

MOOR SOLUTIONS FOR GREEN LIVING: AN ANDALUSIAN CASE STUDY

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ABSTRACT

The chief Spanish tourist destinations in the region of Andalusia are ingenious examples of sustainable design using regional materials and natural heating and cooling mechanisms harmonious with a typical Mediterranean climate. Palace and garden complexes like Seville's Alcázar, Cordoba's Courtyard of the Oranges and Granada's Alhambra are three of the best surviving examples from this region. This case study examines the environmental innovations of these surviving monuments built under Moorish rule. Central to Moorish design is the patio—the enclosed, inner courtyard of most residences and public buildings which often incorporated artesian fountains, cisterns, ornamental vegetation and edible plants. While the Western European landscape design tradition situates the garden as a supplementary space to the central residence, the historical design tradition of the Middle East and North Africa, brought into Spain by the Moorish invasion of 711 CE, makes the garden integral to all human-inhabited structures. Examining the history, design and function of Andalusian buildings and patios provides inspiration for contemporary sustainable design in other Mediterranean climate regions such as California. Modern concepts of energy efficiency, water conservation, the use of natural and regionally-sourced materials and appropriate environmental siting are also evident in this design tradition. Furthermore, the opportunity for the contemporary sustainable design community to take inspiration from the structural innovations of an historically Muslim population provides a politically progressive solution to our current environmental crisis.

Keywords: sustainable design, natural ventilation, patios, Andalusia, Islamic gardens, Moorish architecture

INTRODUCTION

Dominant features of Moorish architecture and garden design, introduced to the Spanish region of Andalusia between the 8th-14th centuries are emblematic of contemporary principles of sustainable design. Examining Andalusian patios, gardens and palaces built under Moorish rule reveals ingenious methods of micro-climate control and natural resource conservation. This paper provides an overview of how Moorish design could inspire current trends in green architecture and landscape design in Mediterranean climates. A further theoretical recommendation is advanced which posits that sustainable design must incorporate local, climate-appropriate and culturally-based design innovations.
 Revaluing the “Oriental” Environmental Tradition

The perils of Orientalism were made clear almost 30 years ago with the publication of Edward Said's radical critique of how the West historically perceived and made use of the Islamic Orient. The fascination with an exotic, sensual other extended to architecture, with Orientalist artists fanning out across the Levant and stoking admiration for mosques, Arab bath houses and monumental structures such as the Alhambra with their prints and drawings. Ultimately, as Said duly noted, cultural appropriations of

exotic otherness often served to explain more about Western cultural desires and deep-seated myths rather than revealing truth or objective understanding of foreign civilizations (1). The necessary course corrections assumed as a result of Said's work have resulted in a fashionable lack of academic interest in the accomplishments of Islamic civilizations, and coupled with global conflicts pitting Islamic cultures against Western capitalism, a virulent anti-Islamic, anti-Arab attitude prevails among the general public.

Thus this effort to resuscitate the innovation of Moorish gardens and architecture also has the ancillary purpose of re-evaluating a cultural tradition that can offer us great insight now as we retreat from our toxic, warring industrial period into a green revolution of ecological living.

Furthermore, as a theoretical position, the re-appropriation of a local, culturally-based building technology brings to the fore a principle that has been lost in decades of international style modernist development across the globe. And it is necessary, as Roger Tyrell explains: "Much of the body of analysis and synthesis within the realm of sustainable architecture has focussed upon the physicality of the built environment, leaving the complex relationship between culture, climate and place largely undisturbed. . . . for an architectural proposition to represent a truly sustainable design solution, reference to the cultural domain must be implicit," (2, 83).

