



# Virtual Reality in World Heritage Gardens

Andalusia - Sicily - Jordan

Project iHERITAGE: ITC Mediterranean platform for UNESCO Cultural Heritage  
ENI CBC Med Programme







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Partners collaborating in this publication:



### **About the ENI CBC Med Program and iHERITAGE Project:**

The iHERITAGE project is co-financed by 90% by the ENI CBC Med Program with a total budget of €3.874.287,06 and has been recognized among the most strategically important projects of all 198 proposals presented throughout the Mediterranean basin. iHERITAGE is committed to assisting the creative industry and innovative startups in Italy, Egypt, Spain, Jordan, Lebanon, and Portugal by funding the creation of new augmented and virtual content in the leading sectors of culture and tourism, as well as engaging with local communities through free access to the Living Labs Program, trainings, awareness raising events, engagement seminars, and the opportunity to apply for grants.

The 2014-2020 ENI CBC Mediterranean Sea Basin Programme is a multilateral Cross-Border Cooperation (CBC) initiative funded by the European Neighbourhood Instrument (ENI). The Programme objective is to foster fair, equitable and sustainable economic, social and territorial development, which may advance cross-border integration and valorise participating countries' territories and values. The following 13 countries participate in the Programme: Cyprus, Egypt, France, Greece, Israel, Italy, Jordan, Lebanon, Malta, Palestine, Portugal, Spain, and Tunisia. The Managing Authority (MA) is the Autonomous Region of Sardinia (Italy). Official Programme languages are Arabic, English and French. For more information, please visit: [www.enicbcmmed.eu](http://www.enicbcmmed.eu)

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Few places of our environment are so pleasant to us as gardens. They are inspiring spaces, places of rest, havens of freshness that allow visitors to connect with nature and to feel part of it. There are many shapes, sizes and styles of garden, but whether small or large, enclosed or open, intimate or monumental, they have accompanied any human habitat since the dawn of time.

And Andalusia represents this garden wealth in a very particular way. In addition to their intrinsic vegetal beauty, many of these gardens are outstanding because of their longevity and their capacity to last, or even survive, over the centuries. Such is the case of the Patio de los Naranjos (Orange Trees Courtyard), in the Mosque of Cordoba, probably the oldest living garden in existence, which has faithfully adorned the Caliphal city for 12 centuries.

In Granada, there are also gardens that have stood the test of time, such as the Patio de los Arrayanes in the Alhambra and the enchanting Generalife. The Patio de la Acequia, for instance, has been an ornamental garden continuously since it was created in the 14<sup>th</sup> century. These three stunning gardens, along with many others in Andalusia, Spain, and Europe, were also featured in the exhibition. Like the gardens of al-Andalus mentioned earlier, they have deservedly become part of the World Heritage and have been recognized by UNESCO.

While these are the gardens that have been preserved, there are many other Andalusian gardens that have been recognized. Some are known specifically through archaeology, such as the gardens that existed in the palatine city of Madinat al-Zahra', while others are only mentioned in the numerous divans of Andalusian poetry, in which there was a whole genre devoted to the description of flowers. Many verses have been dedicated to these gardens, transporting us to beautiful and fragrant spaces covered with flowers where water is always present.

Andalusia is still home to many gardens that are direct heirs of the gardens of al-Andalus, such as those found in the Real Alcázar in Seville. The Andalusian garden heritage is intricately connected with the tradition of the gardens of Antiquity, including those of the Roman, Persian, and Byzantine empires. This heritage is still alive today, with new gardens being created that reproduce the models associated with the gardens of al-Andalus. These gardens include amazing pools, myrtle beds, citrus trees, cypresses, and other elements that make them truly unique.

The exhibition title itself reflects the combination of the concepts of garden and heritage, inviting visitors to reflect on gardens as ornamental and heritage elements. It immersed us in real and imaginary gardens made of paper, stone, sound, and music. There were gardens for children, gardens in engravings, paintings, and photography -gardens that have inspired all the arts. The exhibition also introduced gardens recreated using cutting-edge technologies, following the line marked by the European project iHERITAGE. ICT Mediterranean Platform for UNESCO cultural heritage.

The exhibition combined very assorted elements, which despite their heterogeneity, dialogued perfectly with each other: there were of course real plants, but also works of art, photographs, museum objects and books, and as a differentiating element, pioneering technologies such as holograms and Virtual Archaeological Reconstructions, which showcased the latest research results in heritage sites recognized by UNESCO.

Today, many of these historic gardens are part of the World Heritage List, with Andalusia being home to numerous examples such as the gardens of the Alhambra and the Generalife, the Alcazar Gardens in Seville, the Albayzin, the Royal Alcazar Gardens in Seville, and the courtyard of the Mosque of Cordoba. Inspired by the creative and renewing principles of the iHERITAGE Project, we feel somehow compelled to showcase and analyze these gardens, discovering how they have evolved and continue to inspire anyone who has had the good fortune to visit or frequent them.

**María de la Concepción de Santa Ana Fernández**

Managing Director

El legado andalusí Andalusian Public Foundation



## **Communicating heritage in the digital era: Exhibition *Gardens. Heritage and dreams* European Year of Skills. Interreg Next Med**

El legado andalusí Andalusian Public Foundation  
Regional Ministry of Culture, Tourism and Sport. Junta de Andalucía

**H**olography, virtual reconstructions and immersive technologies are the core aspects of the project iHERITAGE ICT Mediterranean platform for UNESCO Cultural Heritage. This project is co-financed by the European Union through the ENI CBC MED Programme and features the holographic exhibition *Gardens. Heritage and dreams* created by the Andalusian Public Foundation El legado andalusí. The exhibition was held in the Corral del Carbón in Granada and curated by José Tito, a botanist and PhD in Biological Sciences from the University of Granada, and the artist María Teresa Martín-Vivaldi.

This publication responds to the need to delve deeper into the methods of communicating our heritage, immersed in the digital age we are living through and in which we will undoubtedly remain, and which have been a major part of this holographic exhibition and other elements at international level that are integrated in the frame of this European project based on the transfer of knowledge.

iHERITAGE focuses on using new techniques for research and exhibition to enhance the interpretation of monuments and sites declared UNESCO World Heritage Sites in the Mediterranean environment. This project



employs innovative tools produced with the latest Information and Communication Technologies (ICT), such as Augmented Reality (AR), Virtual Reality (VR), and Mixed Reality (MX).

The celebration of the holographic exhibition, along with the virtual archaeological reconstruction and other interpretation techniques discussed in this publication, coincides with the European Parliament's declaration of the European Year of Skills (2023), recognizing the significance of the dual ecological and digital transition. This declaration opens up new opportunities for people within the EU framework.

To promote sustainable growth of innovation and a culture of lifelong learning, this project and exhibition share common subjects with the European Year of Skills, including collaboration with government authorities, social partners, companies, the academic world, and civil society, while emphasizing individual responsibility. The innovative elements of this project are the result of public-private collaboration and the joint efforts between the Andalusian Public Foundation El legado andalusí -a public entity with an extensive background in the cultural and heritage scopes-, researchers from the University of Granada and the School of Arab Studies (Higher Council for Scientific Research), and small and medium-sized companies. The goal was to bring our heritage closer to both European citizens and those outside the EU and the Mediterranean area as we navigate through the climate and digital transition era.

Virtual Reality (VR) is considered to be one of the most effective ways to provide immersive and astonishing experiences in the cultural sector. However, when it comes to preserving and sharing our cultural and heritage legacy, it is crucial that the virtualization of environments remains faithful to the unique qualities and particularities of these objects, spaces, and places. This has been the primary objective of both this exhibition and the project as a whole.

This publication is an exemplary effort in transnational cooperation within the EU and beyond its borders. The collaboration between El legado andalusí and the teams of researchers has resulted in a hypothetical 3D holographic reconstruction of an *almunia* or agricultural estate based on a 13<sup>th</sup>-century manuscript, *The history of Bayad and Riyad*, preserved in the Vatican Library. In addition, three holographic helixes have been displayed to showcase the evolution of the landscape of the Generalife from the 16<sup>th</sup> to the 20<sup>th</sup> century. This monument, together with the Alhambra, was declared a UNESCO World Heritage Site in 1984. Additionally, a Virtual Archaeological Reconstruction of the Almunia del Chapiz, a building and garden located in the Albayzin neighbourhood, the oldest in the city and the origin of Granada, which was declared a World Heritage Site by UNESCO in 1984, was also undertaken. The scientific discipline of virtual archaeology, digital archaeology or cyber-archaeology studies and develops ways of applying computer-assisted visualization to the comprehensive management

of archaeological heritage. This technology offers enormous potential today as it is not limited only to computer-assisted visualization, but also applied to exploration and simulation, as in the case of the Almunia del Chapiz.

The holographic works developed by the Department of Architecture of the University of Palermo (Italy) within the iHERITAGE project, showcasing the Arab-Norman buildings of the *Cuba* and the *Castello della Zisa*, as well as the Canal *Gesuitico Alto*, a *qanat* of Arab origin, have been added to the exhibition produced by El legado andalusí. These works were coordinated by Professor Rossella Corrao and exhibited in the holographic helixes. Professor Corrao is also the author of an article entitled *Discovering the Arab-Norman Gardens and Buildings of Palermo, a UNESCO World Heritage Site, through New Technologies for Communication and Information*, which provides another perspective on these applications and serves as an ideal complement to the contents featured in this publication.

It is, in short, a privilege for El legado andalusí, to which we must add the contribution in these pages of researchers from the Hashemite University of Zarqa (Jordan), the Jordanian German University of Amman and the Department of Antiquities of Amman (Jordan) in the article entitled *Insights on landscaped gardens of desert culture: the Umayyad and the Nabataean gardens*, coordinated by Dr Talal Akasheh, a specialist in the field and former curator of the Nabataean city of Petra.

