figure 16: North gallery in the Court of Myrtles after the 1890 fire (source: https://www.legadoandalusi.es/magazine/when-the-alhambra-was-in-ruins/?lang=en.)

Prior to the realisation of the master plan, an economic study was conducted to analyse the monument as an economic resource, to analyse the quantitative and qualitative extent of the tangible and intangible aspects of the site and compare it with several cultural centres on a regional and national scale. Moreover, the significance of the site highlighted Alhambra as the leading cultural centre and emphasized the need to improve the preservation and future management based on ~~and consider~~ the dual significance of the site, namely the economic and social aspects (Del Mar Villafranca, 2007).

As a first step to the creation of the master plan, the different types of potential environmental and human risks were determined. Thereafter, several strategic solutions were developed to ensure optimal results (Villafranca Jiménez, Gutiérrez-Carrillo, 2019). According to Maria Del Mar Villafranca Jimenez, the director of the Board of Trustees of the Alhambra and Generalife, the plan had several strategic axes:

Preservation focuses on the comprehensive conservation of the site, focusing on the environmental, artistic and historic aspects all at once and ensuring a sustainable preservation for the future.

Cultural landscape Working in accordance with the European Landscape Convention (2000) and highlighting the Alhambra as a cultural landscape with heritage significance and historic background.

Sustainability to work on the enhancement of the sustainability of the site, to overcome the challenges related to tourism activities and preserve the historic, artistic, social and economic aspects of Alhambra.

Information and knowledge to create a platform that matches the new technologies of the 21st century, to communicate information, publish research, spread knowledge and raise awareness about the site.

The Master plan presents several punctual actions that will certainly contribute to enhancing the sustainability of Alhambra. Firstly, the document classifies the site as an urban settlement with unique cultural landscapes, therefore, it is suggested to improve, correct and extend the heritage protection perimeter and buffer zone, together with preparing a general inventory catalogue that cites real estate assets of the monuments and their surroundings. Moreover, the catalogue will also include the ethnographic heritage, gardens, forests, orchards and the values of the flora and fauna through digital thematic cartography. The plan suggests incorporating georeferenced cartography as a standard platform that relates data with spatial reference to further usage as a platform for all upcoming actions (Del Mar Villafranca, 2007).

Afterwards, the plan intends to improve the pathway and road systems for better access to the monument as well as an enhanced internal and external connection, plus planning an eco-friendly and non-pollutant transportation system within the protected perimeter of the site. Several cultural facilities and services will be planned in the surroundings as well as creating the Alhambra campus,

which includes the archive, libraries, museums, laboratories, restoration workshops, warehouses and technical offices (Del Mar Villafranca, 2007).

The plan promotes several risk management strategies to prevent the imbalance between the natural landscapes, human activities and heritage management:

- **Seismic movement**

  The Alhambra management has signed an agreement with the Centre of Research and Testing of Public Works to conduct a geomorphological analysis and a geotechnical assessment of the site. Due to previous seismic activities, accumulated damage can be observed and is still visible on the architectural structure of Alhambra and the instability of the hillside (Villafranca Jiménez, Gutiérrez-Carrillo, 2019).
- **Climate change and desertification**

  As a result of global warming and accumulated drought periods, the loss of vegetation can be observed around the complex, which increases the risk of erosion and decreases sustainability. For this purpose, the plan includes a desertification risk map to assess soil degradation and to define the root causes of the decrease in biodiversity. Later on, the plan introduces a drought control programme based on several observations and measurements. Secondly, the Master plan promotes the application of scientific methods to identify the least harmful chemical treatment to reestablish the biological and ecological balance of the Alhambra Gardens (Villafranca Jiménez, Gutiérrez-Carrillo, 2019).
- **Fire risk**

  The Master plan emphasises the fragility of the site and presents an action plan ensuring a design protection system to increase water resources availability and easy access to the fire control department in case of potential risks (Villafranca Jiménez, Gutiérrez-Carrillo, 2019).
- **Tourism and sustainability**

  The Alhambra complex is the leading cultural attraction site for tourists on the regional and national and international level; certainly, mass tourism represents a threat to the fragile state of the monument. The master plan focuses in this matter on achieving a “balanced, sustainable and comprehensive” strategy as an attempt to balance heritage management and economic benefits. After conducting an in-depth analysis of the tourism flow in the region, its management and its impact on the Alhambra monument, a capacity system was proposed as a preventive action, particularly in the most fragile areas of the castle. Moreover, the plan suggested several thematic routes passing by different viewing points internally and externally.

These routes will systematise the tourist flows within the monuments. Lastly, the plan proposes to enhance the data analysis before ticket reservation as a means to control capacity management. This action proved to extended the tourism season all over to eight months and contributed to ensuring better sustainability within the site (Villafranca Jiménez, Gutiérrez-Carrillo, 2019).

During my visit to Alhambra, the visitor management approach was very clear, particularly in the most delicate areas of the site, creating a balance between strict management and open access. The accessibility and usage of the Nasrid Palace area were tightly controlled with a strict entry schedule and clearly defined routes; only 300 people are allowed in the palace each half hour, and tourists were guided along designated pathways to ensure the minimal impact on the fragile elements of the patio. In the case of the military fortress (Alcazaba), the entrance is less strict than the Nasrid Palace, as there is no entry schedule or limited routes, but only a limited number of visitors inside the area. In contrast, the rest of the courtyards, including the Generalife, are freely accessible as they are more robust areas. From my personal point of view, visitor restrictions as a planned strategy for heritage management offer valuable insights into sustainable preservation practices. In fact, observations during the onsite visit revealed that the implementation of a daily visitor cap, along with limited visit time, proved to be a critical and successful mechanism to reduce the impacts of mass tourism and ensure sustainability. At the same time, these measurements contribute to raising the awareness of visitors by making them conscious of the importance and fragility of the site, which encourages a deeper appreciation for its preservation. The approach highlights the Alhambra as an exemplary model for sustainable heritage management, effectively balancing accessibility and long-term preservation of both cultural and environmental assets.

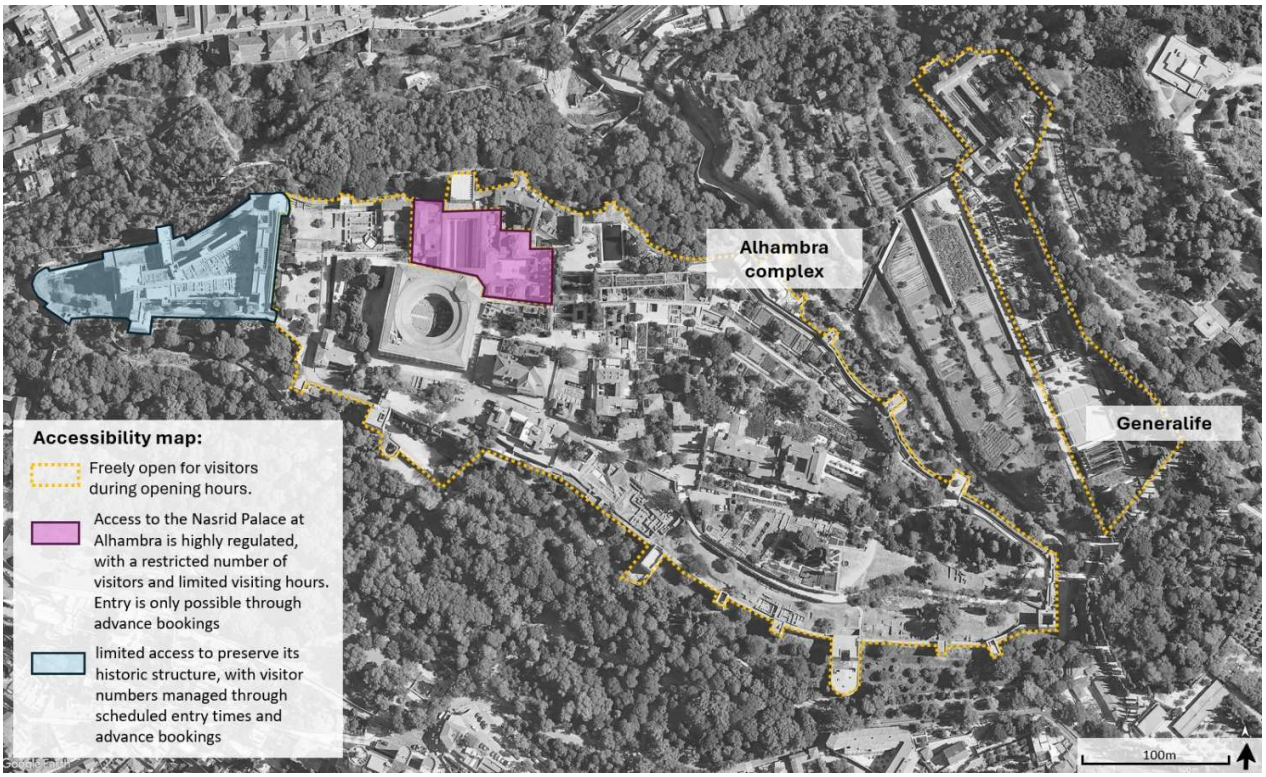


Figure 17: Accessibility and usage map (Made by the Author, Google earth Map

In conclusion, the Alhambra administration incorporated science-based solutions into their preventive heritage management plan (Villafranca Jiménez, Gutiérrez-Carrillo, 2019). The initiative seeks a better understanding of the future of the monument, its sustainability, its potential and cultural significance. Moreover, the example of the Alhambra is aiming to become a global reference for tourism management and sustainable conservation strategies (Del Mar Villafranca, 2007).

4.3. Royal Botanic Gardens, Victoria in Melbourne - A Landscape Succession Strategy

Botanic gardens have been contributing to the physical safeguarding of flora on both national and international scales through taking care of living plant collections, management of natural resources and lastly seed banking (J. Entwisle, 2019). For over than 30 years, botanical gardens have elevated their engagement towards plant conservation mainly as a response to the biodiversity loss because of climate change (Bramwell, 2024).

The Royal Botanic Garden of Melbourne is considered a centre of botanical research of high significance. It was established in 1846 and currently hosts more than 8,000 taxa from a wide range

of habitats around the world. The garden within its 38 ha area is a representation of the 19th-century landscape style, merging the picturesque garden art style and the botanical and collection aspects (The Victorian Heritage Database, 2002). The Botanic Garden and its plant collection are a source of research, education, and conservation studies as well as an aesthetic and entertainment space of high cultural heritage (Symes, 2017). In fact, the garden is a host of living, local, rare plant collections and a depository of endangered plants by extinction. Moreover, the garden has thematic plantings following different geographic, horticultural and ecological collections (The Victorian Heritage Database, 2002).

Besides its horticultural value, the garden holds a major social significance as well. The site is also a host of several historic built elements, such as a collection of pavilions, gates, nursery buildings, etc. The garden is also a major tourist attraction for national and international tourists due to its educational and recreational variety, and it hosts several public events throughout the year, including artistic performances and official celebrations (The Victorian Heritage Database, 2002).

The landscape succession toolkit

In 2018, the Royal Botanic Gardens Melbourne hosted the Botanic Gardens Climate Change Summit where 13 representatives from several worldwide botanic gardens agreed to launch the Climate Change Alliance of Botanic Gardens (CCABG) with the objective to be the voice of botanic gardens all over the globe and to tackle the climate change impacts on such fragile sites (Royal Botanic Gardens Victoria, 2021). The CCABG published a “Landscape Succession Toolkit” with the goal of guiding and assisting botanical gardens to adapt their plant collections to the impacts of climate change and to manage the transition of cultivated landscapes to be sustainable under the projected climate by following a step-by-step process (Climate Change Alliance of Botanic Gardens, 2022).

Benefits of landscape succession

The Climate Change Alliance of Botanic Garden cite 5 benefits of the landscape succession strategy in their published document “Landscape succession for 'Climate Ready' Botanic Gardens (Climate Change Alliance of Botanic Gardens, 2022).

- Plant conservation: By understanding the potential risks for the rare and vulnerable plant species, priority is given to safeguarding the plant collection and acting urgently to tackle climate change and ensure conservation actions.

- Strategic landscape management for climate change adaptation: Planning a landscape succession strategy will reveal several management gaps within the site and will effectively encourage several improvements in different areas such as plant conservation programs, water management, carbon emissions, biosecurity, human wellbeing, etc.
- Sustainable urban development: using the nature-based solution to decrease urban heat island effects, focusing on the vegetation's cooling capacity, shade-providing and transpiration capacity of large trees or tree canopies, which might effectively improve sustainability on local, regional, national and even global scales.
- Improving human well-being: Certainly, increasing sustainability will impact human well-being positively, not only by providing health benefits but also by improving the vital connection between nature and humanity's survival and improving the physical and mental well-being.
- Upgrading the scientific and professional knowledge: botanical gardens provide a unique opportunity to detect and survey the climate change phenomenon and its symptoms through deep learning challenges and opportunities to adapt and tackle the complexities of future climate conditions.

Landscape Succession Strategies and Actions

The Climate Change Alliance for Botanic Gardens developed a strategy that contains 5 main actions to achieve the correct goal of the landscape succession. This strategy can be used both by individuals and by institutes of botanic gardens (Climate Change Alliance of Botanic Gardens, 2022).

- Understand climate change:

The first action of the strategy is the science-based assessment of the potential risks of climate change, to collect data and information regarding the current and historical climatic conditions and, secondly, to become more familiar with the projected climate. Furthermore, a deep understanding of the impacts of climate change on the ecosystem of the garden is necessary to gather knowledge about scientific adaptation methods.

- Identify the impacts and the potential risks on the site:

Consists of running in-depth investigations to disclose the potential risks of climate change and their intensity on the site, this might be achievable by analysing the existing plant collection and

identifying the list of resilient plants for the future firstly, then to pointing out the management gaps and perceive their association with climate change and lastly to investigate if any potential challenges were not taken into consideration in the previous analysis.

- Prioritise the protection of more vulnerable plant species within the garden:

To have a successful landscape transition, the strategy suggests employing a predictive method for future plant selection, mainly to predict plant performance in the future. This can be achieved through several methods, by reviewing plant species from several locations that are native to similar projected climatic regimes of the given location.

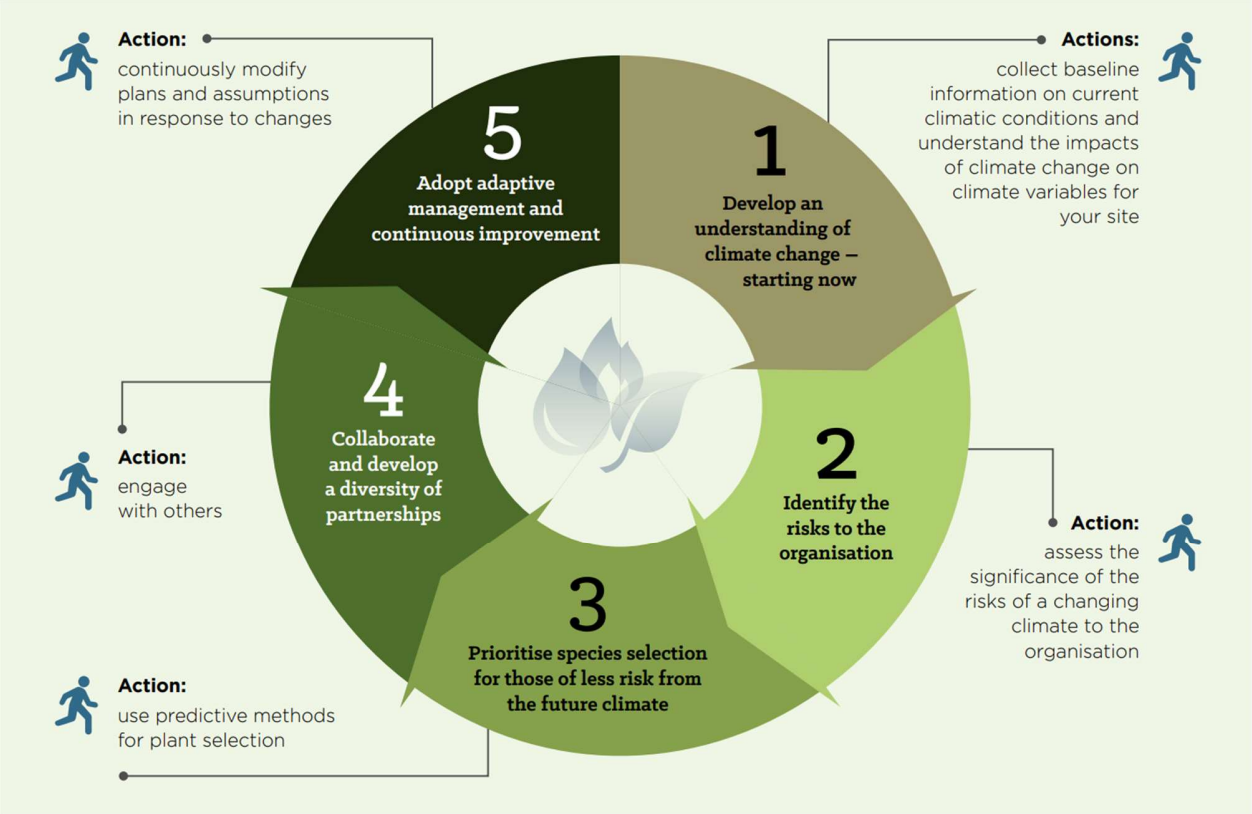


Figure 18: Landscape Succession for 'Climate Ready' Botanic Gardens: A Landscape Succession Toolkit (Source: https://www.rbg.vic.gov.au/media/tagodzaa/ccabglandscapesuccessiontoolkit.pdf)

- Continuous preservation and adaptive management

Because of the unique nature of botanic gardens and to achieve optimal results, a continuous adaptive management and preservation method is necessary, where the method is a continuous cycle that starts with setting targets and planning, then proceeds with implementing the intervention, to

monitor and evaluate the implemented actions, and lastly to consider the adjustments in case the results did not match the target.

- Collaborations and partnerships

Since climate change is a global challenge, it should be addressed collectively to ensure a sustainable future; for this purpose, the last action of the landscape succession strategy encourages engagement with other organisations through partnerships and networking, the purpose of which is to seek essential scientific resources and expertise to manage environmental issues effectively.

Applying the Landscape Succession Strategy in the Royal Botanic Gardens, Victoria, Melbourne

Climate change impacts

The climate change projection in Melbourne Gardens was assessed thoroughly by merging several developed models by international organisations and applying the best practices that are suitable for the site. The strategy was based on scenario 4.5 and scenario 8.5 from the Representative Concentration Pathway[3] (RCP) (Kendal, Farrar, 2017).