There remains a long-standing gap of knowledge that obscures Arab scientific and engineering achievements, most noticeably in the field of water management. Most of the time, historians neglect to mention Arab achievements in hydraulic engineering between the fall of the Roman Empire and the Renaissance (3). When they are mentioned, many scholars insist that Arab technology was either imported from China and India or simply derived from pre-existing Greek and Roman models. While these ancient civilizations did have a powerful impact on Arab technological development, their particular innovations shouldn't be simplified or dismissed. Furthermore, during the 20th century's period of rapid growth from the 1950's to the 1980's, modern industrial building methods were introduced in towns and cities across most Mediterranean regions and prevailing international schools of architecture were adopted without question in Arab societies. This style necessitates massive water consumption and promotes heating and ventilation technologies that increase the urban heat island effect and require more and more energy to attain so-called "comfortable" temperatures. These developments also encouraged modern inhabitants to look derisively upon the material culture of their pre-industrial era. And yet these pre-industrial living technologies provided perfectly satisfactory living conditions that maximized the local climatic conditions and conserved natural resources (4).

As architects, planners and designers look for innovative solutions to our current environmental issues, I would like to bring Arab garden and building technologies to the forefront, because the principles demonstrated in their finest works provide solutions to our contemporary issues of water scarcity, peak oil, soil depletion and over-industrialized agriculture. As we are here in California, the Moorish mode of interacting with the climate, developed over centuries in the Mediterranean basin, is very appropriate to our current conditions. There is already a strong aesthetic influence of Moorish culture in California, brought over by the Spanish conquistadors and furthered by real estate developers and the tourist industry. Yet this aesthetic is only window dressing and must be matched by a deep foundation in the sustainable technologies that accompanied them in their original context. What use is a wall of decorative tiles if it is not sited correctly on the property? For what benefit is a fountain that never circulates water? Why place a shady garden behind a house with air conditioning running 9 out of 12 months of the year? Our current adoption of the Moorish design aesthetic is superficial, so it is imperative that further adoption of the style incorporate the sustainable technologies that underlie its built heritage.

Why start with Andalusia? The gardens of Persia are replete with fantastic sustainable strategies drawn from ancient civilizations, as is the fertile crescent, the living oases of Oman, and the recent natural building developments in Saudi Arabia. The answer is simple. I didn't honeymoon there. We went to

Andalusia. And let's back up just a bit before we spend the afternoon at the Alhambra. Is it true that all pre-modern structures are sustainable because they were built before industrial development and the urban pollution explosion? Possibly. Typologies of premodern housing such as the wattle and daub hut, the animal skin shelter like the Native American teepee, adobe dwellings, grottos, igloos and bedouin tents all offer human habitat with non-toxic, renewable materials and low energy consumption. But of these options, which will work with modern civilization? The particular appeal of Moorish architecture is its relative modernity and elegance in proportion to its high measure of sustainability. People today could comfortably live in the gardens and buildings of Moorish origin. There is an enduring potential for the Moorish mode of building and urban planning that accommodates most of our contemporary needs for safety, sustenance, sustainability and delight.

Introducing Andalusia

Phoenicians, Vandals, Visigoths, Romans, Moors and Christians have inhabited Andalusia over the past millenium, and each civilization left its architectural legacy. When the Moors arrived on the Iberian peninsula from North Africa in 711AD, they inherited a network of Roman towns and irrigation canals across the region. The Moors built on top of existing fortresses, bridges, city walls and civic structures like temples and public baths. So their innovations were not born of a tabula rasa, and they also carried their own influence from previously conquered territory in Persia, the Arabian gulf and North Africa. This was "a reality in which Arabic, Spanish and Berber elements subjected each other to mutual influence of varying intensity on the fertile soil of Islam, giving rise to unparalleled peaks of achievement," (5, 18). The aesthetic hallmarks of interlocking multi-lobed arches, decorative masonry-work and colorful glazed bricks define the Moorish style, which peaked in the 13th-14th centuries. You can also find these motifs in modern buildings effecting a sort of Moorish revival. But a simple aesthetic appreciation for Moorish architecture overlooks the rich climate-influenced design elements that can also be appropriated today to enact more sustainable architecture.