Finally, we would like to point out the relevance and the need to continue exploring this path of heritage dissemination through digital research. In this line, the European Commission has approved the transnational cooperation programme Interreg VI-B NEXT “Mediterranean Sea Basin” (NEXT MED), which covers a cooperation area of 15 countries. Interreg NEXT MED aims to contribute to intelligent and sustainable development throughout the Mediterranean basin by supporting a balanced, long-lasting and far-reaching partnership, a common Mediterranean scenario in which new technologies in heritage interpretation should also be a key point and for which the foundations have been laid with initiatives such as the exhibition *Gardens. Heritage and dreams* exhibition and the iHERITAGE project.



## El legado andalusí: innovative technologies at the service of heritage interpretation. *Gardens. Heritage and dreams*

El legado andalusí Andalusian Public Foundation  
Regional Ministry of Culture, Tourism and Sport. Junta de Andalucía

The Andalusian Public Foundation El legado andalusí, an entity supported by the Ministry of Tourism, Culture and Sport of the Regional Government of Andalusia (Spain) has undertaken, as a partner of iHERITAGE project, the mission of interpreting UNESCO Cultural Heritage, both material and intangible, experimenting with leading-edge technologies such as holograms, virtual archaeological reconstructions or 360° videos. All these avant-garde technologies served to mould the discourse of the exhibition *Gardens, Heritage and dreams*, installed in the Corral del Carbón building, in the historic centre of the city of Granada (Andalusia). Through these virtual resources, combined with more conventional exhibition techniques, the Foundation tried to show visitors how innovative technologies are put at the service of the interpretation of heritage, while introducing the subject of historic gardens integrated in UNESCO World Heritage sites. The

starting point were the monuments of Granada that have deserved such distinction: The Alhambra and the Generalife and the Albayzin district.

### The context

It is an undeniable fact that the historical stratification, unique environmental characteristics and the socio-cultural diversity of the millennial Mediterranean basin, among many other factors, have given rise over the centuries to a complex system. The interaction between civilisations and the context in which they arose and lived have contributed to generating an immense and varied cultural legacy, both tangible and intangible.

El legado andalusí, an Andalusian Public Foundation depending on the Ministry of Tourism, Culture and Sport of the Andalusian Regional Government, contributed

with its experience, together with eight other partners from Mediterranean countries (Spain, Italy, Portugal, Egypt, Jordan and Lebanon), to the interpretation of this world heritage through the implementation of the European project iHERITAGE: ICT Mediterranean platform for UNESCO Cultural Heritage, co-financed by the European Union through the ENI CBC MED Programme.

In its broadest sense, the initiative aimed to promote the use and application of the most advanced technologies in the dissemination and interpretation of World Heritage in the countries of the Mediterranean basin, thus taking a technological turn to the traditional perspective that has generally been used when interpreting heritage sites. Through virtual or augmented reality technology resources such as holography, virtual archaeological reconstructions, virtual reality glasses and booths, re-contextualisation or augmented reality guided tours, the aim pursued was to reveal the secrets of the most authentic and genuine Mediterranean heritage, both tangible and intangible.

El legado andalusí brought together all the technological resources proposed by iHERITAGE to achieve the postulated results and agreed to integrate them into the scientific discourse the exhibition *Gardens. Heritage and Dreams* revolved around. Together with exhibition components of a more conventional or traditional nature, these avant-garde elements made up a complete line of contents whose elements complemented and dialogued with each other to communicate a clear message to the

visitor and the end user: identifying, disseminating and giving its fair value to the Cultural Heritage of Humanity, recognised as such by UNESCO, starting from the emblematic monuments of the city of Granada, but observed from the peculiar perspective of their green spaces: gardens, *cármenes*<sup>1</sup>, orchards, recreational estates, courtyards, farms...

### Spaces and history

The Corral del Carbón building, a 14<sup>th</sup>-century Nasrid *funduq* or *alhóndiga*<sup>2</sup> located in the heart of the city of Granada, was the ideal setting for this exhibition which proposed a tour of the World Heritage gardens and combined the virtual and the traditional.

The building is the only Arab *alhóndiga* still standing on the Iberian Peninsula and is practically completely preserved. It was erected in 1336, and is a faithful reflection of the history of Granada and of the Arab heritage that is present throughout the city. It was originally a public building intended to house merchants and their goods during the markets, since from the 12<sup>th</sup> century, Granada was an obligatory stop on the trade routes, which is why the Corral del Carbón acquired special relevance during the Zirid<sup>3</sup> and Nasrid<sup>4</sup> periods of al-Andalus. It had spaces for storing goods such as grain and wheat, and rooms for housing merchants. It was also strategically located next to the *Alcaicería*, the old silk market, and the Great Mosque.



Different moments of the exhibition *Gardens. Heritage and dreams*, including the projection on holographic helixes and the multi-screen audio-visual production.

After the Christian conquest, the coal merchants became the main guests of the *alhóndiga*, which is why it received its current name of Corral del Carbón<sup>5</sup>. The splendid porticoed courtyard of the Corral del Carbón served both as the anteroom and as the first exhibition space, in which the visitor was introduced to real

plants, to four vegetal varieties that identify different gardens in Granada's environment and with which the city fully identifies: citrus trees, emblematic of the gardens of Europe; vines, indispensable in Mediterranean gardens, myrtles, representative of the gardens of al-Andalus, and cypresses, omnipresent in the gardens of Granada.

## Holographic solutions

One of these ancient rooms, originally intended for the storage of goods, was transformed for the occasion into a holographic space within the exhibition *Gardens. Heritage and dreams*.

Taking into account the available options, technical factors, and specific characteristics of the room and

holographic devices, El legado andalusí's team, together with the exhibition curators, decided to project four independent holograms mounted on four holographic propellers or helixes. In this way, the holograms took on a significant role in the exhibition. They consist of videos or images which, through the use of light and the application of several simultaneous planes, make a three-dimensional image or video appear. They are created

Frame of the holographic video recreating in 3D the orchard described in the manuscript *Hadith Bayad wa Riyad*.



through holography, a photographic technique that uses technology to bring images or videos to life in three dimensions.

In the holographic fans or propellers used in the exhibition, the image is created through a high-powered RGB LED strip housed inside the blade. Rotating at high speed, this LED strip mimics the colours emitted by the LEDs inside, reproducing the desired video.

As part of the exhibition discourse, which sought to harmonise the UNESCO world heritage and the gardens as a world heritage sites, the hypothetical 3D-holographic reconstruction of an *almunia*<sup>6</sup> was undertaken for the first time, basing on a 13<sup>th</sup>-century manuscript, recreating its corresponding volumes (characters, animals, plants) and elevations, as they appear in the *Hadith Bayad wa Riyad* (*The story of Bayad and Riyad*), a manuscript preserved in the Vatican Library. The result could be admired in the form of holography in the first of the holographic helixes installed in this room.

The three remaining holographic helixes invited the visitor to take an evolutionary tour showing the changes in the landscape of the Generalife between the 16<sup>th</sup> and 20<sup>th</sup> centuries. Together with the Alhambra, the monument was declared a UNESCO World Heritage Site in 1984. The holographic tour of the Generalife proposed a journey through three moments in the history of the monument:



Frame of the holographic recreation of the courtyard and pond of the Nasrid orchard described in the *Hadith Bayad wa Riyad*.

## MULTIMEDIA CONTENT



Scan this QR code to visualise on your mobile device a hypothetical holographic reconstruction of an agricultural estate based on the 13<sup>th</sup>-century manuscript *Hadith Bayad wa Riyad*.



1

2



3

**1 Moorisco (Moorish) Generalife**

Included the first Christian transformations, between 1526, the date of Andrea Navagero’s description, and 1567, the date of Anton van der Wyngaerde’s sketches.

**2 The post-Romanesque Generalife**


Between 1856, the beginning of the construction of the High Gardens, and 1875, when the *Paseo de las Adelfas* was built.

**3 The Generalife, from private to public**


Around 1934, when the works by Leopoldo Torres Balbás, the architect-conservator of the Alhambra were completed.

**MULTIMEDIA CONTENT**


3D holographic reconstructions



Moorish  
Generalife



Post-Romanesque  
Generalife



The Generalife,  
from private to public

The hypothetical reconstructions were based on a wide variety of documentation from different periods, especially from the Alhambra Archives and travellers’ chronicles, plans, drawings, engravings and photographs.

The holography was produced by the company Ideos-Media Estudio Creativo S.L. according to the research agreement signed between the Andalusian Public Foundation El Legado Andalusi and the University of Granada. The process, from the beginning, went through distinct phases:

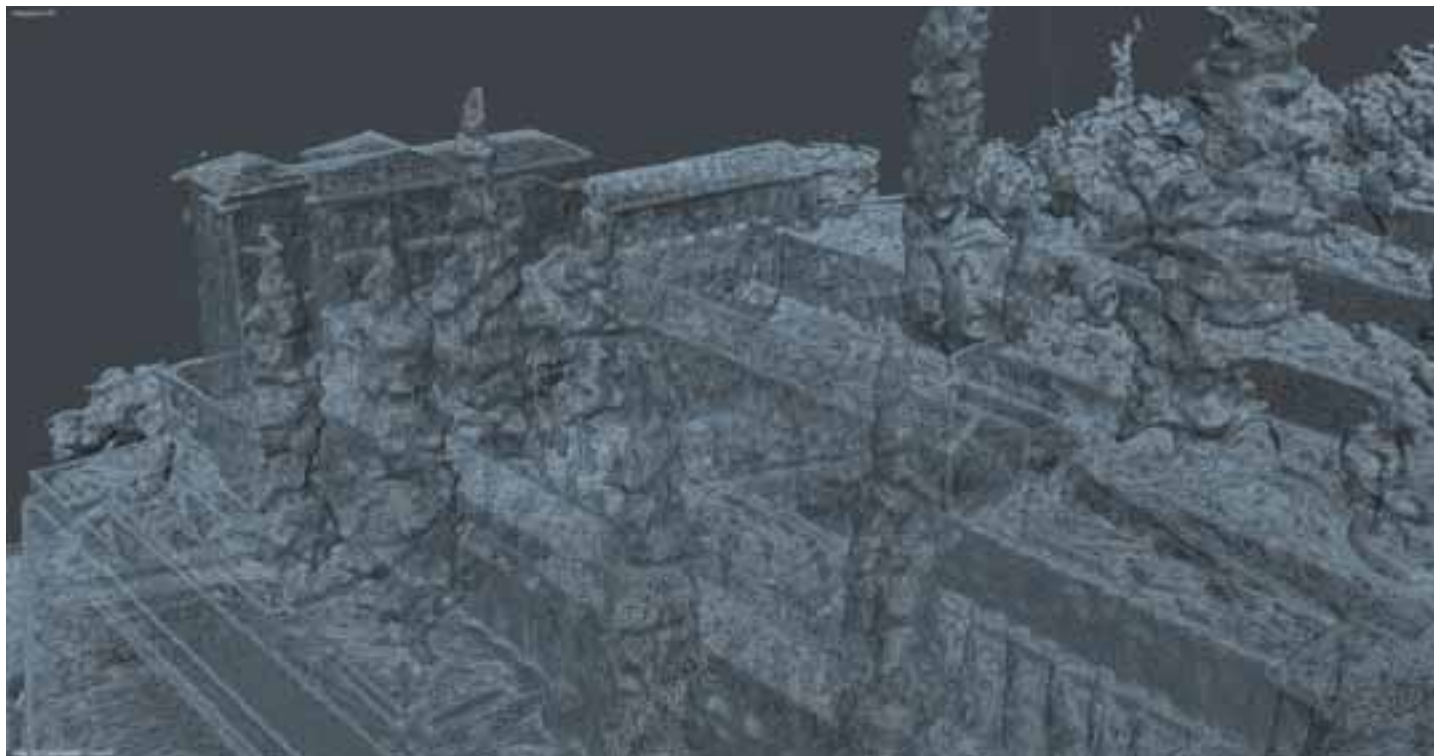
Phase 1: Creation of a base 3D-base model from physical photogrammetry: in this phase an auxiliary 3D model was generated to serve as the basis for the subsequent modelling process using Metashape software product. This was the development of the sequence:

- Taking photographs with DSLR camera, rotating lathe and neutral background.
- Image processing and obtaining alignment points.
- Calculation of the dense cloud (three-dimensional point cloud).

Phase 2: Creation of the 3D model: in this phase all the necessary architectural elements of the Generalife were modelled (according to the corresponding historical hypothesis), using 3Dstudio Max software.

- Calculation of the 3D grid from the point cloud.
- Calculation of the texture on the 3D grid from the photographs.

Phase 3: Texturing of the 3D model and creation of shaders: in this phase the different materials that were to



Detail of the three-dimensional grid.

contain each of the elements modelled in the previous phase were created using Unreal Engine 5 software.

**Phase 4:** Implementation of the lighting system, virtual cameras and rendering of sequences: in this phase the global lighting system was established (direct light + GI or HDRI) for the whole scene, the virtual cameras were created by

defining their optical parameters and animating them in order to subsequently render the video sequences. The software used was Unreal Engine 5.

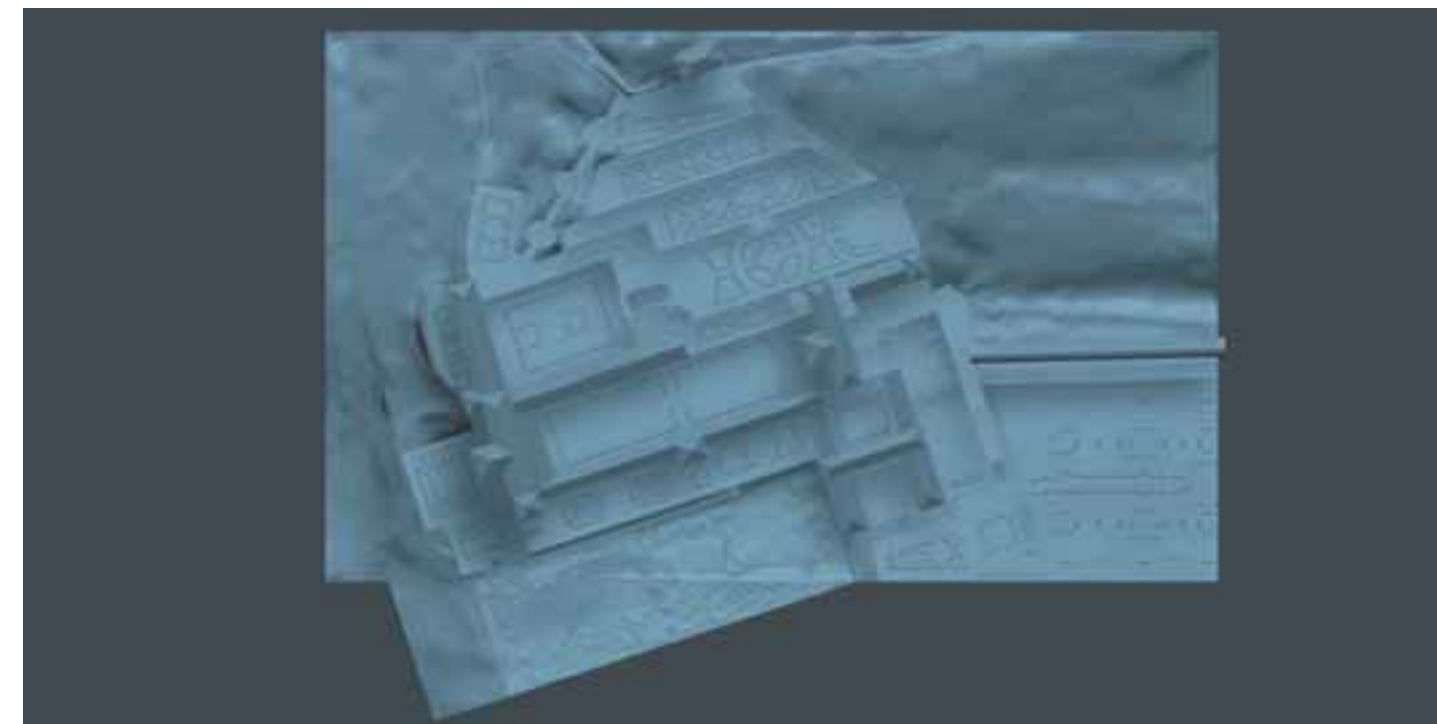
**Phase 5:** Vegetation and plant ornaments (cypresses, myrtles, fruit trees) were then implemented: in this phase, the different trees and plant elements required for each

historical scenario were outlined. The software used was Unreal Engine 5.

**Phase 6:** Post-production and video editing: in this phase, the sequences rendered in the previous phase were improved using post-production techniques and edited according to the proposed script to obtain the final video in MP4 format. The programs Adobe After Effects and Adobe Premiere Pro were used.

Also on display in this room were some of the holographic works developed and provided by the Department of Architecture of the University of Palermo (Partner to iHERITAGE), representing the *solatia* of the *Cuba* and the *Castello della Zisa* (Norman buildings), as well as the *Canal Gesuitico Alto*, a *qanat* of Arab origin, which completely adapted in format and dimensions to the holographic propellers.

A plan showing the land areas, made using digital sculpting techniques.





### Spherical videos. The enveloping Generalife

In the second of the rooms adjacent to the main hall of the exhibition, and also in line with iHERITAGE outputs, a spherical or 360° video sequence was screened, that allowed the spectator to discover almost every corner of the Generalife, the summer residence of the sultans of the Alhambra. It not only showed the visitable areas of the monument, but also revealed ancient Arab hydraulic constructions related to the conduction, storage and irrigation of the fertile orchards of the Alhambra. The projection was framed by original paintings created purposely for the exhibition by María Teresa Martín-Vivaldi, renowned artist from Granada and curator of the exhibition.

The 360° video included the following sequences:

#### Sphere 1. *Albercones*<sup>7</sup>

- Hydraulic Complex of *Los Albercones*;
- Nasrid reservoir;
- Fortified tower with the well and the ancient horizontal waterwheel;
- Orchard of *La Mercería*;
- Reservoirs by architects Torres Balbás and Prieto Moreno.

#### Sphere 2. *La Acequia*<sup>8</sup> Courtyard

- *Salón Regio* (Royal Hall);
- Southern Pavilion;
- *Acequia Real* (Royal channel) or *Acequia del Sultán* (Sultan channel);
- Water Fountain;
- A meadow with flowers;
- Myrtle tree;
- Viewpoint-*Qubba*.

On the previous double page, architectural modelling using the 3D-grid obtained in the photogrammetry process as a basis. Below, detail of one of the paintings created for the exhibition design by María Teresa Martín-Vivaldi.



The Generalife in 360°. Moment of Sphere 2: *La Acequia* Courtyard.

#### Sphere 3. Orchards

- Vines;
- Olive trees;
- Horticultural crops;
- Mediaeval access;
- Terrace retaining walls;
- Palace;
- New gardens: the cypress architecture.

#### Sphere 5. Orchards

- Pomegranate tree;
- Hackberry;
- Fig tree;
- Agriculture in terraces;
- Horticultural crops.

#### Sphere 4. Courtyard of *El Ciprés de la Sultana* (The sultana's Cypress)

- The Sultana's Cypress Tree;
- The aquatic garden;
- Belvedere viewpoint;
- *Escalera del agua* (Water Staircase);
- Remains of wall paintings;
- Waterfall in the *Acequia Real*.

### MULTIMEDIA CONTENT



Scan this QR code to visualise the 360° video with the different locations of the Generalife on your mobile device.



### The main hall. A maze of myrtle

The third and main room of the *Gardens, Heritage and dreams* exhibition was located on the ground floor of the Corral del Carbón. As the visitor explored this room, he could discover, hidden behind a green labyrinth that mimicked the dense myrtle hedges of the Alhambra, exceptional museum pieces, including the marble basin of al-Hakam. This original piece dates back to the 10<sup>th</sup> century and was lent by the Archaeological and Ethnological Museum of Granada. Excellent pictorial works such as *Arquitectura Verde* (Green architecture), by Santiago Rusiñol (1898) or *Dos Jardineros en el Patio de los Leones* (Two gardeners in the Lions' Courtyard), by Wilhelm Gail (1838) were also showcased.