- **(RCP) 4.5 Scenario:** The scenario suggests that placing a variety of technologies and strategies will lead to a decrease in carbon emission by 2045 following a peak in 2040, However, the temperature will globally rise by 2℃ to 3℃ by 2100 and it is projected that many plant species and animals will not be able to adapt (Kendal, Farrar, 2017).
- **(RCP) 8.5 Scenario:** This scenario predicts the continuation of heavy fuel usage and minimal measures to reduce carbon emission, so these acts will lead to a global increase in the temperature of 4.3℃ by 2100 compared to pre-industrial times. Therefore, extreme weather events will become more frequent and a rise in the sea level threatens the coastal ecosystems (Kendal, Farrar, 2017).

Both scenarios predict that eventually temperature will increase by 1.7 ℃ in the case of RCP 4.5 by 2050, or a 3 ℃ increase by 2070 in the case of RCP 8.5 (Kendal, Farrar, 2017).

[3] Representative Concentration Pathway (RCP) are climate change scenarios to project future greenhouse gas concentration adopted by the Intergovernmental Panel on Climate Change (IPCC).

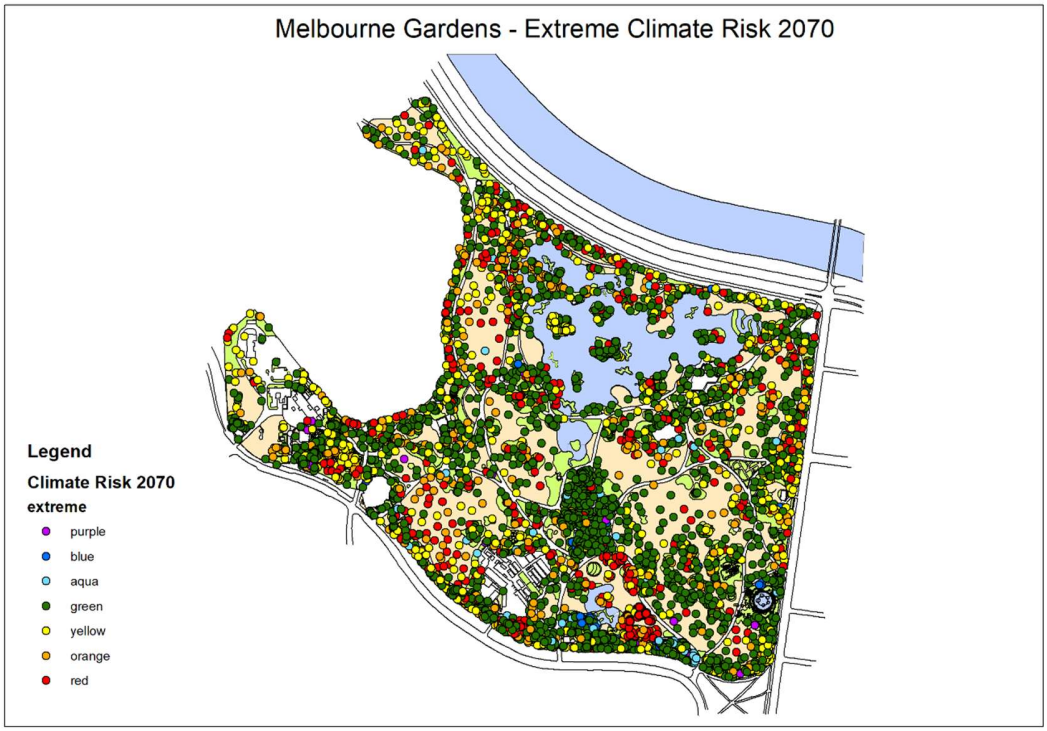


Figure 19: Melbourne Garden: the impacts of the projected climate on the current plant selection.(Source: https://www.rbg.vic.gov.au/initiatives/landscape-succession-strategy/assessment/)

The annual temperature recorded before 1950 in Melbourne was approximately 14.8°C and has been steadily increasing in Melbourne (between 1995 and 2014) to reach 16.3°C, although these numbers are generally pronounced in minimum, referring to the overnight temperature, increases in the daytime temperature have been observed as well. Moreover, the annual rainfall has decreased from 650 mm to an average of 564 mm in the last 25 years. These changes are in fact the impact of human-induced global warming due to the significant CO_2 emissions, while the urban heat island effect has aggravated the global situation (Kendal, Farrar, 2017).

Landscape succession strategy

The Royal Botanic Gardens Victoria launched their landscape succession strategy (LSS) from 2016 to 2036. The purpose is to simultaneously preserve the diversity of plant species within the garden and plan the transition of at least 75% of the plant species to be suitable for the projected climate of Melbourne in 2090 (Entwisle, Cole, Symes, 2017). Moreover, while the landscape succession strategy is contributing to the safeguarding of biodiversity and enhancing sustainability, it is also preserving the garden's heritage for future generations (Royal Botanic Gardens Board Victoria, 2016).

The Melbourne Botanic Gardens has been facing several major challenges related to the adaptation of the garden to the projected future climate, preserving the historic built elements within the garden, to manage and secure water resources within the garden, to safeguard the biodiversity in the face of global warming and lastly to ensure a successful transition of the garden and to maintain the cultural significance of the site. Intending to achieve the landscape succession goals and objectives, the Royal Botanic Gardens of Melbourne have developed five strategies and targets according to their published documentation (Royal Botanic Gardens Board Victoria, 2016).

- **Strategy 1** is to manage the plant collection transition to be suitable for the projected climate by improving the living collections database, to ameliorate the assessment approaches for defining the suitability of the plant collections to the projected climate and to seek collaborations with the purpose of conserving the rare, threatened flora in Victoria.
- **Strategy 2** is to create a plant selection of different ages and a high diversity of taxa, aiming to have equal or more than 8400 taxa of mixed age by 2036.
- **Strategy 3** is to improve the sustainable usage of water supplies and resources, attempting to fulfil all the irrigation needs from sustainable resources by 2020.
- **Strategy 4** is to increase the effectiveness of landscape design, aiming to enhance the green and built infrastructure for adaptation to the future climate.
- **Strategy 5** is to better understand the impacts of climate change on botanical gardens. The fixed target is to create effective communication and interactions between botanical gardens and public communities to raise awareness about climate change, biodiversity and environmental benefits.

In conclusion, with the implementation of the landscape succession strategy, the Melbourne Botanic Gardens management is confident that they are fully ready to adapt to the upcoming changes while also preserving the qualities of the landscape and its diversity (Entwisle, Cole, Symes, 2017). Moreover, the assessment and monitoring of the results should be continuous, as further research is needed to achieve optimal results.

4.4. Climate-positive project: Royal Botanic Gardens Kew

The Kew Gardens have been listed on the World Heritage list since 2003. The gardens host several elements that illustrate different landscape designs between the 18th and the 20th centuries (UNESCO World Heritage Centre). The Botanic Gardens, established as a scientific botanic centre in

1759, hosts the largest fungal collection in the world and has been focusing on documentation and plant conservation for the last 250 years (Hopper, 2015). The gardens are spread over more than 120 Ha and are the largest collection of living plants (over 27,000 taxa), Kew Gardens is indeed a critical subject for climate change, moreover, besides being a botanical garden, it is also the host of scientific institutions with dedicated researchers. The institution has launched several programmes and strategies at both on global and local levels to ensure the sustainability of the garden and its components.

The UK Climate Impacts Programme published a briefing report, *"Climate change Scenarios for the United Kingdom",* that predicts major changes in both the global and regional climate of the United Kingdom for the upcoming years, the UKCP18[4] projects that all areas of the UK territory will have a warmer climate by the end of the 21st century. Furthermore, it predicts that summer seasons will experience a greater increase in temperature than winter, especially based on the high carbon emission scenario predicted on the hypothesis of the continued high greenhouse gas emissions. As a result, the yearly average summer temperature might rise by 0.9℃ to 5.4℃ (Lowe, Bernie, Bett, et al., 2018)Furthermore, it is expected to witness an increase in the frequency of some extreme weather events (Bisgrove, Hadley, 2002).

- **Kew Gardens' Strategy "Our Manifesto for Change 2021-2030"**

The strategy focuses on 5 priorities, starting with delivering science-based solutions for the protection of biodiversity and the sustainable use of natural resources. this will contribute to ending biodiversity loss and will lead to the safeguarding of valuable and endangered species and ecosystems both within the UK and on a global level. Secondly, to focus on inspiring more people to be involved in the protection of the natural world and empowering communities to act for the ecosystem. Moreover, the strategy focuses on training and passing the knowledge to the next generation of experts. the goal can be achieved by developing new learning centres, launching education initiatives and creating worldwide partnerships. Lastly, the strategy emphasises in the 4th and 5th strategies the extension of the garden's reach using digital resources to encourage debate and help shape the decision-making by influencing national and international opinions and policies (Kew Royal Botanic Gardens, 2021).

[4] United Kingdom climate projections 2018 - https://www.metoffice.gov.uk/pub/data/weather/uk/ukcp18/science-reports/UKCP18-Overview-report.pdf

- **Kew: Climate positive by 2030**

The Royal Botanic Gardens' sustainability strategy follows three pathways in order to reach its objectives, tackling climate change and the biodiversity crisis, based on its published strategy (Royal Botanic Garden Kew, 2021):

- **Actions:** Setting tangible actions to respond to the environmental emergency, minimising the impacts of the current climatic challenges and reaching sustainability.
- **Expertise:** to benefit from Kew's world-leading expertise and implement sustainable practices and nature-based solutions to reach the main goals
- **Voice:** Using the large network to raise awareness about environmental sustainability and encourage partners and collaborators to act against climate change and biodiversity loss.

Published in 2021, the document's main goal is to urgently tackle the climate and biodiversity crisis. In fact, this strategy has been designed specifically for the Kew Gardens on its local scale as it presents a set of actions that can be implemented in the gardens to achieve the future vision. As indicated in the document title, the main objective of the strategy is to be climate-positive by 2030. In order to achieve this goal, RBG Kew will firstly and most importantly act to minimise the carbon emission level by transitioning to clean energy consumption for the purpose of travel around the site, heating and power for the buildings and the greenhouses (Royal Botanic Garden Kew, 2021).

Actions:

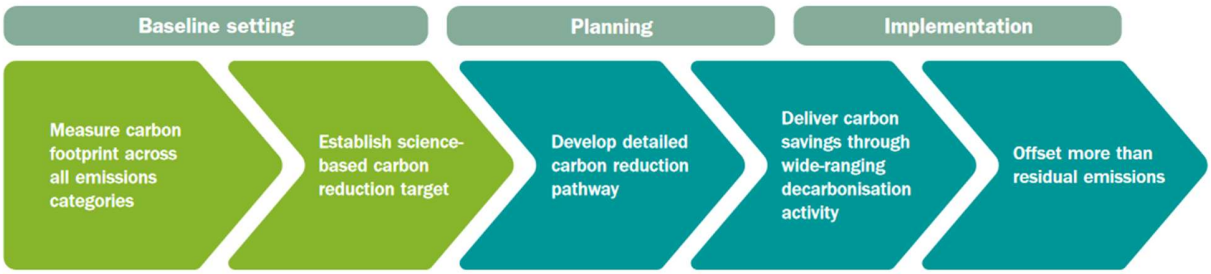


Figure 20: five steps plan to become climate positive by RBG Kew 2021

The Kew Gardens' management set a list of actions to achieve the goal of being climate-positive by 2030 based on a 5-step plan. The strategy starts with a baseline setting, to firstly monitor and measure the already existing carbon footprint for all the emission categories. In fact, in 2020, a carbon footprint analysis was conducted that included both direct and indirect sources of carbon

emissions following the Greenhouse Gas Protocol[5]. The analysis has shown that the indirect emissions, caused by the value chain generally, are the highest, forming almost 70% of the total carbon emissions within the gardens. Moreover, the strategy plans to share the emissions annually and aims to lower the carbon footprint as fast as possible to go below the estimated emissions reduction target. The strategy suggests that the carbon emissions reduction within the gardens will continue through the utilisation of energy-efficient measures, the usage of electric heating and electric vehicles, and raising awareness about sustainable behaviour (Royal Botanic Garden Kew, 2021).

The published strategy aims to cover all aspects of the Botanic gardens, built elements, ecosystem and services, including the already existing historic buildings. The aim is to further analyse the energy needs to plan a low-carbon electric heating pathway for the greenhouses, moreover, adding new buildings to the site which are respecting the net-zero standard. The plan also emphasises the importance of preserving the ecosystem and the valuable living collections, and focusing on using plant species that are suitable for the current and future climate, as well as sustaining a balanced ecosystem (Royal Botanic Garden Kew, 2021).

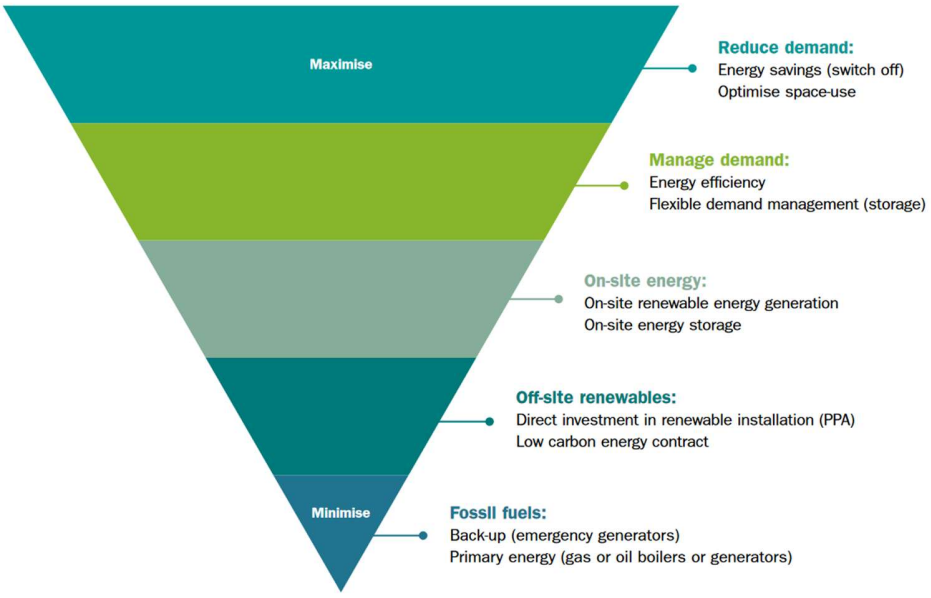


Figure 21: Energy hierarchy by RBG Kew Climate Positive 2030 by RBG Kew 2021

[5] The GHG Protocol Corporate Accounting and Reporting Standard provides requirements and guidance for companies and other organizations preparing a GHG emissions inventor source https://ghgprotocol.org/corporate-standard

Furthermore, the plan aims to update the management and maintenance within the garden, for instance, the hydrological update will be implemented by developing water and irrigation strategies and to maximise the usage of collected rainwater. The plan also seeks to offset the carbon emissions from business travel no longer than 2025, encourages the visitors and the staff to use sustainable travel modes to reach the garden and aims to switch to 100% electric vehicles by 2030 by installing vehicle charging facilities that can be used by the visitors and the staff. Lastly, the strategy plans to implement a recycling and reuse strategy and seek to decrease the carbon emissions from the investments by setting strict sustainability KPIs within their investment contracts (Royal Botanic Garden Kew, 2021).

Expertise:

The Royal Botanic Gardens, Kew is well known for their wide horticultural knowledge and expertise and holds a world-leading position in this matter; in fact, they have been sharing knowledge and sustainable practices to tackle climate change and biodiversity loss through nature and science-based solutions. The Climate Positive by 2030 strategy emphasises the historical and cultural values of the gardens as well as the horticultural and botanical significance, and highlights that the site should sustain high standards. In fact, the gardens' horticultural experts have been employing several sustainable practices, they have suspended the usage of peat from their compost due to its negative environmental impacts, they introduced biological controls for natural pest management, planted disease-resistant plants in order to reduce the usage of pesticides, and work against the non-native and invasive species (Royal Botanic Garden Kew, 2021).

Kew Gardens is planning to be active and promote biodiversity and natural habitat protection by working on policies and decisions. In fact, the strategy states that Kew intends to work on fact sheets in order to promote sustainable solutions by emphasising carbon offsetting, tree planting and reforestation, etc. Moreover, Kew is including their staff in environmental and sustainability responsibilities by providing learning and development opportunities. This will not only help the staff to participate in reaching the objectives, but also will raise awareness about recognising the reporting the changes all around the site (Royal Botanic Garden Kew, 2021).

Voice

Certainly, Royal Botanic Garden Kew holds a significant place worldwide due to its cultural and historical value and scientific achievements. The strategy discusses helping the communities to understand and engage in sustainability practices and raise awareness against potential risks and the

need for urgent change. Moreover, the strategy highlights the significance of having a balanced relationship with nature, therefore, they plan to discuss sustainability publicly and share their possible sustainable solutions and their outcomes. They will also promote the sustainability topic and broadly communicate it and cover public concerns as well. Kew Gardens will share their scientific achievements on sustainability within the garden with their visitors as an inspiration to take action and encourage the visitors to become climate and biodiversity advocates as well (Royal Botanic Garden Kew, 2021).

Figure 22: Clean energy transportation within Kew Gardens (Source : https://www.hortweek.com/kew-sets-roadmap-becoming-climate-positive-2030/parks-and-gardens/article/1717005)

Overall, the Royal Botanic Gardens Kew utilized their scientific expertise to monitor the climate change impacts on the site by measuring carbon emissions and analysing their daily activities, to later conclude a list of actions that support sustainability within the gardens and decrease the global warming risks, furthermore, they proceeded with delivering pieces of training and sharing their knowledge and experience in order to help to safeguard several sites all over the globe and lastly, they have been communicating the biodiversity issues and climate change impacts publicly as an act to raise awareness globally, not only to partners and scientific institutions but to the visitors too.

5. HISTORIC GARDEN ADAPTATION AND CONSERVATION TOOLKIT

Gardens, as living creations, are constantly evolving and changing, hence, their preservation and management should evolve and upgrade with them to match their optimal condition and preservation (Plumptre, 2007). In fact, the concept of change and transformation, whether it is natural or historic, is the main motivation for the evolution of human civilisation, and they are actually the cause of why we have heritage sites and not their threat (Holtorf, 2020). The real challenge that we are facing when dealing with historical gardens is actually the process of adaptation to these natural and constant changes that may occur on the heritage sites.

Knowing that historic gardens are indeed more complex heritage sites due to their fragility and the living green elements, special attention should be paid to succeed in the conservation processes. By analysing several successful precedents and understanding the conservation principles and global guidelines, the author concluded a list of actions that might be useful and guide successful adaptation and preservation strategies within historic gardens. In the following toolkit, the author aimed to cover all valuable aspects of a historic garden and to ensure a sustainable strategy that will extend the valuable heritage to future generations.

5.1. Aims and objectives

The collected and introduced solutions and techniques might be useful and effective proposal and a proper pathway that leads to the adaptation of historic gardens to the current challenges, the purpose of which is to safeguard the historic garden and prevent the deterioration and the loss of our heritage; furthermore, the toolkit might also be a research topic and reference in the field of historic gardens conservation.