Climate Characteristics

The region of Andalusia covers an area of 87,000 square kilometers anchored by the Guadalquivir river, which flows past the two cities of Sevilla and Cordoba and with its tributaries, transports water between the two mountain regions: the Sierra Morena mountains in the north and the Sierra Nevada ranges in the south. In this region, wet, mild winters are followed by dry, hot summers. This particular climate, called Mediterranean, is found all over Southern Europe, the Middle East and North Africa, as well as in South Africa, parts of Australia, Chile and California. Similar flora and fauna are found in areas with these climatic conditions, which makes the style of architecture and garden design widely exportable.

The Islamic Garden

The image of a garden of paradise has held a powerful grip on the imagination of the Arab world because the Koran prophesies a heavenly garden as the reward for a righteous human life. Creating gardens on Earth, then, became a way of contemplating the divine and creating daily spiritual inspiration. The garden is a space of ablution in preparation for prayer, as well as a chamber for contemplation: "In a garden, people should be free to relax in open spaces which, despite being exposed to intense heat, gratify their eyes, ears and sense of well-being," (6). This philosophy found expression during the Islamic world's greatest period of garden design in 14th century Andalusia. Unlike the English notion of the garden as an exterior, managed wilderness held separate from the daily flow of domestic life, Andalusians practiced (and continue to enjoy) integrated indoor and outdoor living. Gardens were frequently placed inside square building structures, and these "patios" enabled an outdoor experience that did not sacrifice residents' privacy. Only local materials—sandstone, limestone and wood, were used to construct interior courtyards, and water, once carefully collected, was preserved by the use of plant containers and sunken

beds for vegetation among elevated walking paths. The patios often become a refreshing private respite from the baking heat. The Moors used native vegetation along water courses, punctuated by fountains and cascades to enhance the patio's atmosphere of tranquility. Patios were common across economic class. During the height of the Moorish period, there were nearly 50,000 properties with garden patios in the district surrounding Seville (6). The gardens employed irrigation to water a diverse array of plants that residents cultivated. Ornamental and edible plants were mixed indiscriminately—beauty came from a mix of aromatic and elegant vegetation that could easily complement cuisine (6).

Natural Ventilation

The patios also took advantage of local wind and air circulation conditions. Thick building walls kept heat near the house during colder periods and shielded the interior from the sun during hot periods. The patio functioned like a solar clock—at any time of day, one could find a comfortable place there as the sun rotated its rays through the open air roof. Stone seats would provide cool resting spots, while “hot seats” were positioned at the optimal spot to capture the heat of the winter sun. The patio functioned as a sink for the cold night air, distributing it into the surrounding rooms in the early morning. During the day, as the sun would begin to penetrate to the patio floor, the courtyard structure acted as a funnel for rising hot air, which pulled cooler breezes through the flanking rooms.

In larger gardens, the use of cool seats allowed natural breezes to concentrate and provide relief from the heat. In the Alcázar gardens in Sevilla, the Jardin de la Danza is composed of a series of thick-walled patios running east-west, one of which encloses a small outdoor room with two benches facing each other. A small, arched southern window on the wall between the two benches draws in a cooling breeze whose effect is accentuated by the cool blue tiles that face the walls. The thickness of the walls, and their white color, repels the summer heat and insulates the interior, keeping it measurably cooler than the air outside. Despite the city's reputation as “the frying pan of Europe,” this cozy spot in Sevilla defies the climatic norms through passive cooling design innovation, (7, 138).

A similar effect occurs in the cool rooms of the Alhambra complex. Small openings in the walls that face the prevailing winds direct the breezes inside. Like in the Alcázar, these small apertures lie above lush gardens and fountains that increase the moisture in the air while filtering out air particles. On this peak above the city of Granada, most of the garden pavilions poke out from a mountainous ledge where air rising up the hillside accelerates to a bristling speed. Here the original architects found a passive way to capture the wind in its natural course—air conditioning without freon!