At the end of this tour, visitors reached a “multi-screen” space where they could admire the Virtual Archaeological Reconstruction of the Almunia del Chapiz, a building and garden located in the Albayzin, a neighbourhood declared a World Heritage Site in 1984, the oldest in the city and the seed of the current city of Granada, which still retains all the magic of its Moorish past.

The hypothetical archaeological recreation of the al-Andalus agricultural estate in 3D of the Almunia del Chapiz in Granada and its surroundings was carried out under the scientific direction of the specialists Julio Navarro and José Tito Rojo, curator of the exhibition. Virtual archaeology, being a fairly recent area, encompasses multiple techniques: photogrammetry, modelling,

texturing, etc. The application of these techniques has sought to provide greater knowledge of archaeological heritage thanks to methods such as virtual restoration, virtual anastylosis and virtual reconstruction.

The material execution of the archaeological reconstruction of the 14<sup>th</sup>-century Nasrid estate required an enormous amount of documentary work beforehand to collect materials. This work involved study, observation, research, and constructive follow-up until the hypothetical survey of the old Nasrid estate was achieved in the most rigorous way possible.

Historically, the origins of the complex have not been clearly determined on the basis of the latest research, and it is thought that it could perhaps be identified with an earlier existing building called *al-Dar al-Bayda* (White House).

The hypothesis that the building may have been one of the three residences that the Granada vizier Ibn al-Khatib (14<sup>th</sup> c.) had in Granada has recently been consolidated among archaeologists, architects and philologists. In one of his writings, al-Khatib spoke of “a palace that I built for myself on the old road, in the eastern part of the city, where I was on the night [of the coup d'état against Muhammad V in 1359], as I resided there most of the year”. This statement by the eminent Granadan figure suggests that he may have been referring to the old road

A frame of the 3D-Virtual Archaeological Reconstruction of *Almunia del Chapiz*, in Granada.



to Guadix, which begins on the present-day *Camino del Sacromonte*, a site that coincides with the location of the *Casa del Chapiz*. His high rank, close to power, suggests that he must have owned an important property given his eminent position in Nasrid society.

However, there is well documented evidence of this estate dating back to 1525, in a lawsuit over the water rights of the *Acequia de Aynadamar*, when the property belonged to the *Morisco*<sup>9</sup> Hernando López el Ferí, owner of the house and El Chapiz orchard. Throughout the 17<sup>th</sup> century the house served as a temporary residence for the nuns of the Convent of Ángel Custodio.

One century later it passed into the hands of the Royal Company of Factories and Commerce of Granada, created two years earlier by Ferdinand VI, and was subsequently leased to various private individuals until it was publicly auctioned in 1852. At this point it was acquired by Mariano Fernández-Contreras.

At the beginning of the 20<sup>th</sup> century, in view of its state of ruin, which endangered its survival, the Provincial Monuments Commission of Granada took steps to have it declared a Historic-Artistic Monument in 1919, until it was acquired by the Spanish State some years later.

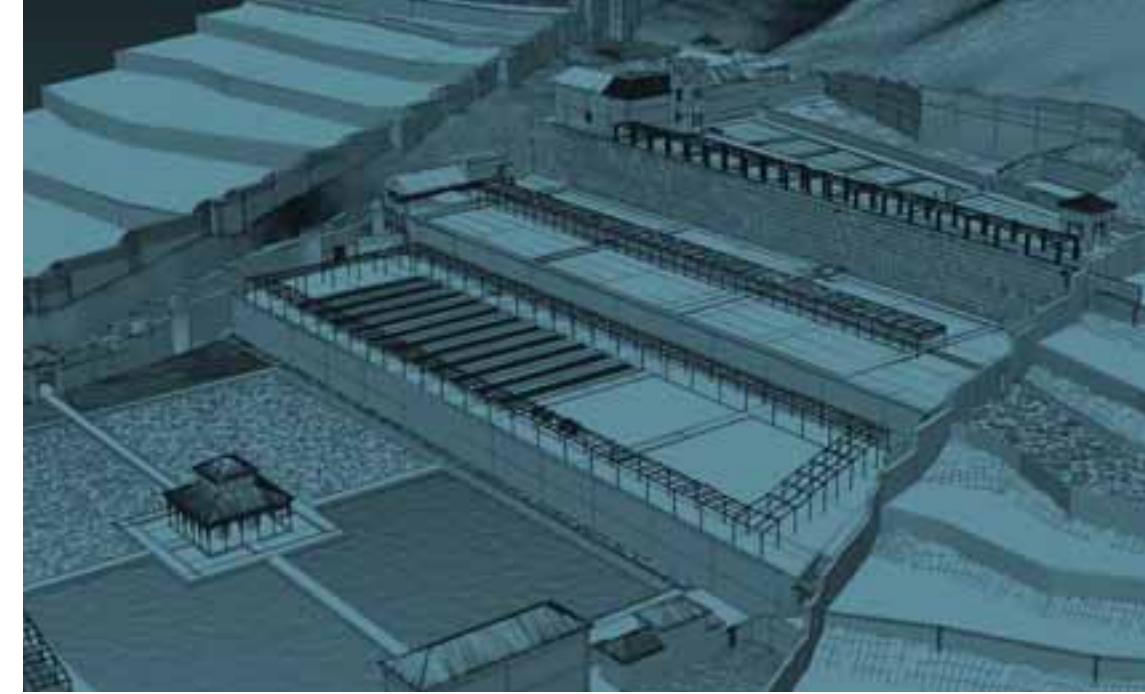
From 1940, after the restoration carried out by Leopoldo Torres Balbás, the architect-conservator of the Alhambra, the School of Arab Studies was established in the complex, under the auspices of the *Consejo Superior de Investigaciones Científicas* (Higher Council for Scientific Research). Since then it has been considered an

administrative model that combines research dedicated to the culture of al-Andalus, heritage conservation and the enhancement of philology, history, archaeology and architecture.

For the virtual reconstruction of the estate, throughout the documentation work for its execution, the research work previously carried out by Camilo Álvarez de Morales (CSIC) and Antonio Orihuela Uzal (CSIC), published in 2013, has been used as a starting point, in addition to an extensive compilation work of planimetry carried out by Antonio Almagro, previous archaeological studies and iconographic documentation promoted by the School of Arab Studies, as well as complementary iconographic information from different archives and private collections.

The 3D reconstruction used updated planimetries of the entire Chapiz estate and its surroundings, carried out by the multidisciplinary team of the Laboratory of Archaeology and Architecture of the City (LAAC), whose members belong to the Higher Council for Scientific Research.

With all the existing information and the comparative studies carried out by Julio Navarro of the Generalife and the Almunia de al-Rummaniyya in Córdoba, which together with the Chapiz correspond to a model of an Andalusí estate built at the foot of a hill with a *parata*<sup>10</sup> layout, the different urban elements found in its immediate surroundings were represented. The reconstruction included different elements:



3D-modelling for the Virtual Archaeological Reconstruction of the Almunia del Chapiz, in Granada.

- The wall of the old medina;
- The suburb of the Albayzin;
- The River Darro and the Aljibillo bridge;
- The road along the Darro River;
- The irrigation channels (Aynadamar and San Juan);
- The perimeter fence of the estate;
- The pools;
- The longitudinal ramp;
- The mill;
- The different *paratas* with their vegetable garden;
- The palace-residence;
- Other landscaped areas;
- Various preserved archaeological and artistic elements.

## MULTIMEDIA CONTENT

Scan this QR code to visualise on your mobile device the 3D hypothetical archaeological recreation of the al-Andalus agricultural estate of Almunia del Chapiz, in Granada.



## Genesis of a World Heritage Landscape

In the same audiovisual space of the exhibition, visitors were surrounded by an immersive, synchronized, multi-screen digital projection titled *Genesis of a World Heritage Landscape*. This projection illustrated the transformation of essential spaces in the city of Granada, showcasing the changing landscapes from its origins to the present day and highlighting its heritage values and specific singularities as a cultural and natural landscape of the first order. The audio-visual module started with an empty area sculpted in relief on a blank scale model that represented the orography of the land on which the city of Granada is settled. This included enclaves of La Sabika Hill, Cerro del Sol, the historic hills, and the Darro River Valley. From this starting point, visitors were able to gain a global vision of the environment and its evolution, as well as close-up views of some of the locations in more detail. Achieving the desired result required a thorough study and research using innovative technologies, departing from documentary and graphic material such as historical photographs, drawings, geolocation studies, texts, etc. This approach contributed to a better understanding and conservation of this heritage, which is listed as a World Heritage Site by UNESCO in the case of the Alhambra, Generalife, and Albayzin quarter and included in the World Heritage List.

The research and documentation work was coordinated by the architect Luis J. García Pulido, senior researcher at the Higher Council of Scientific Research, in

collaboration with specialists in Urban Planning and Territorial Archaeology, belonging to the Laboratory of Archaeology and Architecture of the City.

*Genesis of a World Heritage Landscape* showcased the evidence and reasons why UNESCO included the Alhambra and the Generalife complex in the World Heritage List in 1984. Ten years later, the Albayzin neighborhood was added to this exclusive list, giving shape to a unique cultural landscape where houses and palaces intermingle with gardens and orchards in an exceptional way. The peculiar history of Granada is the only way to understand how such an extraordinary oddity has been possible. The visitor became familiar with the context, how the landscape was green in the beginning, thousands of years ago, when the territory was populated by holm oak and riparian forests. In an environment of water scarcity, the abundance of springs and the rivers Darro and Genil allowed the first settlements to establish on those hills. With the arrival of the Muslims, Granada's fortune changed. From the 11<sup>th</sup> century, under the Zirid dynasty, the inhabitants of nearby Madinat Ilbira decided to move their capital from Ilbira to Granada. From then on, the Andalusí Garnata would gain new momentum. New water channels were laid out, new walls built, and new suburbs sprang out... Granada lived thanks to the water from the irrigation channels, including that of Aynadamar, named after the fountain from which it springs, the *Fuente de las Lágrimas* (Fountain of Tears), in the municipality of Alfacar. With the Nasrid dynasty, between the 13<sup>th</sup> and 15<sup>th</sup> centuries, the town grew considerably,



### MULTIMEDIA CONTENT



Scan this QR code to view *Genesis of a World Heritage Landscape* audiovisual screening on your mobile device.

attracting populations fleeing from the advances of the Christian kingdoms. It was then that Muhammad I, the first Nasrid sultan of Granada, decided to build a palatial city on the hill opposite the Albayzín: the Alhambra.