The suggested guidelines aim to firstly, maintain the historic integrity of the historic gardens and preserve it's identity and spirit, secondly, to incorporate sustainable strategies aiming to eliminate the loss of biodiversity and preserve the ecosystem of the site, and lastly, to address the climate change issue by reducing the vulnerability of the garden in the face of climate change effects.

5.2. Scope of the toolkit

The proposed strategy applies to a wide range of historic gardens and cultural landscapes with different landscape designs, history, climate, cultural background, historic background, and private and public spaces.

5.3. Suggested strategy

The author proposes a consecutive strategy that covers all aspects of historic gardens, analysing the past, present and potential future of the site and working on solving the current issues and simultaneously working on preventing future challenges.

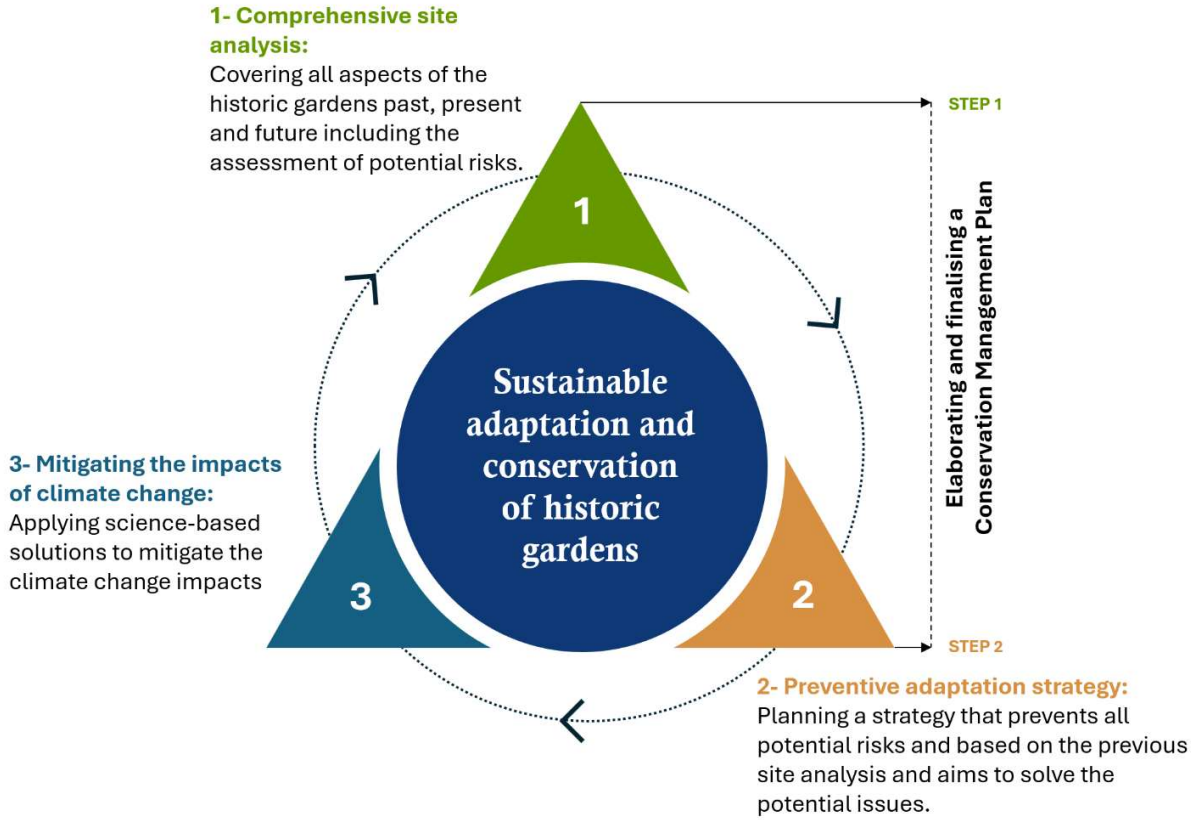


Figure 23: Three essential steps for sustainable historic garden conservation and adaptation (by the Author)

5.3.1. Comprehensive site analysis

Historic assessment

Certainly, when working with heritage sites, the very first step of assessment is investigating the historical value of the site, its cultural background and its artistic point of view. This step relies on the archival materials that come in different forms, such as maps, plans, photographs, literature, paintings and in other cases, interviews with historians and management staff. This will lead to understanding the original state of the garden, the initial design intent by the artist and the events that occurred within the site and led to its current state. Moreover, archaeological techniques might be useful, such as pollen analysis to determine the previous plant species and aerial photograph analysis to find buried built structures, depending on the current state of the garden.

Site survey and analysis

Historic gardens are a combination of culture, art and nature, making them subject to several different factors, so the author suggests in this toolkit to categorise the factors into two categories, fixed and mutable factors.

- Fixed factors:

A physical survey must be conducted for the garden, analysing the fixed factors such as topography, design layout, material and construction techniques, ornamental elements and the existing biodiversity and plant conditions.

- Mutable factors:

The ecological and management survey should also be conducted simultaneously to cover the changing factors, like the garden's ecosystem, water source and soil quality, tourism management, usage and cultural events, etc.

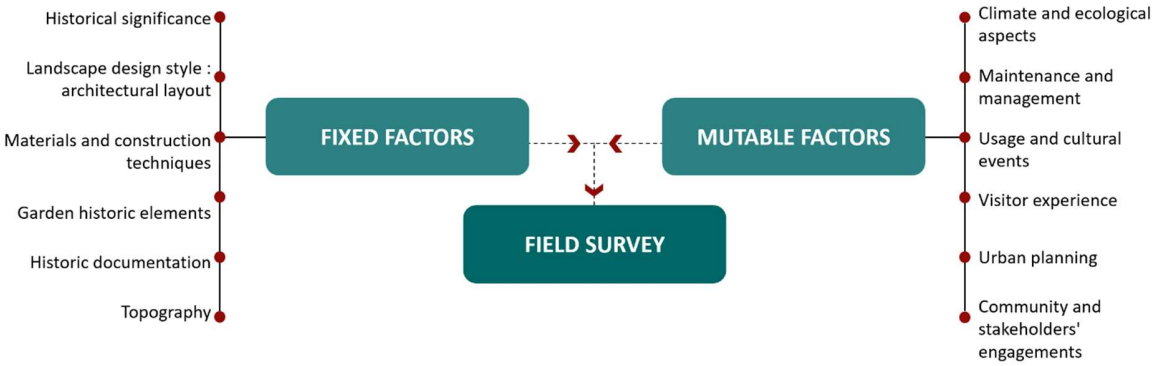


Figure 24: Fixed and mutable factors in historic garden (by the author)

5.3.2. Preventive strategy

Historic garden conservation is a continuous process where ongoing assessment and maintenance should be implemented for sustainable outcomes. For this reason, the strategy should focus on different time scales by including both instant solutions and preventive actions in case of potential risks.

Following the deep site survey, it is recommended to develop a preventive strategy for the historic site. This strategy implements a future vision of the garden, assessing the future risks and potential challenges. In fact, the strategy focuses on the risk assessment of the site recognising its heritage significance and should proactively address risks before irreversible damage occurs.

Risk category	**Preventive measure**
Climate change	Adaptive planting design Efficient water management Reduce carbon emissions within the site introduce clean energy
Mass tourism	Visitor flow control Buffer zone for vulnerable areas
Biodiversity loss	Invasive species management Creating a native plant inventory
Knowledge gap	Traditional skills and handcrafts preservation digital archiving
Disaster risk	Fire, floods, pest outbreak control

Table 5: Exemplary framework for preventive strategy for a historic garden (Source: Made the Author)

Climate change adaptation

Green elements represent a large portion of the historic garden, as described by the ICOMOS in the Florence charter; historic gardens are living heritage and thus subject to climate change and its impacts. In fact, climate change as a global issue nowadays is impacting every aspect of our modern life and is a threat to our future as well. These heritage spaces are more fragile as they were designed for different times and different climates. For these reasons, climate change monitoring should be implemented in historic gardens.

The strategy starts with a climate assessment on different scales, like regional and local. Several open-source GIS tools can be used to analyse the projected regional climate, while remote sensing tools could be used for a more local analysis within the site. Moreover, reporting plant diseases or any deterioration caused by pests, and the change of blooming cycles, is mandatory to track the current impacts. In addition to that, analysing the energy usage and carbon emissions might help to identify the main source of carbon and other pollution within the site. These unsustainable, environment-burdening problems can be later on treated and improved by using clean energy sources and transport means.

It is recommended to evaluate the list of used plants within the garden and confirm their adaptability to the current and projected climate. A sort of landscape succession strategy is recommended in this matter as a natural solution to improve the ecosystem and prevent climate change impacts. In this matter, the green elements of the garden should be part of the solution to safeguard the heritage and built elements of the site. Less pesticides will be used if a resilient and climate-compatible plant selection is used.

The adaptation of the Burra charter conservation strategy

Inspired by the conservation process published in the Burra Charter by ICOMOS in 1999, three main steps are crucial:

- **Understanding significance:** seeking to examine the site and understand, evaluate and document its historic and cultural significance.
- **Developing policy:** Based on the state and significance of the site, elaborate a conservation process and determine policies that will restore the site and insure a its preservation in the future
- **Management:** Lastly to apply continuous, monitoring, maintenance of the site.

Conclusion

The elaborated toolkit has a multilayered approach aiming to cover all aspects of a historic garden including the projected potential risks and threats. The document is flexible to be applied in different scales, climate situation, cultural and historical background etc. However, the toolkit also recognizes the local legal frames and policies and encourage to align them with international recommendations and practices. The toolkit emphasizes the importance of extracting knowledge from

different previous case studies and precedents aiming to utilize the positive practices and avoid the potential risks. Furthermore, the toolkit takes in to consideration that further research and practice is needed to have a more sophisticated and complete approach to adapt historic gardens to contemporary challenges.

6. NATIONAL BARDO MUSEUM, TUNIS

The Bardo Palace complex in Tunis is a historic site for culture and power, it represents a significant model of tunisian architectural and cultural heritage. this project was selected due to the historical significance of the bardo palace complex as reflection of tunisian architecture and colonial influences as well as their potential to contribute to contemporary cultural and ecological aspects. moreover, this study addresses critical gaps in both the documentation of the history of the bardo palace complex and the practical applications of restoration methodologies in post-colonial context. the project demonstrates that the toolkit for historic gardens adaptation serve as a model for sustainable heritage preservation.

1. Tunisia general context

Tunisia is located along the southern Mediterranean coast in North Africa, its strategic location has made it a historical crossroad for different civilizations and cultures, each has profoundly shaped and influenced its cultural and architectural landscape. Tunisia's historical significance is reflected in its nine UNESCO World Heritage Sites, which highlight its archaeological and cultural importance.

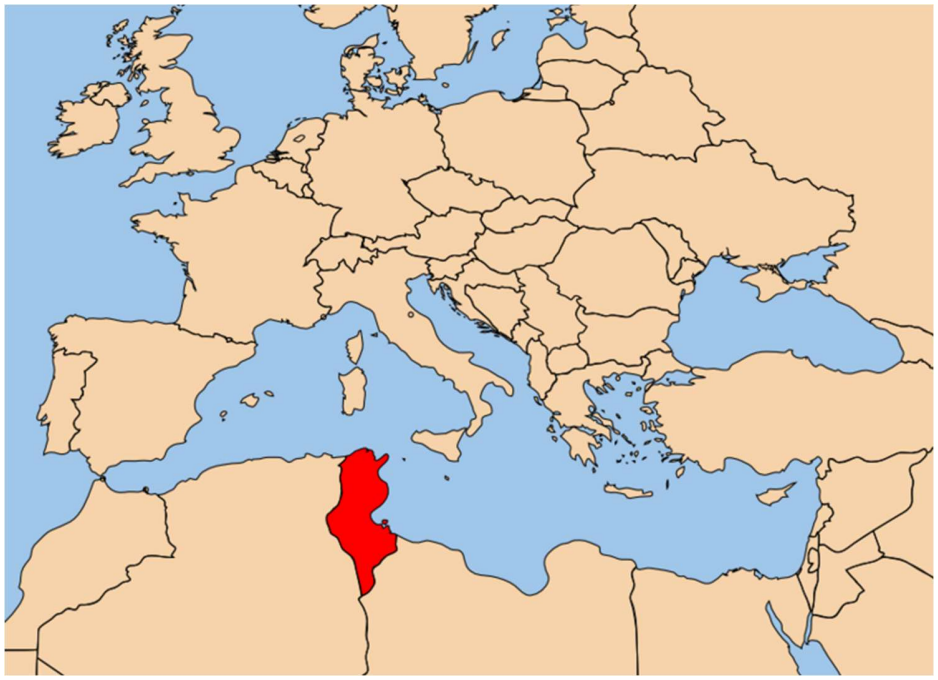


Figure 25: Tunisia location (Source: https://commons.wikimedia.org/wiki/File:Tunisia-map.1.PNG)

- **Climate change in Tunis:**

Tunis is the capital and largest city in Tunisia, situated on the Mediterranean coast and is increasingly exposed to the diverse and intensifying impacts of global warming. In fact, North Africa is considered a climate change hotspot, according to the World Meteorological Organisation. The region is witnessing a significantly accelerated warming trend since the average annual temperature rose by +0.4°C between 1991 and 2023 (World Meteorological Organization, 2024). According to The National Institute of Meteorology, for the RCP 4.5 scenario, temperature may rise up to 1.8°C by 2050 and can reach 3°C by 2100, moreover, the average annual precipitation can decrease by 5% to 20% by 2100 (The National Institute of Meteorology). The high temperature and the lower precipitation result in more frequent drought periods, the increased evaporation that impacts directly both surface and groundwater reserves, ultimately decreases overall water availability (The National Institute of Meteorology).

The Tunisian government is very aware of the climate change threats and is proactively aiming to apply mitigations and climate change adaptation measures effectively. Nowadays, the dense urban fabric in Tunis is contributing in the acceleration of climate change impacts and applying pressure ion the heritage sites of the city (Ben Salem, Lahmar, Simon, et al., 2021). Moreover, the country has been working on several initiatives and policies supported by both national efforts and international cooperation. In 2021, submitted an updated Nationally Determined Contribution (NDC) to the United Nations Development Programme (UNPD), aiming to reduce carbon emissions by 45% below 2010 levels by 2030 (UNPD, 2023).

- **Heritage preservation in Tunisia:**

Tunisia's history is marked by several colonial empires that deeply influenced the society's culture and traditions, and architecture. In fact, as of 2024, Tunisia has 9 World Heritage Sites registered on UNESCO (UNESCO Centre du patrimoine mondial). Heritage preservation trends started to develop in Tunisia after the country attained independence from France in 1956. The government attempted to direct all its policies towards modernity and the future established by the Western world to (Coslett, 2020).

Tunisia has a robust and evolving legal and institutional framework for heritage protection. The existence of national comprehensive laws provides a legal basis for heritage protection, together with the international guidelines and recommendations. Moreover, Tunisia has several dedicated institutions with a scientific and technical conservation focus.

	Key objectives and responsibilities	Primary Responsible Body/Bodies for the implementation of the law/decree
Ministry of Cultural Affairs	• Overall policy direction for cultural heritage. Preservation orders for monuments and sites Promotes intangible cultural heritage	**Law No. 86-35 concerning the Protection of Archaeological Property, Historic Monuments and Natural and Urban Sites, 1986** **Law No. 94-35 relative to the Code of the Heritage of Archaeology, History and the Traditional Arts (Heritage Code) 1994 (amended 2011)**
Institut National du patrimoine INP (National Heritage Institute)	• National inventory of cultural heritage, scientific research, safeguarding, restoration and preservation of historic sites and monuments. • Supervision of preservation and restoration works according to legal and scientific standards. Participation in the development of conservation management plans. (National Heritage Institute)	
National Heritage Commission	• Advisory role to the Minister of Culture Affairs • Provides expert opinions and submits proposals concerning protecting and listing historic monuments and cultural sites. • Its consultation is mandatory for key decisions under the Heritage Code. (UNESCO Database of National Cultural Heritage Laws, 1994)	
Agence de Mise en Valeur du Patrimoine et de la Promotion Culturelle AMVPPC (Agency for the Development of Heritage and Cultural Promotion)	• Execution of state policy for the enhancement and exploitation of cultural heritage. (Agency for the development of heritage and cultural promotion, 2022)	

Table 6: Key legislation for heritage conservation Tunisia

Protection and Enhancement Plan:

In fact, the Code for the Protection of Archaeological, Historical, and Traditional Arts Heritage in the **Law No. 94-35 of February 24, 1994, concerning the Code of Archaeological, Historical,**

and Traditional Arts Heritage mandate the creation of Safeguarding and Enhancement Plan ("Plan de Sauvegarde et de Mise en Valeur" PSMV) in article 8 and article 13 (INP, 1994). The primary purpose of the safeguarding and enhacement plan is to ensure the protection, conservation and enhacement of heritage sites, it is a detailed document that typically includes parcel plans and specific regulations defining permissible and prohibited constructions as well as archituectural standards to be respected (style, colour schemes, materials), the plan also provides the restoration and conservation requirements for the identified heritage elements, and regulate the usage and activities within the site (INP, 1994).

“ Article 4 – “Historical monuments are considered to be immovable properties, whether built or not, whether privately owned or part of the public domain, whose protection and conservation are of national or universal value from the standpoint of history, aesthetics, art, or tradition.”

“Article 8 (First paragraph amended by Law No. 2001-118 of December 6, 2001) – The relevant departments of the ministry responsible for heritage shall, following the publication of the decree establishing the cultural site and within a period of five years—renewable by joint order of the minister responsible for heritage and the minister responsible for urban planning—develop a **Protection and Enhancement Plan** for the cultural site.

The development of the Protection and Enhancement Plan for a cultural site follows the same procedures as those governing the preparation of the urban development plan. It is approved by decree, upon the proposal of the minister responsible for heritage and the minister of urban planning, and after consultation with the **National Heritage Commission**.”

“ Article 13 – The **Protection and Enhancement Plan** includes the zoning map and the regulatory provisions.
The regulatory provisions specifically establish:

- The activities authorised within each zone,
- The conditions under which said activities may be carried out,
- The easements specific to each zone.

As of the date of approval of the "Protection and Enhancement Plan," all works undertaken within the cultural site are subject to the special regulatory provisions set forth by the approval decree.

The regulations provided in Articles 9, 10, 11, and 12 of this Code shall remain applicable."

The Protection and Enhancement Plan (PPMV) is one of the strongest tools for legal protection for safeguarding archeological sites, historic monuments, and natural landscapes in the Tunisian heritage law, it establishes strict zoning and protection perimeters, controls land use by banning incompatible activities near heritage sites and encourages the sustainable development of the protected sites. Moreover, the PPMV is internationally recognised as it aligns with UNESCO world heritage regulations and justifies Tunisia's commitment to heritage safeguarding.