Bountiful Water

The abundant use of water in the Alhambra gardens also contributes to the comfortable microclimate established there. For instance, in the Patio de los Leones, water coursing through channels in the patio's marbled floor create a refreshing ambiance. Four runnels divide the courtyard into quadrants with a fountain burbling in the center, flanked by 12 marble sculpted lions. The courses of water narrow slightly as they flow into adjacent pavilions and end up in circular pools recessed into the ground. At certain points, bubbling spouts splash water onto the floor, which causes the marble to glisten and cool the air. In the multiple reflecting pools in front of impressive pavilions, blue ceramic tiles increase the perceived depth of the pool, adding to the psychological cooling effect (7).

But this abundant use of water was only possible because Moorish methods of water collection in a relatively dry climate were designed to conserve every single precious drop. The Moors irrigated with canals from underground springs because they were available throughout the year, whereas rivers often dried up in the summer (4). They also brought water down from mountain springs using acequias, slender aqueducts that meander downhill using gravity, perfectly calibrated so that they neither moved too fast,

which could cause overflow, nor too slowly, which would make dry up the water. Cisterns provided a fundamental method of maximizing storage of rainwater and runoff. Sunken underground and protected from sun and evaporation, the water inside remained cool. Integrated into dwellings, they would not only store water for the dry season, but manage the microclimate in and around the dwelling by providing a thermal mass to absorb heat. Cisterns could also double as cooling reflection pools in front of grand buildings.

By the 10th century, at a time when no other city exceeded 10,000 inhabitants, Córdoba supported half a million with the most advanced water system in the world. The Courtyard of the Oranges, which sits at the entrance to the Great Mosque, is a prime example of Cordoban innovation. The patio uses a web of gutters, pipes and miniature aqueducts to collect water in large cisterns beneath the patio. A dense grid of trees flower and produce fruit and shade for the hundreds of thousands of visitors each year. Three fountains and a pool keep a steady cooling air stream circulating through the trees and once provided a comfortable space for pre-prayer ablutions. The rhythmically-spaced orchard also resonates visually with the forest of columns and horse shoe arches inside the Great Mosque, providing continuity inside and out. The growing trees transpire water that stabilizes the local microclimate. Leaves permit water evaporation to cool the air and increase humidity, which helps to filter out wind-borne pollutants. Thick green foliage provides a cool shade, which also stanches the evaporation from irrigation channels and on the leaves (7, 203).

Return to a Locally and Culturally-rooted Sustainable Architecture

After decades of hegemonic international-style design prevailing in our city centers, and suburban sprawl perpetuating our dependence on a petrochemical economy, the vision of an eco-city must be enhanced by sustainable innovations from earlier cultures. The developments of Moorish civilization in Andalusia, which incorporated interior patio gardens with water and vegetation to cool the air moving into the building, and used thick clay walls for thermal mass and regulation of internal temperature, are appropriate models for sustainable buildings in Mediterranean climates. As Stuart Walker writes in *Sustainable by Design*:

In traditional cultures, there is often a very good fit between material artifacts and the environment, cultural values and beliefs, and ways of life. Traditional cultures can be excellent examples of how to live in more sustainable ways. We can learn from vernacular design which can provide us with at least some insights into the diversity and richness of locally appropriate design,” (8, 36).

As a concluding example, while developing a new facility for Torrent Pharmaceuticals in Ahmedabad, India, Brian Ford first studied the traditional Mughal cooling technologies that used deep wells and thermal masses before he constructed a passive downdraft cooling system. While his design solution used the contemporary technology of micronizers that spray water into hot air taken in from the top of the building, cooling it as it descends down a windshaft, the principles underlying this design innovation derived from an ancient climate control mechanism (9, 98). Applying ancient technology to present conditions can often realize the happy medium of culturally-specific, locally-sourced sustainable design that reduces energy outputs and maximizes comfort and cost.

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