A rich hydraulic system of irrigation channels, reservoirs and cisterns supplied water to palaces, streets, houses, orchards, *cármenes*, gardens and landscaped areas. A fertile plain was to provide several harvests a year. Olive trees, orange trees, lemon trees, fig trees, vines, mulberry trees... roses, myrtles, jasmines... gave shape to a botanical universe that would attract the attention of successive chroniclers and travellers. This historical, patrimonial, gardening,

Frame of the multi-screen audiovisual projection *Genesis of a World Heritage Landscape*.

hydraulic and human evolution, which has remodelled the landscape of Granada and its surroundings to make it what it is today, was revealed this multi-screening.

Granada, impregnated with history and legends, with memory and impressions, is the city of the *cármenes*, of the gardens, of the Vega, of the Alhambra, of a World Heritage paradise. A place of nature and culture where the richness of the landscape lends itself to the enjoyment of inhabitants and visitors alike.

### Notes

1. Type of urban dwelling of Andalusí origin in Granada, with an annexed green space, garden and orchard at the same time, which constitutes an extension of the residence.
2. Grain Exchange building, also intended for hosting traders and pack animals.
3. The Zirids were a Berber dynasty with origins in Kabylia, a mountainous region of Algeria. A branch of the Zirids moved to al-Andalus and first settled in Madinat Ilbira. Then moved to Granada in 1013, founding the Taifa of Granada, an independent Muslim kingdom that emerged from the disintegration of the Caliphate of Córdoba.
4. The Nasrid dynasty was the last Muslim dynasty to rule the Kingdom of Granada from 1238 to 1492. Their fall marked the end of al-Andalus. It was during the rule of this dynasty that the Alhambra Palace was built, considered to be the greatest exponent of Nasrid art.
5. Meaning "Courtyard of Charcoal."
6. An *almunia* was originally an orchard or farm and by extension a country estate or country house, surrounded by gardens and arable land suitable for cultivation.
7. Artificial large water reservoir, with masonry walls, for irrigation.
8. Irrigation channel.
9. The *Moriscos* were descendants of the Muslim population of al-Andalus, who for several decades had been tried to be converted to Christianity by force. Between 1609 and 1613, around 300,000 Moriscos were expelled from the various Hispanic kingdoms.
10. A small, narrow terrace that is made on the slope of a hill or mountain in order to flatten it for cultivation.



## Discovering gardens and buildings of Arab-Norman Palermo UNESCO World Heritage Site through innovative ICT products

Rossella Corrao. Department of Architecture. University of Palermo (Italy)

The main activities of the researchers from the University of Palermo involved as Partner in iHERITAGE project, have been aimed to qualify and improve the level of information, communication and use of the nine wonders of “Arab-Norman Palermo and the Cathedrals of Cefalù and Monreale”, listed by UNESCO as World Heritage in 2015, and of the other Norman artefacts (buildings, pieces of art and infrastructure, as the Arab underground water pipes named *qanat*) not yet included in the World Heritage List.

To extend the valorisation of Norman heritage in Palermo and abroad and to maximize the involvement of public (researchers, students, citizens, NEETs), augmented and immersive virtual experiences can be used: the innovative ICT technologies can be also useful for involving people with disabilities, overcoming the limits derived from the architectural barriers, without compromising the aesthetical integrity of monuments with ramps or elevators, promoting a more inclusive society. This specific topic has been addressed by University of Palermo with



On the previous page, 3D reconstruction of the *Cuba*, with the pond and the garden, University of Palermo for iHERITAGE.

On this page, representation of the original level of the pond in front of the façade of the *Cuba*, as it can be seen today.

the development of VR products that can be managed simply by using eyes.

Some of the nine civil and religious structures of UNESCO Arab-Norman Palermo site (two palaces, three churches, three cathedrals and a bridge), dating from the era of the Norman kingdom of Sicily (1130-1194), have been virtually reconstructed by giving evidence of their original aspect and functions, mixing scientific information and reconstructive hypotheses, with effects digitally created. Based on valid scientific investigation, laser scanning and photogrammetry data acquisitions, the relationships between the different buildings of UNESCO Arab-Norman Palermo and the other Norman buildings and systems not included in the World Heritage list yet – but worthy of attention for a future inclusion – have been highlighted.

The holographic reconstructions carried out by fellows enrolled in iHERITAGE project have been developed by exploiting the results of analyses and studies of the

researchers and the external experts involved in the Seminars of the Living Lab launched in March 2020. In the exhibition developed by PP8-El legado andalusí in Granada entitled *Gardens. Heritage and dreams* the holographic reconstructions of two Norman *solatia* and a *qanāt* are visible. They testify the close connection between nature and architecture in the Norman Era in Palermo.

The role of vegetation and water in the Norman *solatia* was strategic as well as in many Islamic buildings where they were often placed –generally in courtyards or patios– for activating the passive evaporative cooling system –usually through water flowing on grooved marble surfaces or in fountains with gushing. Norman *solatia* of Palermo were built always near water sources like rivers, artificial lakes and/or underground water channels (*qanat*) and/or irrigation channels that characterized the so called “Piana dei colli” (a wide plain in the north of the city delimited by the hills that surrounded it and the slopes of Pellegrino Mountain), at that time full of gardens. In his *Liber De Regno Sicilie*, Hugo Falcandus, in his narration of the history of the Norman kingdom of Sicily between 1154 and 1169, wrote: “... Who will ever be able to sufficiently admire the marvellous buildings of this illustrious city [Palermo], the richness of the springs scattered throughout the territory, amenities of evergreen trees or aqueducts useful to citizens for every use? Who can praise enough for the extraordinary beauty of the plain that stretches for nearly four miles between the city and the mountains? [...].

Here you admire flourishing vineyards for the abundant richness of vegetation and for the generosity of the famous fruit, there you see valuable gardens for the admirable variety of fruits and towers suitable for vigilance and the pleasure of rest [...] the water then flows from the channels towards the various cultivated spaces, irrigates them and makes small cucumbers grow, the longest watermelons and melons of an almost spherical shape and the plants of pumpkins that spread in the pergolas of connected reeds. If you then turn your gaze to the various species of trees, you see the pomegranates, sour and sweet, with the grains hidden inside and protected on the outside against bad weather by the hard skin. You see cedars [...] You see lemons that with their sourness can give flavour to food, oranges [...]. What about walnuts, almonds, figs of different species and olives that provide the oil that is used to season foods and to fuel the flame of the oil lamps? What about the pods of the siliqua [...] the tall tops of the palm trees and the dates that hang from the top of the bare stem?”<sup>1</sup>. The gardens described by Falcandus and referred to the period between 1154 and 1169 were productive gardens, as also described by Ibn Hawqal, Muslim traveller that visited Palermo in 977<sup>2</sup>. These productive gardens, due to the expertise of the Arabs in the construction of the numerous channels for the irrigation which made the entire area very luxuriant, were strictly connected to the three large parks –*Gennat al-ard*, *Fawarah*, *Menani*– where Papireto, Kemonia and Oreto rivers flowed, partially realized by Arabs but extended by

Normans and filled with wild animals and raptors (among which griffin stands out) for carrying out their primary activity of pleasure: hunting. In these large parks, *solatia* were built too.

*Al-Aziza* (“The Splendid” in Arabic, *Zisa* in Italian), *Qubba* (“Dome” in Arabic, *Cuba* in Italian), *Uscibene* palaces, Altofonte castel, *Fawarah* (“Bubbling source” in Arabic, *Favara* or *Maredolce* in Italian) are the main

*solatia* still visible today even if not always in their original configuration and, unfortunately, totally engulfed by the buildings of contemporary city.

For a better understanding of the buildings’ characteristics and their original context, 3D reconstructions have been developed by University of Palermo, also for the holographic exhibition dedicated to Gardens in World Heritage Monuments, entitled *Gardens. Heritage and*

*dreams*. *Zisa* and *Cuba* palaces, and their immediate surroundings, have been reconstructed by considering the results of studies carried out by experts in the field of history of architecture, architectural engineering, agronomy and botany as well as the imaginative reconstructions of painters of the 18<sup>th</sup> and 19<sup>th</sup> centuries.

For the exterior digital reconstruction of *Cuba*, fishpond, and garden, that probably surrounded it when it

was built in 1180, reference was made to perspective drawings made by Gally Knight<sup>3</sup> (18<sup>th</sup> century), De Prangey<sup>4</sup> and Adolf Goldschmidt<sup>5</sup> (19<sup>th</sup> century) and studies conducted by Fazello, Giuseppe Caronia<sup>6</sup> and Vittorio Noto<sup>7</sup>.

Regarding the large roof of the central hall of *Cuba*, the existence of a dome is debated. A digital model hypothesis has been formulated, supported by insights from



On the left, *Cuba*, by Rocco Lentini, 1922. Oil on canvas. On the right. 3D-virtual recreation of the *Cuba*, with the pond and the garden, University of Palermo for iHERITAGE.



3D-virtual recreation of the *Cuba*, with the pond and the garden, University of Palermo for iHERITAGE.



360°-photo of the *Zisa* today with the new garden.  
The works began in 1993 and were completed in 2011.



*Veduta con Castello della Zisa* (A view of the *Zisa* Castle), by Rocco Lentini, 1935. Oil on canvas.