2. The Bardo museum's historical background:

The National Bardo Museum, previously known as the main Bey Palace, located in the capital Tunis, is considered the second largest national museum in Africa after the National Egyptian Museum. Nowadays, the National Museum holds a positive reputation internationally for the quality of its collection as it holds the largest mosaic collection in the world (Mrabet, 2016). Besides its wide collection and significant artefacts, the building itself is also a Heritage Site registered in the 1920s in the National Tunisian List of Historical Monuments (Mrabet, 2016).

The monument is recognised as the pure representation of Tunisia's past cultures and artistic heritage, however, due to several contemporary challenges, the author proposes to re-evaluate the current state of the Palace by conducting historical and spatial analysis of the site and elaborating a theoretical conservation plan to insure the sustainable preservation of the Bardo Palace for future generations.

6.1. Historic review:

Bardo was built in the 15th century as a recreational palace located on the periphery of the Medina of Tunis, the Capital of Tunisia. The name "Bardo" is of Spanish origins of "Prado" which means garden and meadows, describing the palace at that time (Bouhamed, 2024). The architectural style of the palace was heavily inspired by the Muslim Moorish architecture in southern Spain with the addition of the Tunisian identity as well.

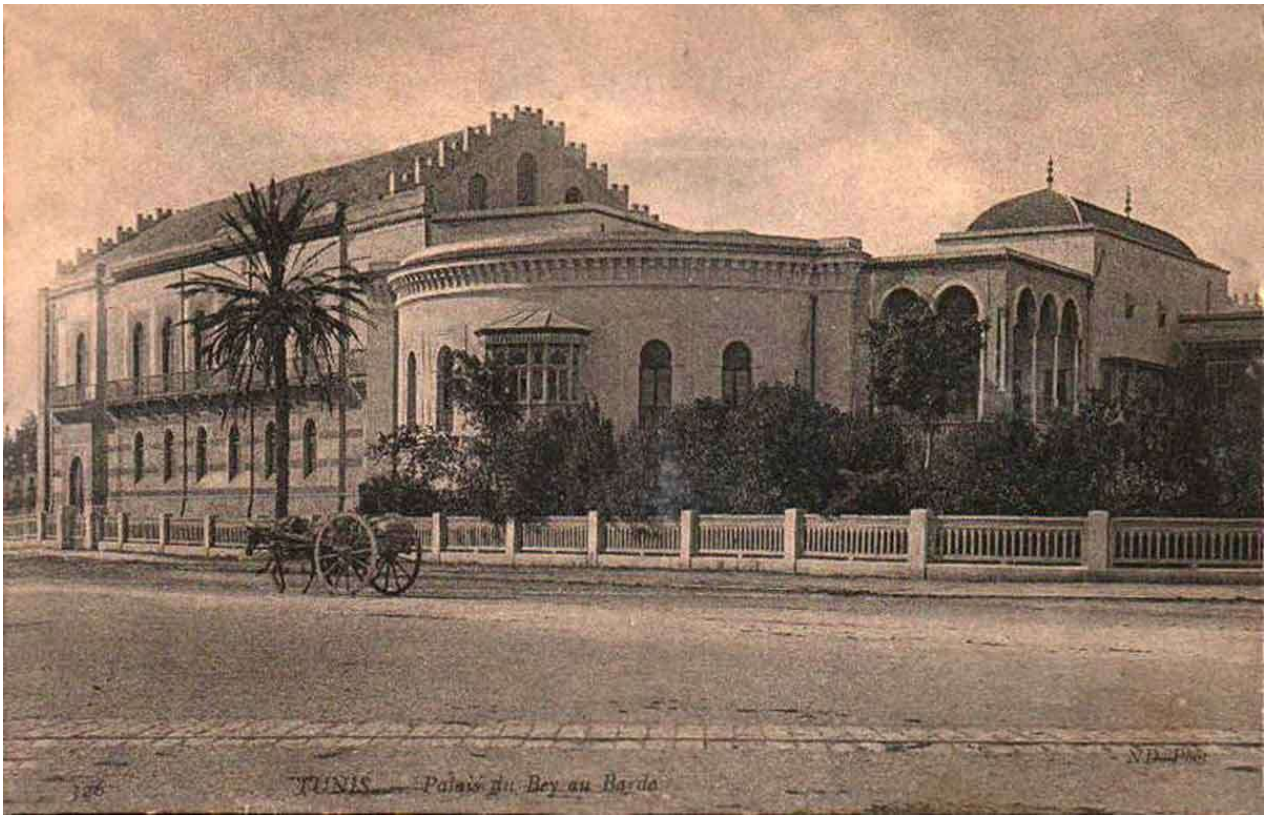


Figure 26: The exterior of The Royal Palace of Bardo in 1900 (Source: https://fr.m.wikipedia.org/wiki/Fichier:Bardo_Palais_du_Bey.jpg)

Since its creation in the 16th century, Bardo Palace has witnessed several significant changes both to its architectural structure and its functions. It evolved from being a royal recreational palace in the 16th century to become the royal permanent residence in the 17th century, which led to a significant expansion in the surroundings and the addition of several buildings to host the servants and the Bey's family. Bardo then became a complex ensemble, hosting around 800 residents and a variety of buildings with residential and administrative purposes in addition to commercial areas and a market (Bouhamed, 2024).(Zaher Kammoun, 2020). Furthermore, during the Husseinite dynasty (1705 to 1957), the Bardo was enlarged to include a mosque, a courtroom, reception room, all reinforced by complete fortification (Bouhamed, 2024).

HAFSID DYNASTY	HAMOUDA BECHA BEY	HUSSEIN BEN ALI BEY	ALI BECHA BEY	MOHAMED BEY AND MOHAMED SADOK BEY	COLONIAL ERA	POST INDEPENDENCE
16th Century	1631 - 1666	1705-1740	1735-1756	1855-1885	1885-1888	1958 - Present
• The Palace was built for recreatio nal purposes	• The Palace was selected to be a permanent residence of the Bey (Ruler) of Tunis. renovated and extended to create a complex of variety buildings of different purposes for the Bey's family and stuff and for commercial purposes.	• The Bey builds a mosque as an addition to the complex and makes more expansions in the building. • Bardo Palace became a more significant building for the government.	• Further architectural renovations and improvemen ts withing the Palace's building including the lion's staircase.	• The Palace is no longer the Bey's residential building but still used for official receptions and juridical functions. • Between 1882 and 1885, the Bey published official decrees announcing that the Bardo will be transformed to a museum of antiquities.	• The French launched major renovation works for 3 years to transfer the building into a museum and named it "Alaoui Museum" to pay tribute to Ali Bey. • The museum was inaugurated in 1888.	• In 1958, the Museum name changed to "Bardo National Museum". • New restauration project launched from 2000 to 2006.

Figure 27: Spatial evolution of Bardo Palace (Source: Made by the author)

Because of the complex history of the Bardo Palace, several interventions and new additions can be seen on the site, as the architectural history of the complex continues to evolve and adapt to the needs of each of the successive rulers and functions, hence, the collections of diverse architectural styles from different eras. For this reason, the Palace presents different impressions to visitors. According to the literature, Peyssonnel[6] called Bardo a large citadel, whilst Lallemand[7] described it as a complex of disorganized buildings (Zaher Kammoun, 2020).

Due to the lack of proper documentation and archaeological data, the structure of the palace during the 15th century is still not clear. for this reason, many historic studies of the palace were based on the descriptions published in the books of travellers during that period (Mrabet, 2016). All the descriptions agreed that the perimeter of the palace has a rectangular shape and high walls. Within the walls, there are multiple buildings with different functions (residential, administrative and commercial), the gardens have a central water basin with several fountains, and the rest of the gardens is mainly planted with orange trees in strict straight lines. Overall, the gardens represent the same features present in Moorish Islamic and North African gardens.

The Bardo palace was transformed into the Alaoui Museum, named in honour of Ali Bacha Bey, and was inaugurated officially on 7 May 1888 (The National Bardo Museum, 2012). Between 1885 and 1888, the French administration of the palace conducted intensive renovation projects to transform the palace into a museum and adapt the site to future needs (Zaher Kammoun, 2020). The transformation works included eliminating several buildings from the complex and redesigning the

[6] Jean-André Peyssonnel (1694 – 1759), French physician and naturalist
[7] Charles Jean-Pierre Lallemand (1857-1938), French geophysicist.

entrance garden into a romantic style. The French addition to the garden has created an eclectic space that combines the Moorish and European styles.

Figure 28: Lion staircase, entrance of Bardo Palace (Source: https://zaherkammoun.com/2020/04/03/le-palais-du-bardo/)

Figure 29: Bardo Palace gardens (Source: https://www.geneanet.org/cartes-postales/view/5240598#0)

*Figure 30: Bardo Palace Garden (source: Jaques Doucet collection https://palaisdumaghreb.wixsite.com/epoqueottomane/palais-du-bardo-tunis?lightbox=dataItem-igtdi9pu_*

Narrative	**Source**
"*As for the gardens, they are almost infinite, filled with orange trees, lemon trees, roses, delicate and fragrant flowers, especially in a place called Bardo, where the gardens and pleasure houses of the king are located. These are built with an architecture that is no less ingenious than magnificent, adorned with carvings and paintings in the finest colours*."	Léon L'Africain, Description de l'Afrique, trad. J. Temporal, Paris 1830, pp. 43-44.
"*To the northwest of Tunis, at a distance of about half a league (two kilometres), lies El-Bardo, where the sovereign resides. It is surrounded by a thick wall with battlements and moats*."	L. Frank, Histoire de Tunis, Paris 1850, p. 11.

"*It is also necessary to see the Bardes (Le Bardo), which are three houses built by the bey for his three children, located about a league from Tunis. These houses feature a number of fountains with beautiful basins made from single pieces of marble brought from Genoa. Like Dom Philipo's, there is an open-air hall with a large reservoir in the centre, surrounded by walkways whose roofs are supported by numerous columns, all paved with black and white marble. The same paving extends to all the rooms, which are adorned with gold and azure and intricate stucco work. There are several magnificent apartments, and all these houses have beautiful gardens filled with orange trees and various fruit trees, arranged very orderly, as is customary in Christian lands. Additionally, at the ends of the walkways, there are splendid arbores. All of this was constructed by Christian slaves."*	J. Thevenot, Relation d'un voyage fait au Levant, Paris 1664, p.546.
"*(Le Bardo) is situated in the middle of a vast enclosed area surrounded by walls, which enclose vegetable gardens, orchards, orange groves, fig trees, and other trees. The first courtyard is surrounded by buildings that house stables, kitchens, storerooms, the living quarters for servants and slaves. All these buildings are single-story structures*."	Chevalier d'Arvieux, Voyage à Tunis édit par J. De Maussion de Favieres, Mémoires du Chevalier d'Arivieux Paris 1994, p. 99.
"There is a garden that is very modest, filled with orange trees planted in straight rows, but there are neither pathways nor promenades. In the middle of this garden, there is a large basin surrounded by white marble with a few fountains, and at the far end, there is a sort of apartment or pavilion, quite graceful, decorated with paintings in a mosaic style. The perimeter of this palace may be about twelve hundred paces."	Peyssonnel et Desfontaines, Voyages, ed. Dureau de la Malle, Paris, t. I, 1838 p. 25-28.

Table 7: Narrative from European travellers in Tunis maybe, you could edit it to the annex, and it is important to refer to all historical information, data, figure, map, picture

Figure 31: Old photograph of a statue in the Bardo garden (Source: https://palaisdumaghreb.wixsite.com/epoqueottomane/palais-du-bardo-tunis?lightbox=dataItem-igtdi9ps)

Figure 32: Main entrance to Bardo complex (Source: https://zaherkammoun.com/2020/04/03/le-palais-du-bardo/#jp-carousel-17480)

Figure 33: Bardo main entrance garden, designed during the French renovation in a romantic style (1885-1888) scale 1/500 (Source: National Tunisian archives)

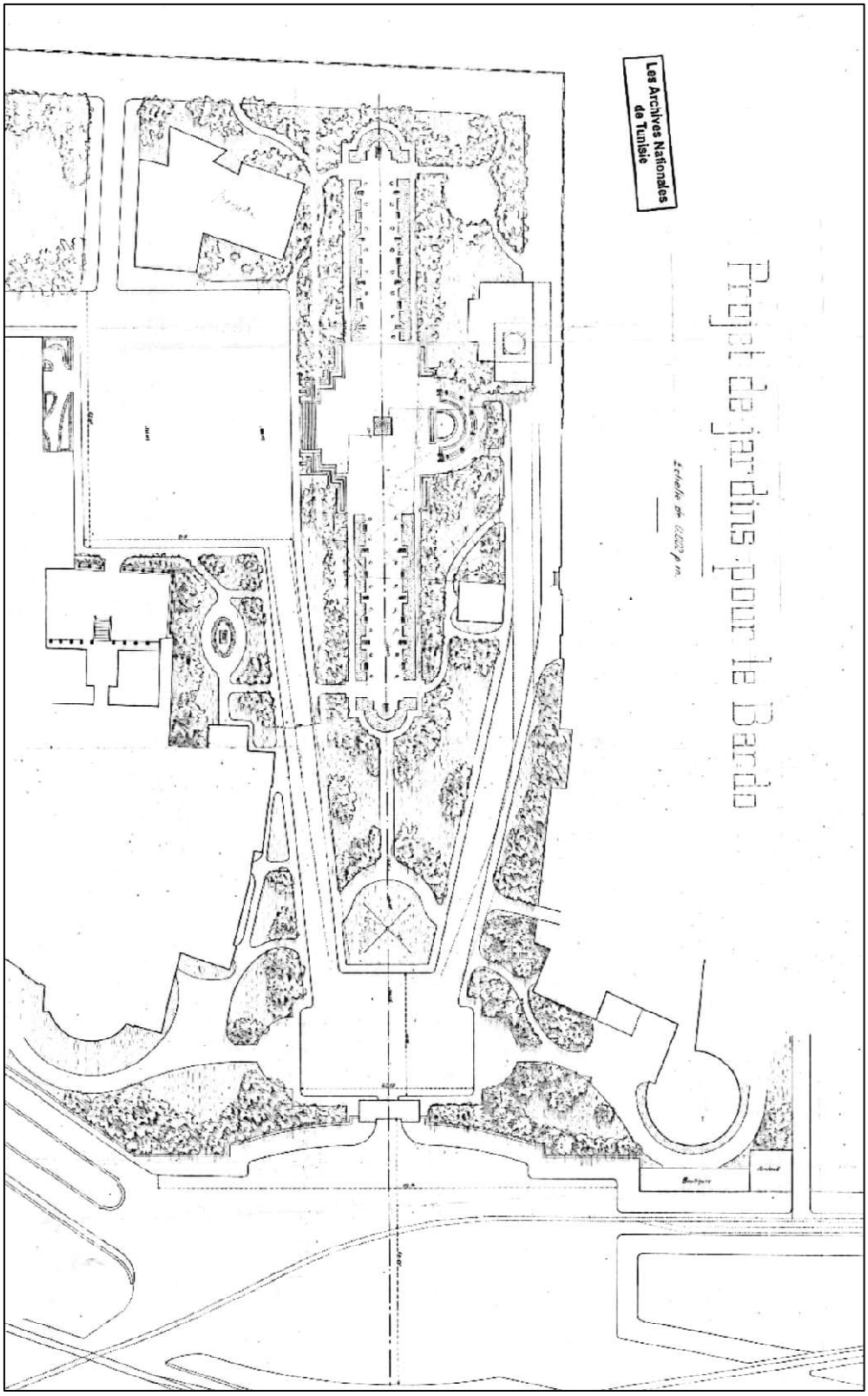


Figure 34: Petit Patio inside the Bardo Palace (Source: https://zaherkammoun.com/2020/04/03/le-palais-du-bardo/#jp-carousel-17587)

From Palace to museum

The Bardo Palace was transformed into a museum during the French Colonial (1881-1956) period. The museum was created in 1882 and was only opened to the public in 1888, named "Aloui Museum" in honour of its founder Ali Bey[8] (Matri, 2018). According to a document derived from the national archives, the Bardo complex has witnessed several demolition works that lasted until 1904. The demolition process included several secondary built elements in poor condition. These transformations aligned more with Western palaces' architectural style (Matri, 2018)Moreover, as a result of the European museology influence in the 20th century, the new museum underwent redesign plans in order to articulate a specific message and enhance space clarity (Bouhamed, 2024).

After the independence, in 1957, a small palace (Ali Pacha's Palace) was transferred to the parliament, and the Museum's name changed to the National Museum of Bardo (Mrabet, 2016). In

[8] **Ali Bey** (Ali III ibn al-Husayn) was the Bey of Tunis (1882-1902) during the French Protectorate.

2009, the museum witnessed a new extension project in an effort to meet the new demands of museography. This project ended in 2012 and added approximately 8000 m^2 of new built surface (Mrabet, 2016). The extension was essential to host a larger number of visitors with a better visit experience and was financed by the World Bank (Bouhamed, 2024).

Figure 35and Figure 36: The Bardo complex before (left) and after (right) the elimination of several built elements in 1892. The left map represents the original layout, while the right map shows the complex after modifications. (Source: Baya Abidi, The farms and palaces during the Husainid period 1705–1957, 2019, National Tunisian Archives)

Moreover, the changes that have occurred in the Bardo complex, impacted the type and intensity of usage. Nowadays, several areas of the complex are not accessible to the public, and a large area of the garden has been transformed into a parking lot for tourist management purposes. The Urban Development Plan, issued by the Ministry of Equipment, Housing and Spatial Planning and the Urban Planning Agency of Greater Tunis, classifies two built elements as listed National monuments within the perimeter of the Bardo complex. Firstly, the small Palace within the Bardo National Museum building, and the ruins of the ancient walls of the Bardo Complex. According to the published Urban Planning Regulations attached to the Urban Development Plan:

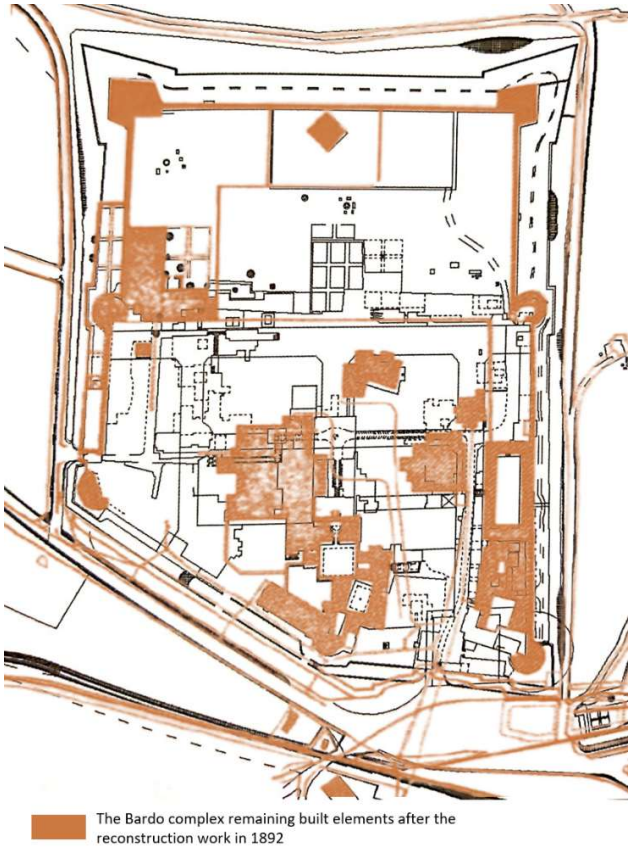


Figure 37: Overlapped historic plans of the Bardo complex before and after the elimination of built elements (Edited by the author)

"*These are lands that include historical monuments (outlined on the PAU) that must be preserved in accordance with Law No. 94-35 of February 24, 1994, relating to the Code of Archaeological, Historical, and Traditional Arts Heritage, as amended and supplemented by Law No. 2001-118 of December 6, 2001."* (Ministry of Equipment, Housing, and Spatial Planning, Urban Planning Agency of Greater Tunis, 2009).

Furthermore, the document classifies the surroundings of the Museum building within the complex perimeter as a Facility of National Influence, but it does not include any specifications regarding its protection and preservation:

"*These are areas reserved for existing or planned facilities of an administrative, cultural, educational, health-related, etc., nature—in general, public facilities under the authority of an administrative body (ministerial departments, local public authorities, and public institutions).*" (Ministry of Equipment, Housing, and Spatial Planning, Urban Planning Agency of Greater Tunis, 2009).

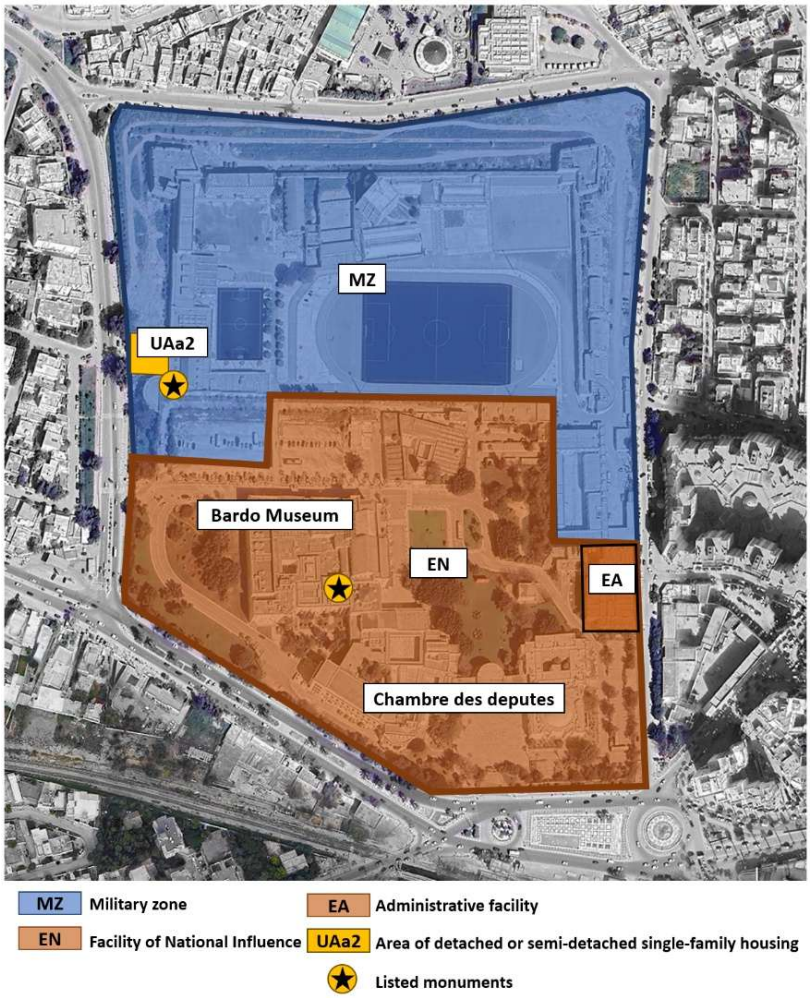


Figure 38: The zoning of the Bardo Complex according to the Urban development plan (Source: Urban development plan of the Bardo Municipality 2009 Edited by the author)

Bardo Built elements:

- **Bardo Museum (Former Beylical Palace):**

The main building of the former Bardo fort served as a residential palace for royal families since the 15th century, several reconstruction, renovation and extension interventions have resulted in the current state of the museum.

- **Military complex:**

Bardo complex originally had a military and defensive purpose as a medieval fortress; this part of the complex is continuously used for the same purpose by the Tunisian Military several architectural military artefacts can still be seen in the site.

- **Assembly of the Representatives of the People:**

The building used to be part of the Beylical residence, Throughout history, especially after independence, the building has been transformed into the parliament of Tunisia with a significant political weight.

- **The Hussainid Mosque**

The building has been serving as a mosque (Islamic religious building) since its establishment within the Bardo complex and is still serving the same purpose.

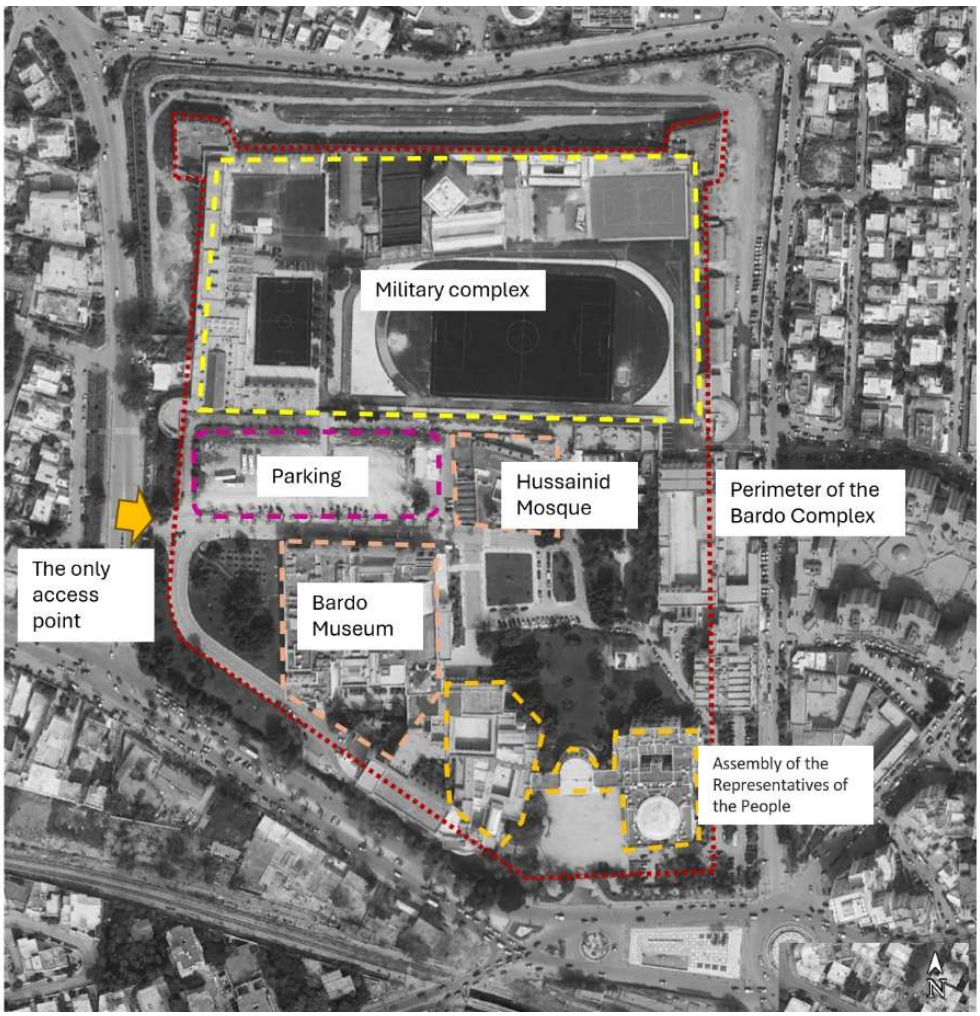


Figure 39: function plan of Bardo complex (Source: Made by the Author)

Figure 40: The Bardo Museum view from the Parking (Taken by the Author)

Figure 41and Figure 42: Bardo Military Base entrance in December 2024 (left), and historic view of the same entrance (right).(Source: Left image taken by the author in December 2024) Bardo Military Base entrance around 1920 (Left Picture: Source: https://www.tunisie-actualite

Figure 43: The Bey Mosque (Source: https://experiencedtraveller.com/journal/2017-05-14-bardo-museum-in-tunis-palace-parliament-and-poet)

Tourism in Bardo

The Bardo complex's gardens serve as a transitional space that visitors use to pass through, even if their primary focus remains the museum's architectural and mosaics collections. The high annual visitor numbers apply indirect pressure on the gardens, including foot traffic, the loss of land because of buildings and parking extensions.

Tourism in Bardo museum has been significantly impacted by two major events, firstly, the Tunisian Revolution against the political regime in 2011, the Revolution has led to economic instability and security challenges, both of which have significantly impacted the country's tourism sector, however, ever since the revolution The Bardo complex gained further national significance because of its political role as a special committees wrote the new post revolution constitution during 2012 and 2013 (Rey, 2018). Moreover, in March 2015, a terrorist attack took place in the National Bardo Museum. The impacts of the event did not stop at the level of the museum but had several

negative consequences on the country's image, as it was considered not safe for tourists for several years.

According to the statistics published by the Tunisian National Tourist Office and Selma Zaiane, the number of visitors to the National Bardo Museum in 2007 was 574,963 (Zaiane, 2008),

however, the number drastically decreased after the Tunisian Revolution to only 39501 visitors in 2015, and lower in 2016. The number increases in 2019, but is still vastly lower than the previous numbers from 2007. The latest visitors' statistics for 2024 are not yet published by the National Office of Tunisian Tourism, however, the estimations are very high and can reach 10 million tourists visiting the country, since the Bardo museum is a highly attractive touristic destination, the estimation of the visitors' numbers might be higher than the previous years.

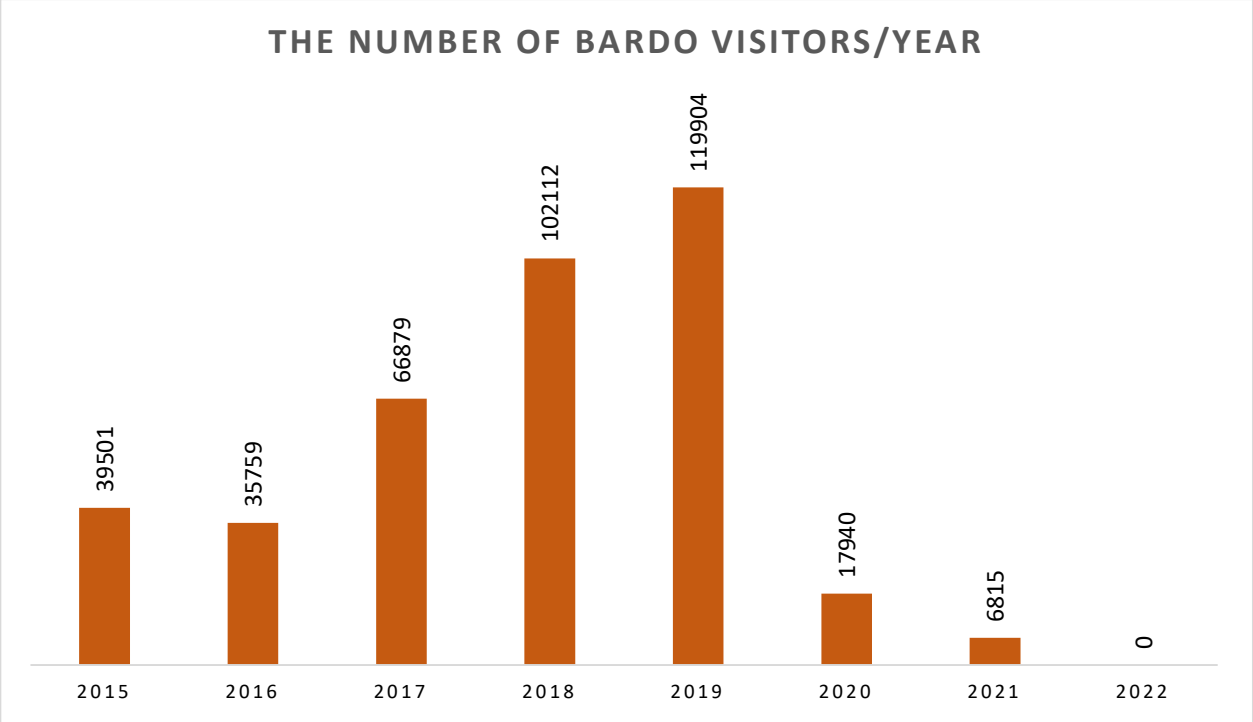


Figure 44: Number of visitors in the National Bardo Museum each year (Source: statistics from ONTT, graph made by the author)

Lastly, because of the high political background, and due to the previous horrific security events, accessibility around the Bardo complex is highly limited, security agents and policemen can be seen around the museum building, and the only accessible part by visitors is the parking area.

Green elements and ecosystem:

Because of the significant structural changes linked to the Bardo complex's history, the green proportion of the site decreased significantly. In Figure 38, the proportional difference of the green elements is very distinctive between 2005 and 2025, compared to 2005, the Bardo complex has more built elements and hardscapes and less green spaces and tree canopy. Based on the 2025 google earth pro calculations, the surface of the Bardo complex, without the military complex, is approximately 86,000 m^2, the built elements and hardscape pathways represent 68.43% (58,850 m^2), the softscapes represent 23.20% (19,950 m^2) and the parking area represents 8.37% (7,200 m^2).

Moreover, the parking surface has increased between 2005 and 2025. Selma Zaiane reported that in 2006, a total of 40 touristic buses were stationed in the parking lot while their engine remained running (Zaiane, 2008)This situation raises several concerns about gas emissions, noise pollution and several impacts that potentially threaten the site's ecosystem and the quality of visitors' experience.

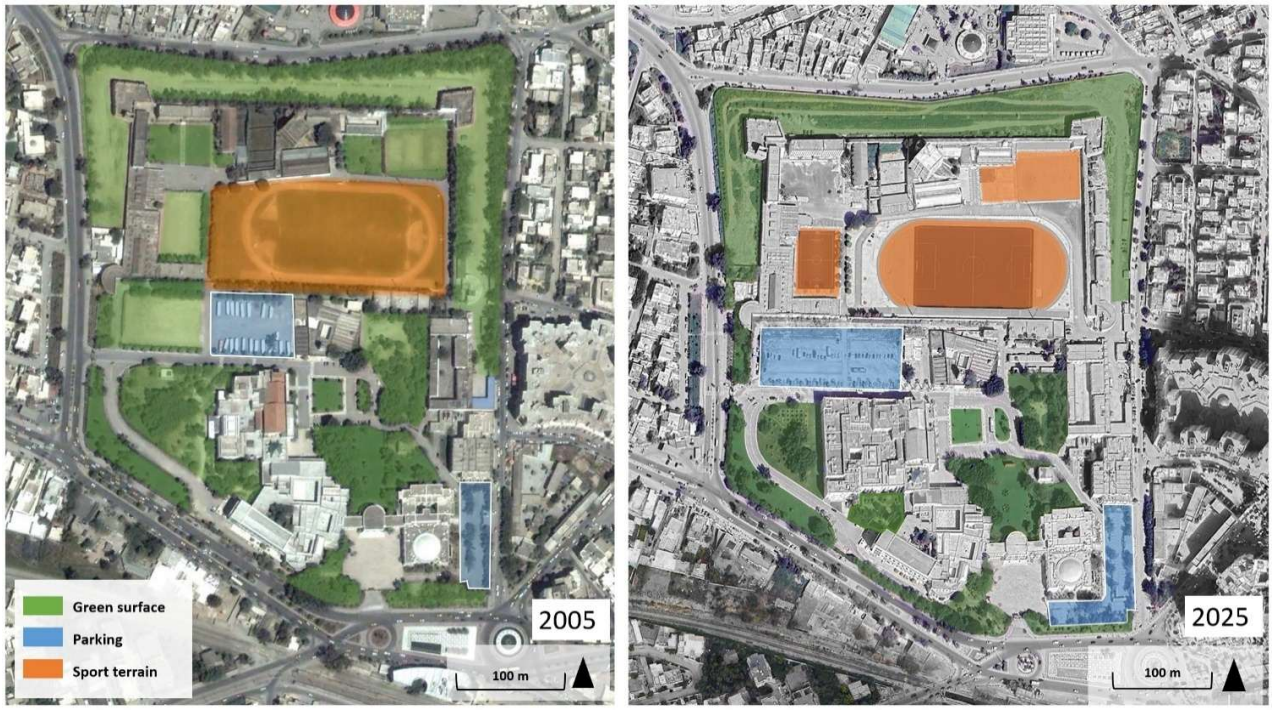


Figure 45 and Figure 46: Bardo complex green proportions in 2005 (left) and 2025 (right).

3. Theoretical reconstruction plan for the Bardo garden:

Problematic:

According to historical references, the Bardo complex has always been related to cultural representation, vast spaces of greenery and multi-usage. Certainly, the cultural and historical significance of the Bardo is highly celebrated throughout its history. However, the museum building has shifted all the attention from the rest of the complex, which resulted in an unbalanced heritage preservation scenario. The historical trajectory of the Bardo's gardens reveals a significant functional shift from being a primary element with a pleasure and recreation function for the Beylical palace to decreasing a secondary element with restricted functions and decreasing area within the Bardo complex.

Challenges and gaps:

Despite the historical significance of the Bardo complex, the collected and analyzed research materials reveal certain challenges in forming a complete picture of the gardens, hence, this strategy will rely on the understanding of the Islamic North African landscape design. As historic gardens are changing entities, especially in the case of Bardo, the reconstruction work will refer to the most documented era from the garden's history and the common landscape design features in Tunis at that period of time (19th century).