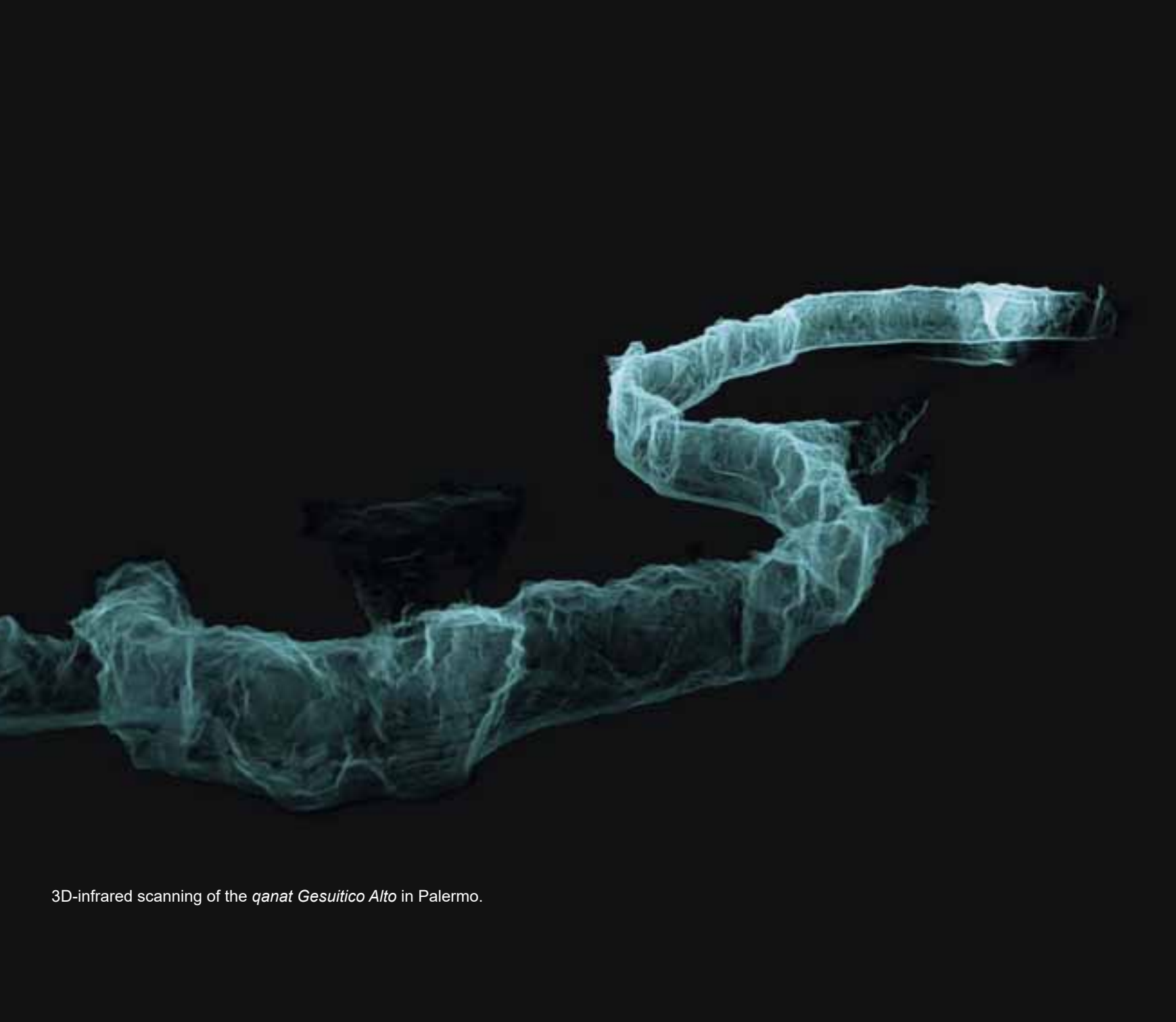


3D-reconstruction of the *Zisa* to be screened using holographic imaging. University of Palermo for iHERITAGE.

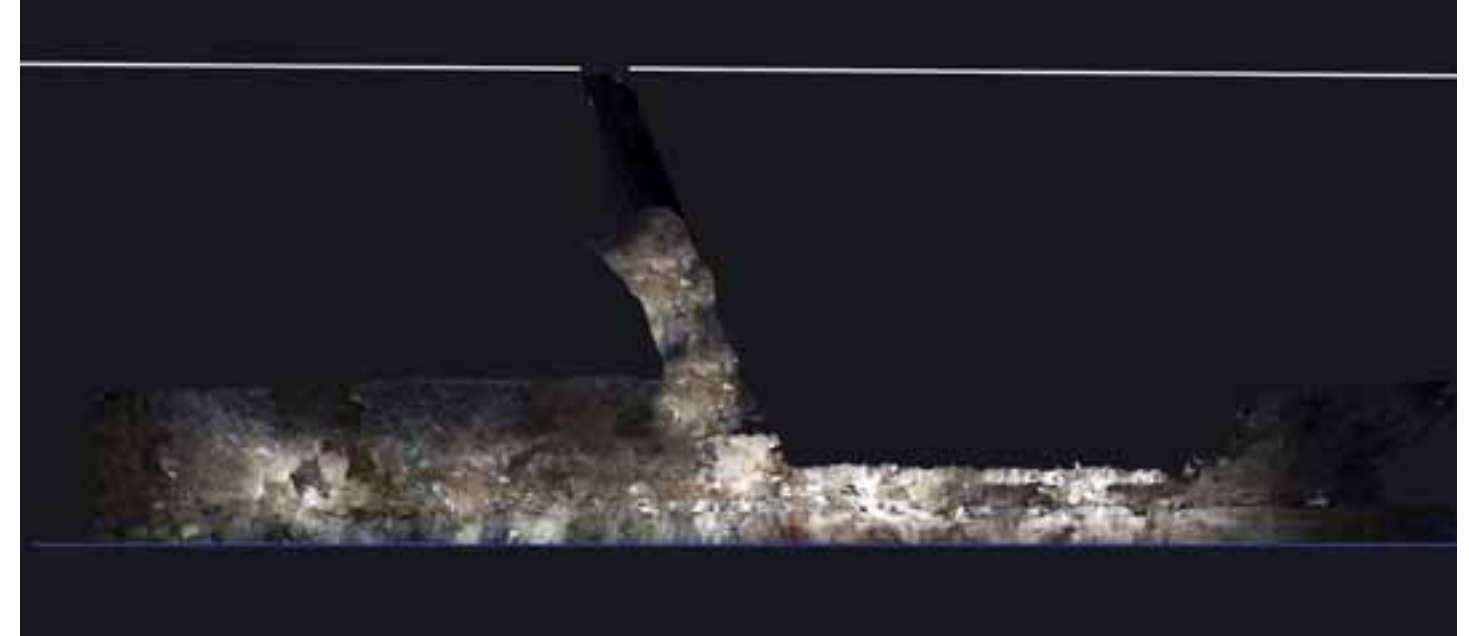
scholars such as Hittorf<sup>8</sup>, Valenti and historical and typological considerations of buildings prior to *Cuba* compiled by scholars Giuseppe Caronia and Vittorio Noto.

The methodological procedure was applied allowing, at the end of the process, to obtain 3D models with a good sampling in terms of geometric-formal definition and quality of the applied texture. The goal has been to create

digital products that meet the requirements of the cultural heritage dissemination standards. We preferred to develop the process within the open-source working environment Blender (stable version 2.93 and beta version 3.0). Particularly interesting has been the phase involving texture mapping that includes multiple preliminary processing, such as mesh partitioning, mesh parameterization and



3D-infrared scanning of the *qanat Gesuitico Alto* in Palermo.



3D 360-photograph of the first level of the *Gesuitico Alto qanat* in Palermo.

texture transfer, which are interrelated and affect the result. As known, in the texture mapping phase the most common problems, due to the often not ideal gripping conditions, are low texture resolution; gaps and undercuts; photographic inconsistencies (variation of light and reflections) and topological errors due to the formal geometric complexity. The libraries available within Blender software use an automated procedure to create Ultra Violet maps. The tool is called the “Smart UV Project”.

Before assigning texture to the edited surface (baking), a new material component was created through procedural techniques within Blender’s “Node Editor”. New information encoded in 2D maps, shaders (displacement map, lightmap, cavity map, etc.) was associated with the component properties. In the final step, after baking, some areas of interest have been selected with the Texture Painting mode tool and emphasized (by creating masks) editing some parameters such as: saturation, contrast, and brightness.



The procedure described above allowed to recreate the context in which the *Cuba* was built, and the landscape surrounding it, as well as the large fishpond that allow people (both visitors or remote users), by comparing the building as well as exists today and the 3D reconstruction visible also in holographic way, to easy understand the original height of the building, distorted today by the lack of the fishpond. During their visit, visitors wander around the building by walking on the bottom of the original fishpond that corresponds to the actual level of the street from which the building is accessible, so they visually perceive the building 2-meter taller than the original.

The same procedure has been followed for the reconstruction of *Zisa* and its fishpond, according to the ideal reconstruction of the painter Rocco Lentini (*Veduta con Castello della Zisa*, 1935) and Giuseppe Spatrisano's<sup>9</sup> ideal drawings (1982), which combine the survey with a description of the monument by the 16<sup>th</sup>-century Bolognese monk Leandro Alberti<sup>10</sup>.

Since water is strictly connected to *solatia*, as already discussed in other paper<sup>11</sup>, *qanat* have been 3D-reconstructed also for allowing people with disabilities to have access to these spectacular underground infrastructure that fed the fishponds of Norman buildings.

The potential of the laser system (wearable mobile laser systems) has been exploited, considering the many logistical challenges of capture (presence of humidity, restricted and narrow areas, lack of light, absence of GPS

signal, inability to stand or survey, etc.) and with the aim to detect complex surfaces with high geometric resolution. 3D reality-based surveying instruments and techniques offer new and effective solutions for the 3D modeling of hypogeal environments. The phases of the acquisition process, 3D data analysis, management and optimization of the digital model set up have enabled us to obtain a realistic scenario of the hypogeal architectural system for the creation of a virtual tour in gaming modality (UnReal Engine by Epic Games) and a holographic projection of the three levels of *Gesuitico Alto qanat*.

### Acknowledgements

Thank to Professors Francesco Di Paola and Vincenza Garofalo, for providing details about the methodology adopted for surveys with laser scanner and photogrammetric techniques; iHERITAGE fellows: Marco Geraci, for data acquisition and processing, and Yury Alogna, for the exterior digital reconstruction of *Cuba*; arch. Francesco Ferla, for the creation of Interactive 360 Photography of *qanat*; prof. Calogero Vinci, for assistance in managing the different phases of surveys and the design of iHERITAGE products.