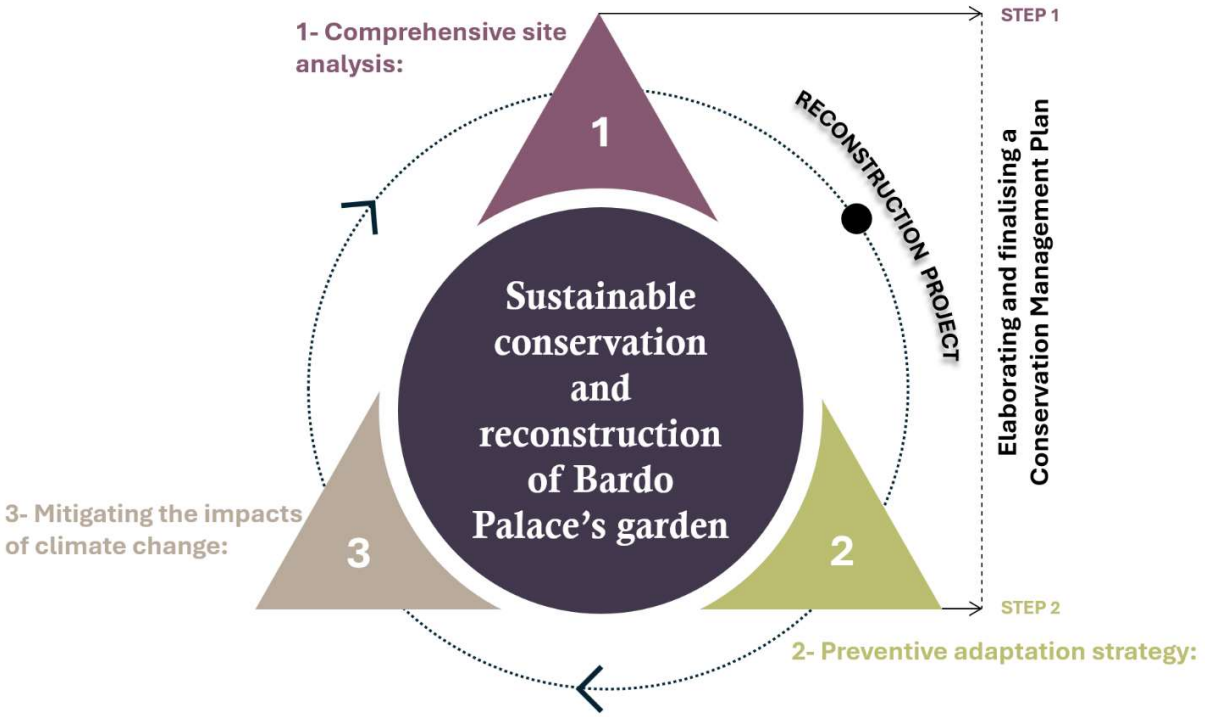


Figure 47: Sustainable theoretical strategy of the Bardo Garden (Source: made by the author)

1- Comprehensive site analysis:

The comprehensive site analysis of the Bardo complex will be based on three main aspects:

Historical analysis:	Analysing archival documents, historic photographs and the narratives of European travellers in Tunis describing the Bardo's gardens features and usage. The historical documents will assist in shaping the original image of the Bardo gardens and its elements.
Comparative approach:	Because of the lack of detailed information about the Bardo museum, analysing similar common design approaches from the same period of time might inspire the recreation of the same style, aligning with the available historic data.
Archaeological potential research:	The lack of archaeological findings in the Bardo gardens is a potential area for future research and investigation. In fact, further significant data about former layouts, water systems, building materials and plant species could be identified for a more accurate restoration process.

Table 8: Site analysis approach for the Bardo garden (Source: Made by the author)

Periodic reconstruction strategy:

According to Jaques: "*period gardens, which are avowedly imaginative re-creations in a style that recalls one from the past*" (Jacques, 1995), based on the background analysis of the Bardo complex, recreating the 19th-century version of the garden is the most convenient reconstruction solution.

The periodic reconstruction of the historical garden space structure may include:

- **Rebuilding and reconstructing lost structures**: Reconstruction of architectural features that have been destroyed, deteriorated or removed over time, including: pathway systems, meows, etc.
- **Replanting historic species**: Reintroducing plant species that were documented in the gardens and have disappeared.
- **Recreating original architectural elements**: Restoring or recreating architectural elements that have been deteriorated or removed over time.

Design features	Reference from the narratives	Source
Plant species	Orange trees Various fruit trees Lemon trees Fragrant flowers orchards fig trees vegetable garden	Léon L'Africain, Description de l'Afrique, trad. J. Temporal, Paris 1830, pp. 43-44. J. Thevenot, Relation d'un voyage fait au Levant, Paris 1664, p.546. Chevalier d'Arvieux, Voyage à Tunis édit par J. De Maussion de Favieres, Mémoires du Chevalier d'Arivieux Paris 1994, p. 99. Peyssonnel et Desfontaines, Voyages, ed. Dureau de la Malle, Paris, t. I, 1838 p. 25-28.
Planting design	Linear tree plantation (Orange trees)	J. Thevenot, Relation d'un voyage fait au Levant, Paris 1664, p.546. Peyssonnel et Desfontaines, Voyages, ed. Dureau de la Malle, Paris, t. I, 1838 p. 25-28.
Water feature	White marble fountain Large basin surrounded by few fountains	J. Thevenot, Relation d'un voyage fait au Levant, Paris 1664, p.546. Peyssonnel et Desfontaines, Voyages, ed. Dureau de la Malle, Paris, t. I, 1838 p. 25-28.
Garden space structure and design style	The garden is located in an enclosed area	
Architectural element	Pavilion decorated with paintings in mosaic style	Peyssonnel et Desfontaines, Voyages, ed. Dureau de la Malle, Paris, t. I, 1838 p. 25-28.

Table 9: Design features based on narratives from European travellers (Source: made by the author)

2- Preventive conservation measures for the Bardo garden:

Following the precedent of Alhambra gardens, the preventive conservation in Bardo garden will be a significant addition as it focuses on long-term risk mitigation, aiming to protect the cultural, aesthetic and ecological values and avoid intrusive interventions in the site. Additionally, preventive conservation strategies are more cost-effective than continuous restoration projects.

- **Priority elements of the garden:** Defining the valuable and vulnerable design elements of the garden, identifying the potential risks that might impact these elements and prioritizing their preservation and maintenance.
- **Effective tourism management:** Identify the potential risks from mass tourism and over usage of vulnerable areas, elaborate a clear tourism management plan covering the potential risks and enhance the security measures.
- **Disaster management:** Develop a risk map for different disaster scenarios (floods, fires, storms, etc.).
- **Reporting and documentation:** Continuous reporting for changes within the garden, maintain detailed archival records and plant inventory as a guide in case of future restoration work (build materials,

3- Mitigation and adaptation of climate change:

Green and sustainable energy:

Tunisia has been significantly impacted by climate change in recent years, the most critical consequences are the high temperature and the severe decline in water reserves, especially in the urban environment. Following the Kew Botanic Gardens steps and aligning with the national Tunisian strategy for climate change, several new measures should be introduced to the Bardo Palace. In fact, clean energy is the key to the sustainable preservation of the garden. In the context of Bardo Palace, the consistent sunny condition presents an opportunity to optimize renewable energy production.

Water management and drought resilient strategies:

Effective water management and drought resilience strategies are mandatory for the sustainable preservation of the Bardo garden in the face of the escalating climate change crisis in Tunisia. In fact, harvesting and storing rainwater from the Bardo museum roofs and paved areas to supplement the water supplies, especially during dry periods.

Sustainable horticultural practices:

The selection of plant species for Bardo Palace must align with the historic evidence and references, and be resilient to the projected climate in Tunis. Several indigenous and traditional varieties have demonstrated drought tolerance and heat resistance over centuries. Moreover, the planting design should also consider the microclimates withing the garden by creating humid shady areas with moderate soil temperature, considering the traditional irrigation systems for arid areas such as drip irrigation to minimize water waste while ensuring deep root hydration, and enhancing the soil quality to prevent organic matter loss through the incorporation of compost.

4- Conservation management plan for the Bardo Palace's gardens

Following the restoration and reconstruction work of the Bardo gardens, developing a structured Conservation Management Plan (CMP) is recommended for the sustainable preservation of the site. The document provides a systematic framework for understanding, protecting and managing the Bardo palace gardens, ensuring that their cultural significance will be preserved for future generations. Moreover, for better results, the CMP should align with ICOMOS guidelines and best practices for historic gardens and the national heritage regulation in the Tunisian Heritage Law.

Key elements of the CMP	Description
Legal Identification and Description	▪ Identification of the site: Name, Location, Legal ownership ▪ Detailed description of the garden's landscape design elements and architectural attributes: Pathways, water features, architectural structures, materials, plant collections, etc.
Cultural and historic significance	▪ Overview of the site's historic evolution, including significant periods of architectural development. ▪ An In-depth analysis of the cultural, historic, social and ecological values of the Bardo gardens. ▪ Identify the main characters and design elements that contribute to the cultural significance of the Bardo gardens.
Design elements assessment	▪ Description of the present condition of the garden's elements, including the physical and the green elements. ▪ Identification of the potential threats within the site, such as climate change impacts, security issues, overuse of the space, and maintenance deficiencies.

Conservation policies and guidelines	▪ Conservation policies: Aligning with ICOMOS practices and the national heritage law. ▪ Maintenance plan: Description of the detailed horticultural practices and the implemented strategy for climate change adaptation and mitigation. ▪ Potential interventions: Guidelines for projected interventions, development and opportunities. ▪ A detailed action plan that outlines the specific tasks and priorities (urgency, and necessities), responsible parties for each intervention within the gardens. ▪ Current and potential funding sources
Monitoring and review	▪ Periodic reviews and revision of the management strategies and maintenance level. ▪ Monitoring the garden's condition, plant health, and the effectiveness of climate change mitigation and adaptation measures.
Public access and social engagement	▪ Raising awareness about the cultural, historic and ecological significance of the Bardo gardens. ▪ Enhancing public access and improving the security policies surrounding the museum.

Table 10: Key elements of the CMP for Bardo gardens (Source: created by the author)

Conclusion:

The Bardo complex has a significant historical and cultural value, it has undergone several complex structural evolutions from the 15th century until the 21st century. Unfortunately, while the Palace building is cited as a national heritage site and is internationally recognized, the Palace's Garden is receiving less recognition despite its historical value. The consecutive transformation and extension projects in the Bardo National Museum building have resulted in significant changes in the complex structure and the green space proportions, and caused a severe tree canopy loss.

While its original name, "Prado", strongly suggests the presence of vast gardens, detailed historical plans are not available among the archival documentation. Because of the significant knowledge gap, the process of surveying and developing a conservation understanding for the site can be considered an act of heritage recovery.

The proposed strategy in this thesis suggests the recreation of the Bardo garden from the 19th century based on the available descriptions and historic photographs, moreover, it suggests further

practices that cover historical, ecological, and legal aspects to ensure a sustainable preservation of the site.

Lastly, the theoretical proposal assists in creating the initial pathway for the reconstruction of the historic garden and acknowledges that further deep investigations are mandatory for a sustainable conservation project. The author emphasises the significance of archaeological investigations in the site as the available documents are lacking several information, encourages a futuristic approach dealing with climate change and biodiversity issues, and finally draws attention to the historic and cultural value of the garden.

7. CONCLUSION AND RECOMMENDATIONS

Historic gardens are a vital cultural heritage intersecting with several aspects of human life, they are living representations of artistic expressions, ecological knowledge and society's history. As multipurpose heritage sites, their significance extends beyond ornamentation and aesthetic aspects, in fact, in dense urban environments historic gardens are contributing in mitigating the impacts of urban heat islands and improve air quality, they function as a community asset that helps enhancing the mental wellbeing of its visitors, and lastly, they can be significant touristic destination that generates revenue while exhibiting historical and cultural aspect as well.

Despite their cultural and ecological values, historic gardens are facing several threats because of the complicated modern environmental, social and economic pressures. In fact, climate change is considered the most critical and urgent issue because of the rising temperatures and the extreme weather events that disturb the fragile microclimates within a historic garden. Urban sprawl pressure adds the risk of land loss and invades of the site's perimeter and boundaries, accompanied by air, noise and soil pollution. Additionally, the loss of traditional handcrafts and horticultural practices showcases the struggle of accommodating a sustainable adaptation in modern contexts.

The preservation of historic gardens in the 21st century requires revision and updating from static conservation strategies to dynamic adaptation. This research has examined how historic gardens conservation can evolve to address contemporary issues while maintaining its fundamental mission of safeguarding its cultural heritage. This thesis reveals through precedents and case studies that sustainable conservation and effective adaptation strategy should balance between existing policies and practices with new realities and issues.

The climate-positive strategy applied in The Royal Botanic Gardens of Kew demonstrates not only the significance of science-based solutions but also the ability of botanical institutions to lead environmental actions while preserving heritage values as well. Their climate-positive by 2030 strategy focuses on eliminating the carbon emissions within the site by implementing a comprehensive carbon management plan that includes renewable energy transitions, sustainable water recycling. On the other hand, the Royal Botanic Gardens of Victoria adopted a different adaptation pathway as they planned a 30-year transition plan and replaced the plant species of the garden with more resilient species that are compatible with the projected climate. The Alhambra preventive Master Plan represents a proactive, knowledge-based approach to preserving the historic gardens against

contemporary threats. its effectiveness lies in clearly defining a framework of strategic aims and targeted actions, ensuring the site's resilience and safeguarding its authenticity at the same time.

Based on the literature review and the precedents, this study elaborated a comprehensive strategic toolkit for the sustainable adaptation of historic gardens to contemporary challenges. The toolkit addresses several dimensions of the garden's elements, incorporating both physical elements and temporal axis to create an integrated approach that respects historical and cultural aspects while addressing present issues and ensuring continuous sustainability and resilience in the future.

The thesis suggests applying the comprehensive toolkit to the Bardo Palace garden in Tunis, and the toolkit demonstrates efficiency in addressing the site's unique challenges. The project proposes to reconstruct the 19th garden layout through archival plans and historic photographs while ensuring sustainable management of the garden's ecosystem and tourism; moreover, it suggests elaborating a long-term conservation management plan as well. The toolkit's multi-elements approach proves its flexibility in different cultural and climate contexts, focuses on balancing the historical aesthetics and climate resistance, and proves that preventive, time-sensitive adaptation can sustain heritage functionality while enhancing ecological performance.

Limitations and future research:

While the proposed toolkit provides a structured, comprehensive methodology for historic gardens' adaptation to contemporary challenges, the prototype still requires further research and result analysis to become more efficient. During the application of the toolkit in the Bardo Palace context, the author came across several issues related to the lack of sufficient archaeological and horticultural data, hence, the solution is still lacking depth. Moreover, the author comprehends that the conservation of Bardo Palace's Garden requires long-term analysis, further historical data, in-depth analysis of the climate change impacts on the site, a political and legal approach due to the national significance of the site and lastly, the cooperation of stakeholders and communities.

Additionally, the toolkit strategy should be flexible and adaptable to address the wide variety of environmental and climate challenges, especially in a global context. This could be achieved by incorporating international communication and cooperation, and taking into consideration the lessons from diverse conservation and historic gardens adaptation models.

8. NEW SCIENTIFIC FINDINGS

THESIS 1: The Florence Charter remains a fundamental layer due to its relevant and still valid definition of historic garden, as well as its emphasis on preservation and conservation. However, considering the contemporary social, environmental, and climate challenges historic gardens are facing, the document and its theoretical statements have become increasingly limited as a reference.

Building on a deep literature review and analysis of international recommendations, guidelines and conservation principles in the first chapter, the Florence Charter is still a relevant and valid document that addresses historic gardens conservation, offering an appropriate and enduring definition of historic gardens while highlighting the significance of their preservation. however, the document's theoretical framework has grown increasingly limited as a point of reference in the light of contemporary social, environmental and climate-related challenges.

The Florence Charter was published by ICOMOS in 1981 as an addendum to the Venice Charter as an attempt to integrate the designed surrounding area, the open or green space around the buildings, into the conservation scope. Based on the analytic approach in the literature review, the charter initially focuses on guiding professionals through the conservation process by providing historic gardens definitions, including the nature of the site, scope, different scales, components, etc. Moreover, it clarifies the types of intervention within the site, the management and overall preservation of the site, the types of heritage-friendly usage and lastly, the legal and administrative protection. The charter is a significant base for the garden heritage preservation pathway, setting the fundamentals of the processes and advocating the values and significance of cultural heritage and promoting the best practices on an international level.

The Florence charter indicates in “article 11” that continuous maintenance in historic gardens is essential to maintain their good condition, especially with the existence of green elements, acknowledging the evolving nature of the site. However, since the creation of the charter, several changes have occurred, including climate change and its impacts on environmental and social aspects globally. Additionally, four decades have elapsed since the publication of the Florence Charter in 1981, which is a significant duration in the context of historic gardens as their main ‘building material’ is the green heritage, the dynamic, living entity consistently influenced by environmental impacts and

the ecological system. Therefore, the current charter's recommendations hardly offer the relevant conservation principles as they cannot address the contemporary social and environmental challenges that historic gardens are facing.

Moreover, ICOMOS Australia have published and adopted the revised version of the Burra Charter in 1999, a significant cultural heritage document discussing the contemporary challenges. However, the document was tailored to fit the Australian Heritage conservation first and is wide ranged to be applied in historic gardens. Hence, the two documents, the Florence Charter and the Burra Charter, might create a balance together, and the historic garden field can benefit from Australia's experience. Still, the efforts to update the Florence Charter to call attention to the contemporary challenges have become mandatory as the conservation of historic gardens faces new and severe challenges all over the world.

THESIS 2: As the most significant document for historic garden conservation, the Florence Charter must be revised in the light of the contemporary challenges, especially climate change and mass tourism, that heritage gardens are facing nowadays.

Based on the literature analysis in the first chapter, several severe conservation challenges could be damaging to historic gardens. Recent studies highlighted critical threats from climate change and mass tourism, which seem to have the most damaging effects. These challenges have exposed gaps in the theoretical framework adopted by ICOMOS in the Florence Charter of 1981.

In the 20th century, the Florence Charter recognised historic gardens as living heritage that should be preserved in both cultural and ecological aspects. Ever since the publication and adaptation of the charter, several improvements have been witnessed in the field. However, accelerated impacts of climate change, biodiversity loss, urban expansions, etc, have created complex challenges that demand an improved approach to historic garden conservation. The charter's current framework no longer includes all necessary pathways for garden preservation, including adaptive management strategies and incorporating sustainable green solutions and facing the climate change impacts.

Contemporary challenges for historic gardens require deep and complex research, regional and international cooperation in the field of evidence-based or case study analyses, and science-based interventions to cope with challenges in the cultural and ecological aspects of historic gardens. Moreover, the growing demand for tourism and accessibility requires the integration of adaptive infrastructure while balancing the authenticity of the site.

Indeed, the Florence Charter is essentially a global guideline that attempts to assist the direction of conservation processes for historic gardens. However, keeping pace with the present-day issues will improve the credibility of the document worldwide. In this context, updating the Florence Charter to reflect the contemporary complexities would provide a more resilient and dynamic tool for authorities and stakeholders in terms of historic gardens conservation.

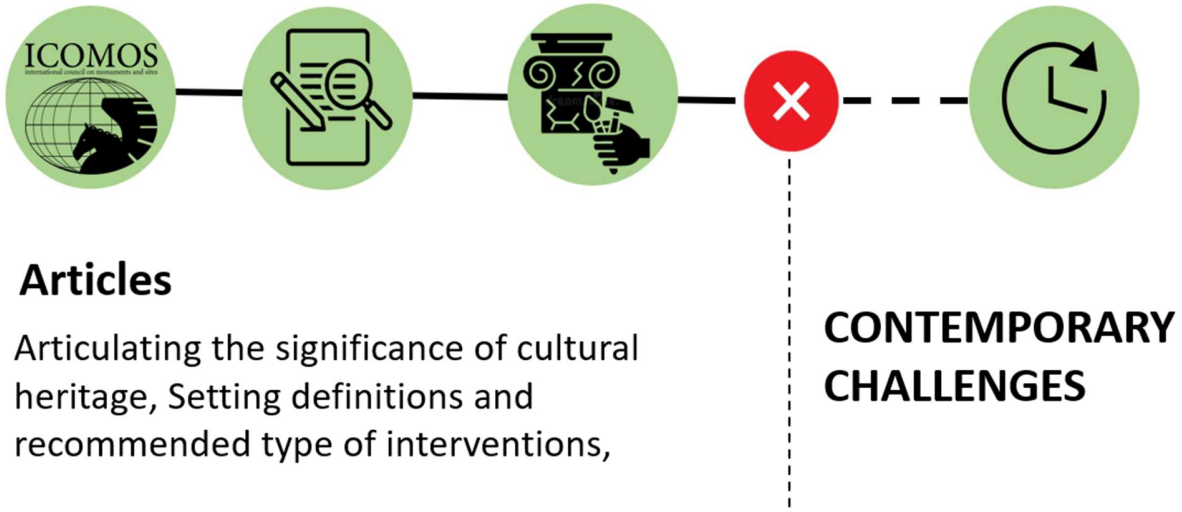


Figure 48: Florence Charter Framework about contemporary challenges (Source: Made by the Author)

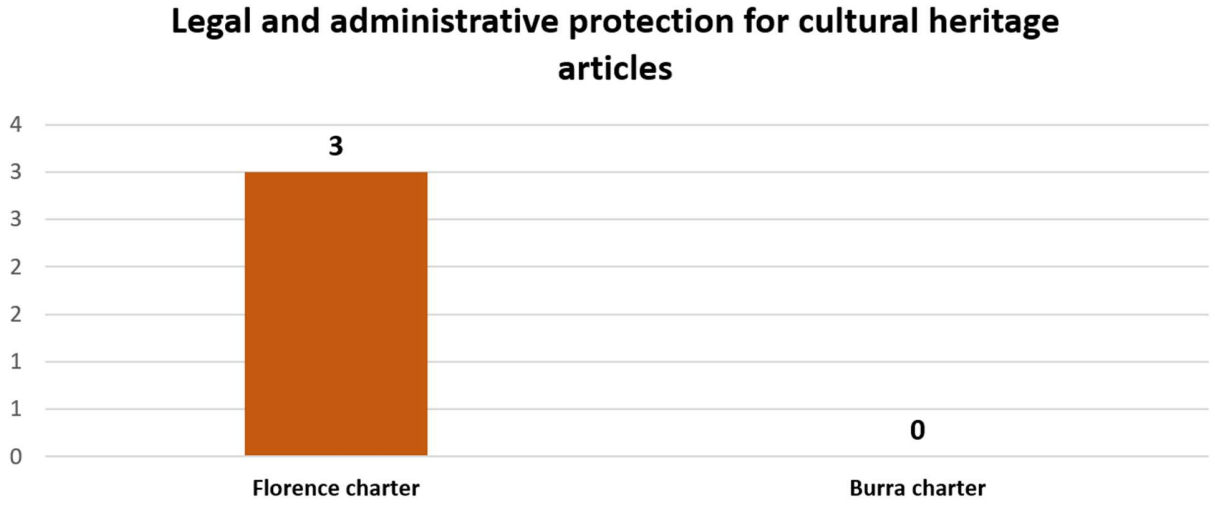
THESIS 3: To ensure the historic gardens' preservation and sustainable conservation on the long term, special attention should be paid to encouraging the legal and administrative protection.

According to the literature review in the first chapter, the Alhambra case study in the second chapter and the historical and site analysis of the Bardo complex in the sixth chapter, legal protection plays a fundamental role in historic gardens' conservation by establishing firm frameworks that prevent unauthorised alterations and ensure long-term preservation. Over time, the lack of legal safeguards risks the loss of the artistic and cultural significance of the gardens.

Heritage protection has always been a complex topic due to the physical fragility and cultural significance of heritage sites; in the case of historic gardens, it is even more complicated as they combine art and nature, making their preservation a long and continuous process. Moreover, conservation processes should not be limited only to the physical restoration of the built elements and

the adaptation of the green elements within a historic garden, as legal protection by the governmental parties is mandatory as well to maintain the results of the conservation efforts.

Certainly, the legal and administrative protection of cultural heritage should be studied and decided by local, regional and national authorities rather than international organisations. However, the ICOMOS charters, even though they hold a significant role in the field of heritage protection by setting definitions, guidelines and recommendations in the process of heritage safeguarding, they do not impose a legal obligation on stakeholders as they are a non-governmental organisation. However, they highly influence experts and professionals worldwide, and thus, encouraging local parties by elaborating and focusing on articles that state the importance of legal and administrative protection of historic gardens will improve the international point of view on this aspect of historic gardens.



"Issues not considered
legal constraints, possible uses, structural stability or costs and returns. These issues will be dealt with in the development of a conservation policy."

Burra Charter

Figure 49: The number of articles for legal and administrative protection for cultural heritage sites in Florence Charter and Burra Charter (Source : Made by the Author)

THESIS 4: Science-based solutions, like the integration of ecological principles with targeted technologies, have resulted in the most effective approach for climate change adaptation and mitigation of historic gardens. As literature review and site analyses show similar processes and dangers for historic gardens all over the world.

The case study analysis in chapter four demonstrates that in terms of climate change adaptation, science-based solutions are the most effective way to ensure that a historic garden can cope with and mitigate the undesirable impacts. The effectiveness of these solutions is the result of combining strong ecological principles with an appropriate framework that is suitable for a vulnerable site like historic gardens.

As historic gardens conservation has evolved recently to match the contemporary challenges, scientific methods in terms of climate adaptation have resulted in positive primary results that are promising in the long term. In fact, throughout this thesis, the author presented different science-based adaptation interventions applied in different major historic gardens, with different histories and backgrounds. Depending on the conservation projects, these interventions should always be simultaneous with the traditional conservation strategies presented by the guidelines and charters.

These science-based solutions in historic gardens focused only on the climate change impacts on the gardens' plant selection and ecosystem. Consequently, they are only dealing with one part of the conservation project. However, in order to achieve a successful conservation project, all the aspects of the garden should be considered. The Landscape succession strategy applied in Melbourne Botanic Gardens was only ensuring the transition of their plant species selection to be adaptable and survive the projected climate for 2090, however, it did not affect any other cultural or historic aspects of the garden. Moreover, the Climate Positive 2030 realised in the Royal Botanic Gardens included the garden's management into the agenda as well by promoting clean energy and green transportation within the gardens, including the historic greenhouses and buildings.

In this sense, the Author proposes that science-based solutions must be applied simultaneously with the tradition and wholistic conservation approaches as these strategies cover different significant parts of historic gardens, science-based solution can cover the adaptation of historic gardens to the climate change impacts while the traditional conservation interventions work on safeguarding the cultural and historic aspects of the site.

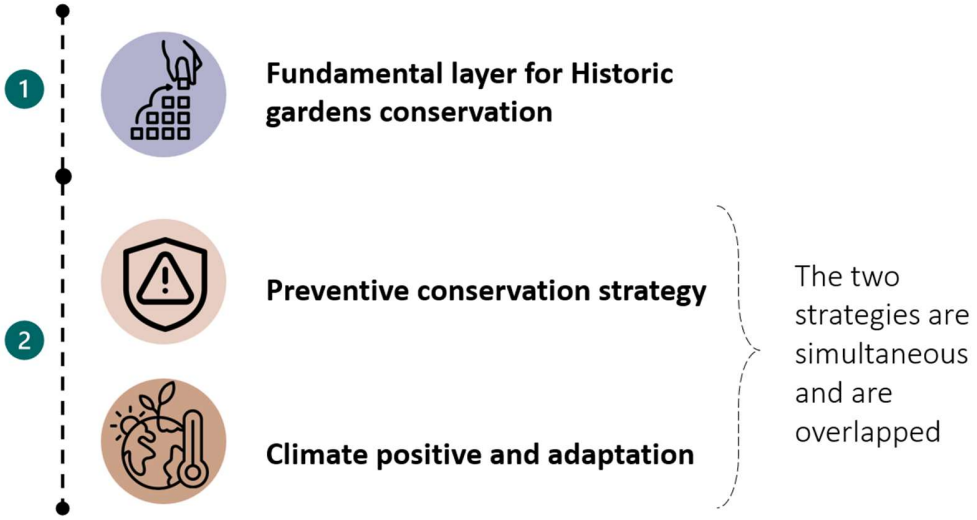


Figure 50: Effective strategy for safeguarding historic gardens (By author)

THESIS 5: During a historic garden conservation project, greater emphasis should be placed on preserving the site's authenticity, including physical and spatial elements, green elements, functions and main character.

Building on the literature review, the case studies and the Bardo Palace example, the site's authenticity is the essence of heritage sites. Authenticity can be easily compromised by inappropriate alterations or inaccurate interventions, therefore, during a conservation project, it is a must to prioritise safeguarding the site's authenticity by focusing on protecting its physical and spatial elements.

Historic gardens are heritage sites that cannot be restored to the exact original state because of several factors, firstly, the original state of the green elements within a historic garden is a complex entity to preserve as it is always a subject to change and evolution, also the horticultural practices differ from the new contemporary applied solution. Moreover, the historic materials used in older designs are hard to imitate and recover.

Heritage conservation is, in fact, an interpretive discipline rather than an exact science, and hence, it might involve a level of uncertainty. However, further efforts should be implemented to fulfil the task of preserving the authenticity of the place. In the case of historic gardens, the efforts include used materials, horticultural techniques, local identity, etc.

As emphasised in the literature review, in some cases, a conservation process can represent a major threat to the site due to several factors:

Loss of authenticity: this might be the result of conducting a conservation and restoration process without understanding the history of the site, and hence leading to neglecting parts of the garden's history because of inaccurate facts. Also, it is always advised to differentiate between the original elements and newly added elements within a garden as an attempt to safeguard the authenticity.

Inaccurate techniques and lack of specialised knowledge: Most of the artistic techniques applied in heritage sites are also considered historical or very rare to find, and the lack of recognition of the significance of these techniques will lead to authenticity threats. In fact, in several cases, reconstruction projects will be applied in historic gardens in order to imitate the original state without the misinterpretation of the original state through applying specific original techniques.

THESIS 6: Exogenous threats, arising from external factors beyond the boundaries of historic gardens, cause significant challenges to their preservation and long-term sustainability.

Referring to the case study of Alhambra elaborated in chapter four, proactive protection against external threats like environmental factors and visitors' impacts is crucial for safeguarding the site. This is ensured by a robust legal framework based on national and regional heritage laws as well as comprehensive management plans like the Alhambra Master Plan. These measures enforced the sustainable preservation of the site and eliminated several exogenous threats and risks.

As cultural heritage sites, the conservation and preservation of historic gardens is mandatory, this might extend on different levels, starting firstly with the conservation project as a physical intervention within the garden, secondly, the continuous maintenance and adequate management and lastly, we should acknowledge the significant role of the legal and administrative protection of the site as well. Heritage sites might be impacted by exterior factors, from outside their perimeter, such as fast urban sprawl, mass tourism, land management, in addition to environmental issues as air pollution, which are considered to be direct threats to the site.

The lack of legal protection, such as laws, regulations and agreements from governmental parties, creates a new challenge to the preservation of the site and makes it vulnerable to different threats as it increases the risk of destruction and the loss of integrity due to the urban development

and infrastructure projects leading to the loss of cultural and historic identity, furthermore, this might also impact the environmental aspects of the site and the loss of biodiversity due to the direct exposure to urban pressure and pollution in general. Moreover, the lack of legal protection might lead to unregulated tourism, overcrowding and mass tourism. Hence, this will impact the internal management of the garden, creating a more challenging atmosphere to control the number of tourists and decrease the visitors' impact on the site. Lastly, the financial resources of a historic garden might be impacted as well in case of no legal protection, this will decrease the legal recognition that qualifies the site to financial support from the government or international organizations, in fact, not only the financial aspect will be affected, but also the site will have lower access to the international aid and expertise in general.

In summary, the legal protection of the site will ensure that the heritage site will be recognised and protected over time, providing financial resources and a framework that protects the site from potential exogenous threats that put the cultural and environmental aspects of the site at risk.

THESIS 7: Despite its cultural significance, the garden of Bardo Palace has not been included when registering the monument as a national heritage site, hence, the lack of a protective value-management has caused the partial loss of the historic garden both in its area and vegetal or built elements. The historical garden was subordinated to the new functions, which resulted in a mass tourism decreasing further the condition and values of the garden's open spaces.

The Bardo Museum is a significant national cultural site, besides its architectural and artistic history, the site currently holds the richest mosaic collection that is indigenous to Tunisia. The monument is registered as a national heritage site since 1920; however, the protection decree only includes two palaces without mentioning their perimeter or gardens according to the urban development plan elaborated by the Ministry of Equipment, Housing and Spatial Planning and the Urban Planning Agency of Greater Tunis. Because of the lack of legal protection, the former historic garden of Bardo has disappeared, especially because of the several restoration projects in the area. One of the gardens has been transformed into a large parking lot to adapt to the visitors' needs, while the Romantic French Garden has lost its patterns and pathways.

Moreover, the Bardo complex experienced significant land loss throughout the years significant land loss due to the new allocated functions and usage. Several areas of the complex are not accessible

to the public as they are registered as military areas or governmental buildings, whilst the only publicly accessible part is the parking area. The added functions to the site led to eliminating the visitors from experiencing the authenticity of the palace's gardens, which led to, hence, a part of the identity of the site is not well exhibited to the public.

THESIS 8: For the context of Bardo Palace's Garden, the periodic reconstruction of the 19th century garden is the optimal and possible proposal due to the lack of historic documentation from the earlier periods.

Based on the historic and the site analysis elaborated in the sixth chapter of this research, the Bardo Palace has witnessed significant architectural evolution projects throughout its history from the 15th until the 21st centuries, the structural alternations have resulted radical changes of the garden's spaces, structure and usage, Even though the data is not sufficient for a reconstruction project, the 19th century version of the garden is the most documented period Based on the collected archival data and the historic photographs based on the collected archival data and the historic photographs.

The thesis proposes to elaborate a reconstruction strategy of the 19th century version of the Bardo garden, which includes several parts of its history: the colonial-inspired design at the main entrance of the palace and the original elements representing the traditional North African landscape design and the influence of the Moorish culture.

However, the thesis proposes further archaeological investigation that might reveal more concrete information about the garden's structure and architectural elements and a deep horticultural investigation in order to identify precisely the previous plant species used within the garden.

- **Practical proposal:**

THESIS 9: The conservation strategy should be based on a profound field survey that includes the garden's past, present, and future to arrive at optimal, long-lasting results. Due to global, regional, and local challenges on environmental, climate, and social aspects, the regular, traditional site survey and analysis method needs revision and development.

As demonstrated in several case studies throughout this research, the key to a successful conservation project lies in the profound site analysis elaborated before the decision-making. The historic background of a historic garden, its current state and the weak points will provide a detailed understanding of the current state of the garden and its weak points. Historic gardens are defined by

both their architectural and green elements, making the site subject to both fixed and mutable factors. Moreover, giving their time of creation the part of the garden should be included as well as its present and future.

Past: Analysing the historic and cultural significance of the historic garden will assist in deciding the conservation process and the preservation level that should be applied. This should be done through analysing archival documents, plans, paintings etc and it considered as a fixed factor as it already happened in the past and could not be changed.

Present: Assessing the current state of the site by conducting a wholistic site survey covering the state of the built elements through assessment of site plans and the current conditions of the materials and the state of the ecosystem and the green elements as well. Moreover, the assessment should also include the usage, management, legal protection and financial resources of the site.

Future: Projecting the future of the historic gardens is essential to understand the pathway of the conservation process especially in the shadow of the fast-changing times and the projected impacts of climate change.

SUMMARY

Historic gardens are living testimonies of cultural heritage, they reflect the artistic, social and environmental values of their establishment period. Because of their uniqueness and vulnerability, these heritage sites are irreplaceable representations of centuries of horticultural knowledge and artistic expressions. This doctoral dissertation examines the field of historic gardens' conservation with a modern approach. It investigates the complex and evolving challenges facing the conservation of historic gardens, emphasising the urgent need for dynamic and modern science-based solutions.

Based on the analysis of international regulations and recommendations, historic gardens are well defined and recognised as cultural heritage, however, the adaptation of these sites to the contemporary challenges, more precisely climate change, is still a grey area nowadays as the Fundamental document for historic gardens the Florence Charter was elaborated by ICOMOS more than forty years ago.

Moreover, several internationally significant case studies have elaborated their site-specific strategies to ensure long-lasting and ecological preservation. the Alhambra Garden management elaborated a preventive master plan to address threats and risk before they occur and prevent irreversible damage, while Kew gardens adopted a different approach tackling the impacts of climate change by reducing their carbon emissions by switching to clean energy and more sustainable and green solutions within the garden, on the other hand, the Royal Botanic Gardens of Victoria applied a more intense solution as they work on adapting the garden to the future projected climate by changing the current plant species to more drought tolerant ones. All these strategies are still ongoing however, they have promising outcomes.

As a result of their literature review and case studies analysis, the thesis proposes a comprehensive Historic Garden Adaptation and Conservation Toolkit. This contribution addresses both physical and temporal dimensions of historic gardens, aiming to ensure continuity, sustainability and resilience while maintaining historical authenticity.

As a last step, the thesis applies the toolkit to the Bardo Palace in Tunis to evaluate its practical utility. The project includes a theoretical reconstruction of the 19th century layout of the Bardo gardens based on archival resources and aims to implement sustainable management and long-term conservation planning. The results demonstrate the toolkit's adaptability and its potential to support heritage functionality while enhancing ecological aspects. However, due to the limited archaeological

data, the project will need further deep site-specific research for a more complete conservation strategy.

In conclusion, the dissertation offers an analytic and practical framework for the adaptation of historic gardens to contemporary challenges. It contributes to the field by linking scientific, cultural and artistic approaches, and provides a groundwork for future research aiming to expand the adaptive strategies and conservation methodologies.