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## MULTIMEDIA CONTENT

### 3D recreation of *Castello della Zisa*



Scan this QR code to view a 3D recreation of *Castello della Zisa* in your mobile device.

### 3D recreation of the *Cuba*



Scan this QR code to view a 3D recreation of the *Cuba* in your mobile device.

### 3D infrared scanning of *qanat Gesuitico Alto*



Scan this QR code to view the 3D infrared scanning of *qanat Gesuitico Alto* in your mobile device.



## Insights on landscaped Gardens of Desert culture: the Umayyad and the Nabataean Gardens

Naif Haddad, Fardous Al-Ajlouni, Leen Fakhoury, Khairieh Amr\*

**G**ardens, besides being affected by geographical and environmental conditions, were influenced by tradition, ritual, and the people's cultural background. The gardens started as a secular endeavour evolving from practical and functional needs. The earliest ancient written records of the Babylonian texts mentioned gardens such as the palace garden of Adad-Shuma-Usur (1218 -1189 BCE). One of the earliest examples of a desert garden was that of the King of Achaemenid, Cyrus the Great (590-530 BCE), at Pasargadae, created in 550 BCE. Persian gardens which developed from Assyrian examples were really pieces of art and some texts talked about hunting and nature reserves in Persian world.

However, some of the oldest agriculture terraces/gardens discovered in the Levant are those 'terraced gardens' in the northeastern part of Jordan in the Badia. The Excavations in several sites around the Early Bronze Age site of Jawa in the Badia, in the northeast of Jordan revealed some terraced gardens attached to fortified dwellings. All these sites had terraced gardens built inside the settlement areas. In fact, the renowned site Jawa can be considered as one of the oldest sites in the world that has a highly sophisticated hydraulic system. At Jawa, water was collected in catchment basins and then diverted into a complex system consisting of canals, dams, and reservoirs<sup>1</sup>. Gardens in arid regions of 100 millimeters precipitation are hard to achieve without

Petra. Aerial view of the Garden Complex with the pool on the right and the Great Temple on the left.

sophisticated hydraulic systems in these sites. Scholars even sometimes call them “gardens of irrigation”<sup>2</sup>.

Gardens are nature as also art. However, in the East, the term nature refers not only to virgin things but also to the things that satisfy their philosophy of nature. Therefore, the “idealization of nature”, or making nature more natural, is understandable in the East. However, aestheticians consider gardens as between art and nature<sup>3</sup>. Carlson writes: “The analogous account holds diverse ways of perceiving natural objects and landscapes. This is to claim that they, like works of art, can be perceived in distinct categories –not in different categories of art, but rather in different categories of nature”<sup>4</sup>.

Art and nature, at least their extremes –pristine nature and pure art– do not have a purpose or a function. However, gardens do have purposes and functions. According to the weight or relationship of art and nature in gardens, Carlson distinguishes four styles of gardens: 'French-style' gardens, 'English-style' gardens, topiary gardens, and Japanese gardens. The question from this perspective is, what about the Early Islamic Umayyad Gardens and the earlier Nabataean ones?

Unfortunately, the first pragmatic studies on the Islamic Garden came as late as the first quarter of the 20<sup>th</sup> century. It was until the 1970's when still it was of marginal importance<sup>5</sup>. Petruccioli stated that “The concept of space in a culture evolved from the desert is by necessity based on protecting living space, thus transforming the enclosure into an archetypal sign of

distinction –not only separation– between the nomadic and the sedentary, between oasis and desert, irrigated and arid land”.

This paper presents some related aspects of the arid or desert Nabataean and early Umayyad landscaped gardens and argues how these Gardens have always played a crucial role in any landscape formation of the Nabataean and Islamic anthropic process.

### Umayyad Gardens

In the early periods of the formation of Islamic societies, Muslims were skillful at changing the landscape they lived in. They transported water to arid land, and they converted harsh lands into productive agricultural lands. In fact, Roman and Persian did similar endeavors, but Muslims were even more successful by integrating this transformation with an entire system of life including ownership, inheritance law and taxation. They were really successful with using the knowledge of those diverse people who lived in the newly conquered lands including Byzantines, Copts, and adherents of pagan people like Zoroastrianism<sup>6</sup>. In fact, Gardens occupied a substantial space in Islamic societies. People tried to devote a space for greenery even in the simplest houses. They left a courtyard for cultivation of plants<sup>7</sup>. Gardens were not only places for pleasure, but they were also places where landscape was mastered in the best way. They were also places where the caliph signed agreements with the tribes living on the countryside.

Because of new ways of watering lands, Jordan and Syria were covered with agricultural lands that looked like greenery islands in dry lands<sup>8</sup>. Already in the Umayyad period some of these gardens such as Qasr al-Hayr East and Qasr al-Hayr West in Syria were built to protect animals from extinction<sup>9</sup>. They were actually natural reserves. Gardens were also important in the Islamic imaginary, in literature and arts. References to the garden as a symbol of Paradise are found in many verses of the Holy Quran. Many poems and in different languages including Arabic, Turkish and Persian described gardens as paradise on earth. Many of the artistic works of arts depicted different images of gardens where the Islamic palace was represented as an enclosed garden with beautifully mastered landscape and watered grounds. With some variations, most of the gardens in the Islamic world followed the design known as Chahar-Bagh<sup>10</sup>. Chahar-Bagh is a typical design that was followed in the whole Islamic world. The layout of the garden was divided into four parts by two perpendicular axes intersecting in the center of the garden<sup>11</sup>.

Soon with the accession of Abd al-Malik bin Marwan in 685 A.D., and the coming of his successor Al-Walid I (705-715), many of residential establishments were constructed in the Levant. In addition to the establishment of monuments in major cities like Damascus, Aleppo and Jerusalem, many more were founded in the rural areas at a distance from urban sites. Some of these structures like Qusayr 'Amra or al-Mushatta, were built in places, that were by the time of their discovery



Above, a partial view of the Citadel of Amman. It was equipped with baths situated between the mosque and a vast courtyard. A large reservoir was built near the baths to supply them with water.

Below, Qasr al-Hallabat, in Jordan. Of Roman origin and rebuilt in the Umayyad period, it included a palace, a mosque, a complex hydraulic system with five cisterns, a large water reservoir and baths.

considered as desert. And that is why some scholars concluded that Umayyad rulers built them because of their attachment to nomadic environments. In fact, apart from Qasr al-Haraneh, they were all parts of large lands devoted to agriculture and cannot be described as nomadic establishments. In spite of the fact that these monuments had different architectural styles, they all had a large residential area, a mosque, a bath, amenities and a garden. The location of some of the Umayyad sites today may lead us to think that their structures were built in secluded places with harsh surroundings. Actually, they were elegant places decorated with beautiful gardens. One of these magnificent palatial structures is the palace at Amman Citadel. It is located in the northern section of the upper citadel over the remains of a Roman construction. The unique royal in style is large in area and built within the city walls of the enclosure. It is large in size and its baths were located to the huge passage leading from the mosque to a large courtyard. To the east of the bath complex, a huge reservoir was built to provide baths with water<sup>13</sup>.

Situated about 12 kilometers east of the Via Nova Trajana, and 60 kilometers to the northeast of Amman, Qasr al-Hallabat was completely rebuilt in the Umayyad period. It was changed from a fortress in the Roman period into palatial residence built within the walls of agricultural enclosure in the Umayyad period. New structures were added including the extra-mural mosque. An agricultural enclosure with highly complicated hydraulic system was constructed. Sliding gates for controlling water

flow were built. Artificial lakes, a number of underground cisterns were erected. The bath complex at Hamman al-Sarah in the nearby area can be considered as a part of the agricultural area. The paintings of the motifs on the floor of the rooms of the palace depicted different fruits like pomegranates, lemons and other citrus fruit, possibly bamuli. Other interesting motifs were groups of lively animals, birds and fish. The animals included Arabian oryx moving slowly with uplifted head. There was also a wolf running at full speed, a hare eating grapes, a leopard and a humped camel<sup>14</sup>.

Khirbet al-Mafjar, also known as Qasr Hisham, one of the most comfortable and elegant sites, was built by Walid II around 739-743 nearby Jericho. It consisted of a large walled courtyard, a palace, a mosque, a beautiful bathhouse and a roofed fountain. The gardens of this monument were watered by an old Roman water channel where water was stored in a large tank. Situated away from the conventional sources of water like 'Ain al-Sultan, Khirbet al-Mafjar offered the advantage of using other alternate water resource which might have given the place a form of autonomy. The discovery of the gate with paving stones and iron plate and bands indicated that this estate was ordered garden with a long arcade looking east toward the fields, Jordan River and highlands<sup>15</sup>.

Qasr al-Hayr East (al-Sharqi), one of the major Umayyad sites in Syria, extends over more than ten square kilometers. Located about 110 kilometers to the east-northeast of Palmyra, Qasr al-Hayr al-Sharqi was

built in the years 700 to 730 in an agricultural enclosure. Irrigation of the estate was done by catching water in the rain-fed Wadi within the low enclosure walls. On the north and south sides there were slide gates installed for controlling the flow of water. In fact, north sluices were used as dams. The southern slide gate had a larger opening to allow water to escape during floods<sup>16</sup>.

Qasr al-Hayer West (al-Gharbi) was constructed in the arid region for the prince Hisham in 724-727. It is located about 60 kilometers west of Palmyra. As with most Umayyad complexes, Qasr al-Hayr al-Gharbi features several components, the palace being the most prominent and well-known. It is a large structure containing a palace, a bathhouse and a caravanserai. A total

Ruins of the Umayyad archaeological site of 'Anjar, in Lebanon, an ancient agricultural enclosure with a sophisticated hydraulic system, a palace and a mosque.





Ruins of Qasr al-Hayr East (al-Sharqi), an Umayyad site in Syria built in the 8<sup>th</sup> century and located on a rain-fed agricultural estate.

length of 18 kilometers of hydraulic system is clustered to the north-west side of the palace. The caravanserai is closer to the hydraulic system. Through a dam called Harbaqa, everything is organized to manage water<sup>17</sup>.