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References:

C Holtorf (2020): *Conservation and Heritage As Creative Processes of Future-Making*. In: International Journal of Cultural Property, 27(2), p. 277–290

K Dreija (2012): *HISTORIC GARDENS AND PARKS: CHALLENGES OF DEVELOPMENT IN THE CONTEXT OF RELEVANT REGULATIONS, DEFINITIONS AND TERMINOLOGY / ISTORINIAI SODAI IR PARKAI: VYSTYMOSI IŠŠŪKIAI REGLAMENTAVIMO, APIBRĖŽČIŲ IR TERMINIJOS KONTEKSTE*. In: Mokslas - Lietuvos ateitis, 4(2), p. 167–175

J Sales (1995): *Garden Restoration Past and Present*. In: Garden History, 23(1), p. 1–9

G Aplin (2007): *World Heritage Cultural Landscapes*. In: International Journal of Heritage Studies, 13(6), p. 427–446

UNESCO World Heritage Centre *Cultural Landscapes*. UNESCO World Heritage Centre. https://whc.unesco.org/en/culturallandscape/. Search Engine: Google. Keywords: UNESCO World Heritage Centre *Cultural Landscapes*. Date of search: 30 October, 2024.

UNESCO (2011): Preparing World Heritage Nominations (Second edition, 2011). 138. p.

Plumptre (2007): Heritage gardens: the world's great gardens saved by restoration. London: Mitchell Beazley. 56. p.

C Funsten, V Borsellino, E Schimmenti (2020): *A Systematic Literature Review of Historic Garden Management and Its Economic Aspects*. In: Sustainability, 12(24), p. 10679

S Silva, P Carvalho (2022): *Historic Gardens Heritage in Portugal: From the Originality of an Art to the Inventory Process*. In: Sustainability, 14(10), p. 5978

M Olivadese, ML Dindo (2022): *Historic and Contemporary Gardens: A Humanistic Approach to Evaluate Their Role in Enhancing Cultural, Natural and Social Heritage*. In: Land, 11(12), p. 2214

J Jokilehto (1999): *A Century of Heritage Conservation*. In: Journal of Architectural Conservation, 5(3), p. 14–33

I Poulios (2010): *Moving Beyond a Values-Based Approach to Heritage Conservation*. In: Conservation and Management of Archaeological Sites, 12(2), p. 170–185

MacCannell (1999): The Tourist: A New Theory of the Leisure Class. University of California Press. 231. p.

Lowenthal (1994): Changing Criteria for Authenticity. In: Nara Conference on Authenticity in Relation to the World Heritage Convention (1994) (Nara, Japan).Nara, Japan: UNESCO World Heritage Centre. p 1–6

L HASHİMOVA (2022): *INTERNATIONAL ORGANIZATIONAL MECHANISMS FOR THE PRESERVATION OF CULTURAL HERITAGE*.

D Jacques (1995): *The Treatment of Historic Parks and Gardens*. In: Journal of Architectural Conservation, 1(2), p. 21–35

J Sales (2000): *Conserving Historic Gardens*. In: Journal of Architectural Conservation, 6(2), p. 72–84

Council of Europe Landscape Convention (2024): *Origins of the Convention*. Council of Europe Landscape Convention. https://www.coe.int/en/web/landscape/origins-of-the-convention. Search Engine: Google. Keywords: Council of Europe Landscape Convention. Date of search: 11 December, 2024.

M Déjeant-Pons (2006): *The European Landscape Convention*. In: Landscape Research, 31(4), p. 363–384

Duedahl, Ed. (2016): A History of UNESCO, Global Actions and Impacts. London: Palgrave Macmillan UK. 344. p.

Valderrama Martínez (1995): A history of UNESCO. Paris: UNESCO Pub. 460. p.

UNESCO (2017): *UNESCO moving forward the 2030 Agenda for Sustainable Development; 2017*.

M Rössler (2006): *World Heritage cultural landscapes: A UNESCO flagship programme 1992 – 2006*. In: Landscape Research, 31(4), p. 333–353

D Rodwell (2012): *The Unesco World Heritage Convention, 1972–2012: Reflections and Directions*. In: The Historic Environment: Policy & Practice, 3(1), p. 64–85

S Burke (2007): *Icomos: Twentieth Century Heritage International Scientific Committee*. In: Journal of Architectural Conservation, 13(2), p. 143–150

Y Ahmad (2006): *The Scope and Definitions of Heritage: From Tangible to Intangible*. In: International Journal of Heritage Studies, 12(3), p. 292–300

B Hanna (2015): *Foundations of an oral history project: The writing of the Burra Charter*. 27(2)

J Lennon (2014): *The Venice Charter Down Under: Its Legacy in Landscape Preservation*. In: Change Over Time, 4(2), p. 322–336

Institute of Historic Building Conservation (2020): *Conservation management plan*. https://www.designingbuildings.co.uk/wiki/Conservation_management_plan. Search Engine: Google. Keywords: Conservation management plan. Date of search: 20 May, 2025.

ICCROM (1998): *Management guidelines for World Cultural Heritage sites*. https://www.iccrom.org/publication/management-guidelines-world-cultural-heritage-sites. Search Engine: Google. Keywords: Conservation management plan. Date of search: 30 May, 2025.

M. Feilden, Jokilehto (1998): Management Guidelines for World Cultural Heritage Sites. Rome: CCROM International Centre for the Study of the Preservation and Restoration of Cultural Prope. 156. p.

Lahmar, Ben Salem, Benkaid Kasbah, et al. (2024): Contemporary Challenges and Sustainable Solutions for Historic Gardens' Conservation. In: EMECI (2024) Recent Advances in Environmental Science from the Euro-Mediterranean and Surrounding Regions (4th Edition), Advances in Science, Technology & Innovation,. Springer Nature Switzerland AG 2024. p 1035–1037

A Rehman (2011): *Conservation of Historic Monuments in Lahore: Lessons from Successes and Failures*. 8, p. 61–69

R Bisgrove, P Hadley (2002): *Gardening in the Global Greenhouse: The Impacts of Climate Change on Gardens in the UK*. In: Technical Report

Pachauri, Mayer (2015): Climate change 2014: synthesis report. Geneva, Switzerland: Intergovernmental Panel on Climate Change. 151. p.

Calvin, Dasgupta, Krinner, et al. (2023): IPCC, 2023: Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, H. Lee and J. Romero (eds.)]. IPCC, Geneva, Switzerland. Intergovernmental Panel on Climate Change (IPCC). 186. p.

RG Taylor, B Scanlon, P Döll, et al. (2013): *Ground water and climate change*. In: Nature Climate Change, 3(4), p. 322–329

K Szabó, J Doma-Tarcsányi, K M. Szilágyi, et al. (2022): *THE EFFECTS OF CLIMATE CHANGE ON THE LIVING HERITAGE OF HISTORIC GARDENS*. In: 4D Tájépítészeti és Kertművészeti Folyóirat, (65), p. 48–63

A Haugen, C Bertolin, G Leijonhufvud, et al. (2018): *A Methodology for Long-Term Monitoring of Climate Change Impacts on Historic Buildings*. In: Geosciences, 8(10), p. 370

M Cassar, R Pender (2005): *The impact of climate change on cultural heritage: evidence and response*. 2

S Millar (1989): *Heritage management for heritage tourism*. In: Tourism Management, 10(1), p. 9–14

Séraphin, Gladkikh, Vo Thanh, Eds. (2020): Overtourism: Causes, Implications and Solutions. Cham: Springer International Publishing. 460. p.

Pereira, Martins (2018): Sustainable Heritage management Towards Mass Tourism Impact: the HERIT-DATA project. In: International Conference on Intelligent Systems (IS) (2018)

BD Taff, J Benfield, ZD Miller, et al. (2019): *The Role of Tourism Impacts on Cultural Ecosystem Services*. In: Environments, 6(4), p. 43

S Pouya, O Demirel, S Pouya (2015): *Historical Gardens at Risk of the Destruction by Visitors, Case Study of El-Goli Garden (Iran)*. In: Landscape Research, 40(7), p. 875–883

M Czałczyńska-Podolska (2014): *UTILIZATION AND PRESERVATION*. In: TECHNICAL TRANSACTIONS ARCHITECTURE, p. 1–15

P Gullino, E Pomatto, W Gaino, et al. (2020): *New Challenges for Historic Gardens' Restoration: A Holistic Approach for the Royal Park of Moncalieri Castle (Turin Metropolitan Area, Italy)*. In: Sustainability, 12(23), p. 10067

UNESCO World Heritage centre *Residences of the Royal House of Savoy*. UNESCO World Heritage Centre. https://whc.unesco.org/en/list/823/. Search Engine: Google. Keywords: (Royal House of Savoy. Date of search: 26 January, 2025.

UNESCO (2009): *Alhambra, Generalife and Albayzín, Granada*. UNESCO World Heritage Centre. https://whc.unesco.org/en/list/314/. Search Engine: Google. Keywords: Alhambra UNESCO. Date of search: 11 September, 2024.

Chisholm, Garber (2018): The history of landscape design in 100 gardens. Portland, Oregon: Timber Press. 537. p.

S Satoh (2020): *The 20th Century Restoration of the Alhambra Patio in Relation to Landscape Design*, (3)

MM Villafranca Jiménez, ML Gutiérrez-Carrillo (2019): *The Alhambra master plan (2007-2020) as a strategic model of preventive conservation of cultural heritage*. In: VITRUVIO - International Journal of Architectural Technology and Sustainability, 4(2), p. 59

J Del Mar Villafranca (2007): *The Director Plan of the Alhambra (2007-2015)*.

T J. Entwisle (2019): *R-E-S-P-E-C-T: How Royal Botanic Gardens Victoria is responding to climate chang*. 1, p. 77–83

D Bramwell (2024): *The response of botanic gardens to climate change*.

The Victorian Heritage Database (2002): *VHD*. https://vhd.heritagecouncil.vic.gov.au/places/12407. Search Engine: Google. Keywords: Botanic Gardens of Victoria. Date of search: 22 September, 2024.

P Symes (2017): *Guiding landscape transition for climatic change: planning in the Royal Botanic Gardens Victoria, Australia*. In: Acta Horticulturae, (1189), p. 137–142

Royal Botanic Gardens Victoria (2021): *Climate Change Alliance of Botanic Gardens*. Royal Botanic Gardens Victoria. https://www.rbg.vic.gov.au/initiatives/climate-change-alliance/. Search Engine: Google. Keywords: Botanic Gardens of Victoria. Date of search: 25 September, 2024.

Climate Change Alliance of Botanic Gardens (2022): *Landscape Succession for 'Climate Ready' Botanic Gardens :: A Landscape Succession Toolkit*.

TJ Entwisle, C Cole, P Symes (2017): *Adapting the botanical landscape of Melbourne Gardens (Royal Botanic Gardens Victoria) in response to climate change*. In: Plant Diversity, 39(6), p. 338–347

Royal Botanic Gardens Board Victoria (2016): Royal Botanic Gardens Victoria Landscape Succession Strategy – Melbourne Gardens 2016 - 2036. p.

UNESCO World Heritage Centre *Royal Botanic Gardens, Kew*. UNESCO World Heritage Centre. https://whc.unesco.org/en/list/1084/. Search Engine: Google. Keywords: Kew Gardens UNESCO. Date of search: 5 October, 2024.

Royal Botanic Garden Kew, 2021. Climate positive by 2030 Sustainability Strategy: urgently tackling the climate and biodiversity crisis.

World Meteorological Organization (2024): *Africa faces disproportionate burden from climate change and adaptation costs*. World Meteorological Organization. https://wmo.int/news/media-centre/africa-faces-disproportionate-burden-from-climate-change-and-adaptation-costs. Search Engine: Google. Keywords: Climate change in North Africa. Date of search: 18 May, 2025.

The National Institute of Meteorology *Le changement climatique en Tunisie | Climat-c*. https://climat-c.tn/INM/web/changementClimatique. Search Engine: Google. Keywords: Climate change in Tunisia. Date of search: 19 May, 2025.

S Ben Salem, C Lahmar, M Simon, et al. (2021): *Green System Development in the Medinas of Tunis and Marrakesh—Green Heritage and Urban Livability*. In: Earth, 2(4), p. 809–825

UNPD (2023): *Tunisia | Climate Promise*. https://climatepromise.undp.org/what-we-do/where-we-work/tunisia. Search Engine: Google. Keywords: Climate change in Tunisia. Date of search: 29 May, 2025.

UNESCO Centre du patrimoine mondial *Tunisie - UNESCO Convention du patrimoine mondial*. UNESCO Centre du patrimoine mondial. https://whc.unesco.org/fr/etatsparties/tn. Search Engine: Google. Keywords: UNESCO Tunisia. Date of search: 21 May, 2025.

DE Coslett (2020): *Preservation and tourism in Tunisia: on the colonial past in the neocolonial present*. In: The Journal of North African Studies, 25(5), p. 727–752

UNESCO Database of National Cultural Heritage Laws (1994): *Décret N.94-1475 relatif à la composition et au fonctionnement de la Commission nationale du patrimoine - UNESCO Database of National Cultural Heritage Laws*. https://www.unesco.org/en/cultnatlaws/decret-n94-1475-relatif-la-composition-et-au-fonctionnement-de-la-commission-nationale-du-patrimoine. Search Engine: Google. Keywords: Tunisia Heritage law. Date of search: 18 May, 2025.

Agency for the development heritage and cultural promotion (2022): *The agency*. https://www.patrimoinedetunisie.com.tn/en/the-agency/. Search Engine: Google. Keywords: Tunisia heritage regulations. Date of search: 18 May, 2025.

A Mrabet (2016): *Muséographie et histoire : le Musée national du Bardo (Tunisie)*. In: Comptes-rendus des séances de l année, N2, p. 805–819

R Bouhamed (2024): *Spatial evaluation of the museum experience in converted heritage: the case of the National Bardo Museum in Tunisia*. In: Acta IMEKO, 13(3), p. 1–8

Zaher Kammoun (2020): *Le palais du Bardo*. Zaher Kammoun. https://zaherkammoun.com/2020/04/03/le-palais-du-bardo/. Search Engine: Google. Keywords: Le palais du bardo. Date of search: 4 December, 2024.

The National Bardo Museum (2012): *The Alaoui Museum during the Protectorate (1881-1955)*. http://www.bardomuseum.tn/index.php?option=com_content&view=article&id=178&Itemid=91&lang=en. Search Engine: Google. Keywords: National Bardo Museum. Date of search: 10 December, 2024.

F Matri (2018): *La reconversion des palais traditionnels en musées aux XIXe-XXe siècles à Tunis*.

V Rey (2018): *The Radicalization of Heritage in Tunisia*. In: International Journal of Islamic Architecture, Volume 7 Number 1(1), p. 67–84

S Zaiane (2008): *Le musée national du Bardo en métamorphose: Pour une nouvelle image du tourisme culturel tunisien et de nouveaux visiteurs*. In: Téoros: Revue de recherche en tourisme, 27(3), p. 18

Annex:

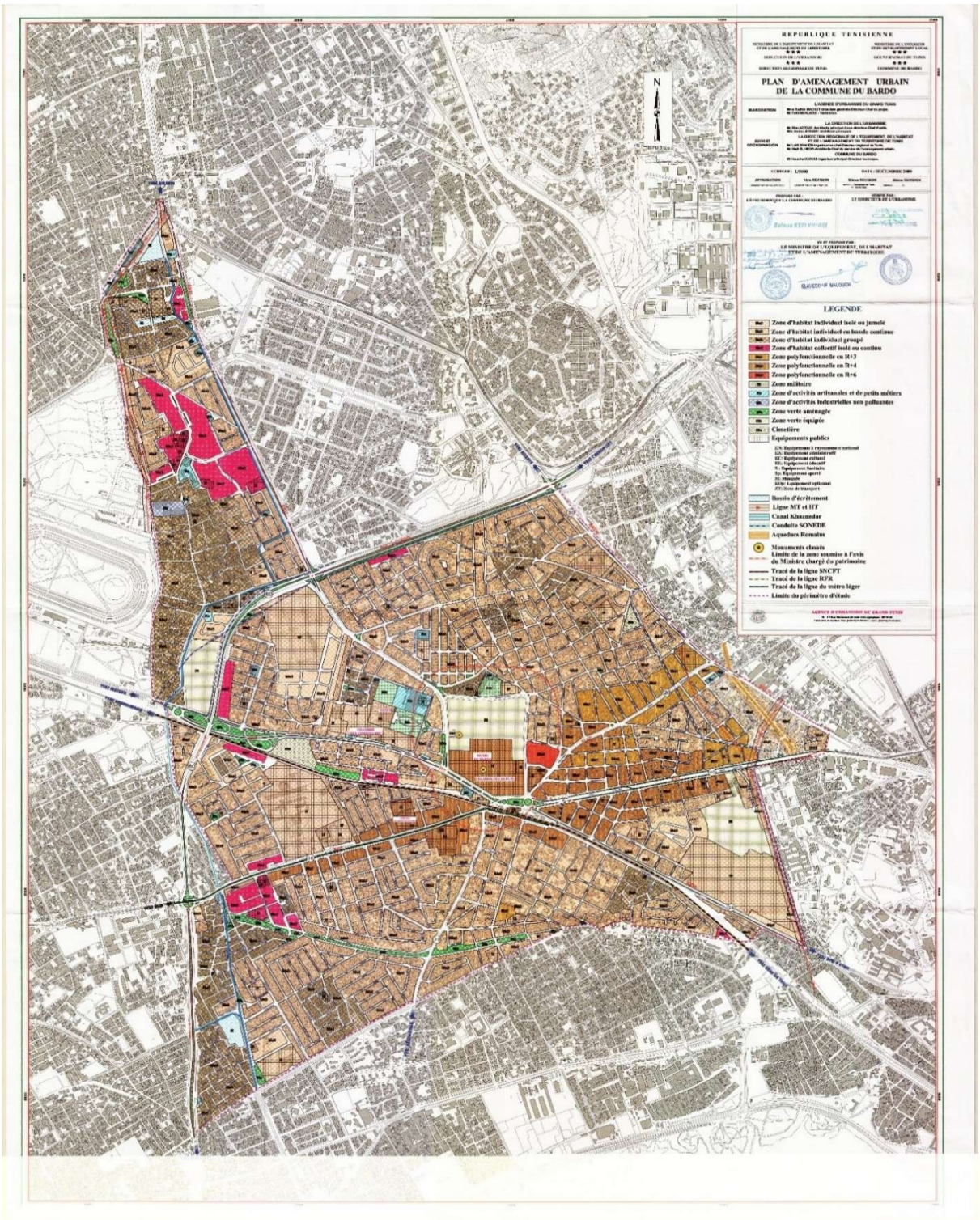

Figure 51: Urban development plan of Bardo region by the municipality (Source: http://www.commune-bardo.tn/4/index.jsp}