The ruins of ‘Anjar in Lebanon, on their part, consist of a large rectangular enclosure connected to highly sophisticated hydraulic system. Therefore, one of its main roles was the cultivation of plants and the domestication of animals. As in other Umayyad palatial structures, it has a palace, a mosque and residential administrative quarters, all built inside the agricultural enclosure. It is about 114,700 meters square in area. Its four gates are regularly oriented toward the four cardinal points of the compass. The walls of the enclosure are supported by forty towers placed at regular intervals. The entire structure is divided by two perpendicular streets. The two axial streets intersect at the center of the enclosure. In this way they represent the archetypal design of Islamic gardens called as Chahar-Bagh. The mosque and the administrative building (Dar al-Amara) are located in the south-east quadrant. Two well-preserved courtyards are situated in the northern half of the structure. A bath similar to that of Qusayr ‘Amra is near the north gate. There is also another small bath to the west of the north gate. The site of ‘Anjar was chosen because Berytus

(modern Beirut) was the closest port to Damascus. The strategic significance of the site was very clear<sup>18</sup>.

### **Gardens in the Nabataean Desert culture**

In the arid and desert-like conditions of North-western Arabia, the Nabataeans, through their capital, represent the accomplishments of a specific group of “farmers and pastoralists with nomadic lifeways that settled in north-western Arabia who built cities and the outcome of centuries of development”<sup>19</sup>. The significant *Book of Nabataean Agriculture* translated into Arabic at the beginning of the tenth century by Ibn Wahshîya. It deals with Mesopotamian agriculture in an arid place. For it also represents the Mesopotamian agronomical tradition, primarily developed independently from Greco-Latin agronomy.

In Nabataean Petra, the landscape and nature, with all their topographical, geomorphic, and environmental changes related to water and floods, were influential in the design and the creative integration of the Greco-Hellenistic and Roman architectural components of the city<sup>20</sup>.

Through their hydrological network of water supply, a unique achievement in human History and creativity, the Nabataeans could build Garden-cities in the very arid

region of Transjordan<sup>21</sup>. The unexpected discovery in 1998 of a huge monumental pool complex with an island pavilion in the area known previously as the “Lower Market” since 1921<sup>22</sup> is a proof of a large landscaped garden terrace with an advanced hydraulic system of channels, pipelines, and a diversion tank (castellum), which carried

water to the pool and watered the garden terrace north of the pool. The water came to the pool from nearby hills to irrigate a large unbuilt earthen terrace that probably housed a garden. A wall running East-West direction functioned as a dam. Fiema (1998) suggested that the Upper Market, including its monumental staircase (width

Colonnaded street, in Petra. In close proximity there was a landscaped terrace that offered a refreshing, verdant oasis amidst the hot, arid terrain.



of 14,80 meters), the renovated shops, the colonnade, and the paved street, were all constructed in the early decades of the second century AD<sup>23</sup>. This is the largest of its kind in Petra.

The pool was 46 x 23 meters and 2.5 meters deep, with an island in the middle. This is a unique achievement in the history of humanity and creativity, as the Nabataeans were able to build real garden cities in the very arid region of Transjordan<sup>24</sup>.

This unique landscaped Garden located in the heart of the Nabataean capital, Petra, is on an artificial terrace/balcony overlooking Colonnaded Street, between the so-called middle market and the so-called Great Temple. This cool and green oasis, surrounded by hot, dry landscapes, with the four-part Garden laid out with axial walkways that intersect the Garden in the centre, would indeed have been an astounding sight for the local community, visitors, and travelers<sup>25</sup>. Moreover, it represents the only example of a Nabataean landscaped garden in the archaeological record of the region<sup>26</sup>. The hydraulic systems deliver water from the *az-Zantūr* ridge to the pool, distributing excess water across the garden terrace while a staircase provides access from the landscaped garden terrace to the pool level.

The garden was built during the reign of Aretas the IV, renovated during the Roman period and in modern period was used for agricultural activities<sup>27</sup>. With the progress of excavations in Petra Garden and Pool Complex, more architectural details, agricultural information concerning types of plants were revealed. The phytolith

study has shown promising preliminary results proving the cultivation of date palm trees (*Phoenix dactylifera*) and the presence of *Panicoideae* grasses which grow only in the summertime in wet areas and therefore suggests frequent irrigation of the landscaped gardens during the dry, hot summers. The location of a Nefesh at the southern edge of the site’s primary axis, evident through the island pavilion’s southern doorway, suggests its symbolic significance in the whole design of the landscaped Garden and pool complex<sup>28</sup>. These elements could be arranged in such a way that they are often more artistically designed than those of nature. Flowerpots for cultivations of plants were also uncovered<sup>29</sup>. In addition, the excavations have uncovered a shaft that appears to have led water more than 10 meters downward, from the aqueduct system to the pool level. The archaeologists have also found underground channels that helped control runoff during the rainy season, revealing the true complexity of the system for the first time.

During the early Byzantine period, the garden gazebo was a large, shaded grove where visitors walked freely among the trees. The garden was eventually converted into “a vineyard or field, with the central platforms still exposed”<sup>30</sup>. In the 20<sup>th</sup> century, local Bedouins cultivated the ash-level surface as a wheat field. However, no signs of ageing trails or other features indicate that these uniform layers of dark soot soil were divided for planting flower beds or other uses.

Nabataean landscaped Gardens have both natural and artistic components, and both components are distinct

and independent. However, this does not mean Nabataean landscaped gardens are parts of nature or only copies of nature. Hence the appreciators need to switch between the two models of aesthetic appreciation: the aesthetic appreciation of art and the aesthetic appreciation of nature, with a positive aesthetics of natural things.

The reconstruction of the Garden's layout, features and views revealed something of the character of its vegetation over time. Furthermore, it illuminated this watered desert site, and the Nabataean methods contributed to the broader development of the emerging field of international landscaped garden science, art, and archaeology.

In this paradigm of Nabataean landscaped Garden, it does not matter if the paths are hidden away; or laid out so that they twist and turn with the land; for artistry here means suitability. To borrow from the scenery here means that although the interior of a landscaped garden is distinct from what lies outside it, as long as there is a good view, we need not be concerned whether this is close by or far away, whether apparent, or the purple rocks raise their beauty in the distance or have a colour decorated walled temple rise into the sky nearby. This is known as skill in fitting in with the form of the land. We can assume that where there is too much space, as in our case, they can put in a thing; where it is difficult to walk upon, they level it; and where it is leveled, they introduce an enclosure.

### **The Garden Complex in Wadi Farasa (Monument no. 244)**

The name of the monument comes from the explorer Gustaf Dalman who visited Wadi Farasa East in 1904 and found lush vegetation at the site, he thus called it 'Gartental' or Garden Valley.

The rock-cut façade of the monument is around 7.5 meters wide, with four supports two of which are free-cut columns *in antis*. This layout put it in the 'Roman Temple Tombs' type established by Von Domaszewski in 1904. The structure had been identified as a tomb, a triclinium or a temple but excavations by the International Wadi Farasa Project in 2001-2003 (who referred to it as the Wadi Farasa East Upper Terrace) established that it was a house built in the second half of the first century AD, with interesting hydraulic installations.

The monument could be reached by an ascending staircase from the south, leading to a platform in front of the house. The surprise was that the platform was built on top of a roofed cistern measuring around 4 x 4 meters and 2.4 meters deep that led to a smaller basin of the same depth, which was used to filter the water; the cistern was fed from a huge nearby basin. Three wide and heavy arches supported the roof of the cistern; heavy column bases found collapsed in the cistern were originally supporting an upper floor above the platform, in the Classical peristyle fashion. The structure was therefore partially rock-cut and partially free-built. The level of the upper floor can still be seen in the cut

Wadi Farasa. A complex system of stone-built and rock-carved monuments with a large cistern that was filled by draining rainfall along grooves in the side rocks.



rock-face to the east (right-hand-side) of the platform as well as at the top of the rock-cut façade, which still retains remains of stucco in the shape of ashlar.

The interior of the house consists of a long front chamber measuring around 6.25 x 6.80 meters that leads to a room 5.0 x 5.4 meters with a window in the left side wall. A long series of steps join the house on the Upper Terrace with the Soldiers' Tomb Complex at the Lower Terrace, so did all these monuments belong to the same rich Nabataean family?

To the north of the house there is an 8-meters high wall. This is the retaining wall of a huge basin measuring some 28 meters long x 5.6 meters wide that collected water from the entire Wadi Farasa, and was itself part of a system of channels, dams and cisterns that also fed the

Wadi Farasa. Grooves on the side mountain brought collected rainwater into the cistern. This is part of an elaborate water irrigation and collection system that probably served to maintain a decorative or vegetable garden.



southern parts of Petra. Two circular openings near the bottom of the retaining wall would have been for metal stop-cock that controlled the flow of water to smaller basins, from which a rock-cut channel led to the cistern beneath the front platform of the 'Garden House'; stairs led from the upper level of the house to the top of the basin which also suggests that the owners may have been responsible for its maintenance.

The structures on Wadi Farasa East Upper Terrace remained in use for around three centuries, until the earthquake of 363 AD that devastated Petra. The area was re-occupied in Medieval times (11<sup>th</sup>-13<sup>th</sup> centuries AD), probably in connection with a Crusader settlement in Petra<sup>31</sup>.





On the previous two pages, aerial view of Garden Temple. While its exact purpose remains unknown, it was likely an integral component of the Nabataean hydraulic system responsible for providing water to Wadi Farasa.

To conclude, in this formal paradigm of a landscaped garden, art dominates nature. Bedal has described the Petra Pool-Complex: as a Hellenistic Paradeisos in the Nabataean Capital, in which the ostentatious display of large bodies of water of this pool complex would have undoubtedly impressed them as a near-miraculous display of power and mastery over nature. However, it can also illustrate the dialectical relations between art and nature within its context, for here nature and art can maintain harmonious relations because they are unequal in strength and cannot conflict.

In conclusion, this Nabatean landscaped Garden might be considered a complex object of aesthetic appreciation. At the same time, the interaction between natural and artificial terraces constitutes the object of aesthetic appreciation. This unique example of Nabataean landscaped gardens seems more artificial and much fuller in the atmosphere of everyday life.

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