



BOTANICAL AND ARCHAEOLOGICAL HERITAGE IN CUBA: THE CAYO BLANCO-GUASABACOA CASE STUDY BOTANICAL AND ARCHEOLOGICAL HERITAGE IN CUBA

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ABSTRACT - The Archeo-Cuba project, Archaeology and Environmental Sustainability, is an international cooperation initiative funded by the Italian Agency for Development Cooperation under the program for the Promotion of Territorial Partnerships and Implementation of the 2030 Agenda. The project adopts a multidisciplinary and integrated approach to addressing climate change in Cuba, aligning with the goals of the 2030 Agenda, through a peer-to-peer training model involving both Italian and Cuban experts. This paper presents the analytical methods applied to the project's target sites, focusing on the interpretation of natural and botanical stratification alongside historical and archaeological layers. It also outlines key findings from both the botanical research and the planning activities carried out at one of the target sites: the Cayo Blanco area, located in Havana Bay. Furthermore, recognizing the value of botanical, natural, and historical-archaeological heritage as a driver of sustainable territorial development, the study proposes environmental conservation strategies based on Nature-Based Solutions to address both ecological and social challenges. All activities are aimed at the future enhancement and sustainable use of the site.

KEYWORDS: CUBA, CLIMATE CHANGE, ENVIRONMENTAL SUSTAINABILITY, ETHNOBOTANY, NATURE BASED SOLUTIONS

INTRODUCTION

Cuba's island, rich in historical and natural heritage, is currently implementing policies strongly oriented toward sustainable development, beginning with urban recovery and regeneration programs. "Archeo-Cuba" is a project aimed at promoting the definition, implementation, and revitalization of territorial public policies in Cuba. These policies focus on identifying, protecting, and enhancing the stratified historical-cultural landscape, alongside the natural environment, moving toward a comprehensive and cross-disciplinary vision of "heritage" in its broadest sense. The city of Havana, particularly regarding its historic center, had already adopted the "Plan Especial de Desarrollo Integral" (PEDI), a framework comprising essential tools

for guiding spatial planning and the integrated development of the historic center. This plan considers culture as a driver of development and places human beings at the center of rehabilitation efforts. It balances the need to valorize and manage cultural and environmental heritage by leveraging the territory's intrinsic resources and renewable energy sources. Moreover, Cuba has recently adopted National Law 155/2023, "Ley General de Protección al Patrimonio Cultural y al Patrimonio Natural", which coordinates the protection of both cultural and natural heritage, explicitly recognizing the interrelationship between these two dimensions. Additionally, several pre-existing planning instruments in Havana must be considered: the Environmental Strategy for the Urban Conservation Priority Zone (ZPC) of Havana (2013–2020), which outlines priorities for protecting natural

resources, strengthening climate change mitigation in territorial planning, and applying environmental policy and management tools; the Management Plan for the Cultural Landscape of Havana Bay and surrounding areas; and the state plan Tarea Vida, which addresses climate change impacts through five strategic actions and eleven targeted measures aimed at mitigating the effects of climate change on vulnerable areas.

Due to its geographical position, Cuba is particularly exposed to extreme weather events. According to the most recent studies conducted in 2017 by the Cuban Ministry of Science, Technology, and Environment and the National Meteorological Institute, the climate is changing rapidly. Projections for 2100 suggest an increase of at least 4.5°C in average temperature and a sea-level rise of 85 cm, potentially resulting in the loss of approximately 5.5% of Cuba's land area.

The intervention strategy also draws upon international frameworks and guidelines, such as those of ICOMOS and UNESCO, addressing the connections and potential strategies to mitigate the effects of climate change on cultural heritage. It also aligns with the objectives of the 2030 Agenda for Sustainable Development, particularly SDG 11 (Sustainable Cities and Communities) and SDG 13 (Climate Action) (Ricciardi & Salerno, 2024).

In this context, the project Archeo-Cuba, Archaeology and Environmental Sustainability, was launched with the aim of recognizing the historical and natural values of selected target sites that are strongly representative of Cuba's history and evolution. The project also seeks to highlight the potential negative effects of climate change on these values, while developing mitigation strategies.

Focusing specifically on the botanical component, the project builds on experience gained in Italy in areas of both historical-archaeological and naturalistic interest, such as the Appian Way Regional Park in Rome, the site of "San Vincenzo al Volturno" (Cicinelli et al., 2017), and the site of "Abellinum". In these locations, efforts have been made to identify botanical elements of biogeographical and conservation interest, both for their appropriate long-term management and preservation, and for their cultural valorization. Attention has also been paid to identifying threats, such as invasive alien species. However, the most innovative approach of the Archeo-Cuba project lies in the use of vegetation as a tool for interpreting the "historical stratigraphy" of the sites themselves.

This contribution focuses on one of the five target sites of the Archeo-Cuba project: the area of Cayo Blanco, located in the Bay of Havana with its name derived from the white hue of this characteristic rock. This area displays key characteristics of landscape and historical stratification, and, thanks to a multidisciplinary approach involving scholars and experts, may serve as a pilot site for testing sustainable actions and interventions.

MATERIALS AND METHODS

Study area

The site under study is located on a small peninsula to the southwest of Havana Bay. An analysis of historical maps (Fig. 1) reveals that this land extension was not always connected to the coastal strip of the bay. It originally appeared as a small island, surrounded by flooded zones, most likely dominated by mangrove ecosystems.

Within this site, at the end of the 18th century, the *Polvorín San Antonio* was constructed (Fig. 2).

This was a colonial-era arsenal comprising a simple rectangular masonry structure, fortified and enclosed by a perimeter wall, which served as a storage facility for weapons and ammunition. It was only in the 1970s, through underwater archaeological investigations, that two indigenous archaeological sites, *Guasabacoa I* and *Guasabacoa II*, were identified nearby (Roura Alvarez, 2025). According to the Management Plan for the Archaeological Heritage of Old Havana, this site is designated as a Priority Area for Conservation and categorized within the Archaeological Risk Zone I granting it the highest level of protection in terms of archaeological significance. Situated in the lower part of Havana Bay, near the mouth of the Luyanó River, the site's exposure to bay currents is particularly pronounced. Over time, sediment accumulation around the former islet has led to its permanent connection to the mainland (Fig. 1). Furthermore, industrial development and urban expansion have resulted in the construction of large platforms supporting shipyard and industrial facilities serving both Havana and the neighboring municipality of Regla to the southeast. These interconnected zones have been infilled with reclaimed material.

Marine currents also carry substantial amounts of waste, especially plastic debris, into the lower-lying areas of Cayo Blanco, where it accumulates heavily along surfaces reached by storm surges and tidal action (Fig. 3).

Sampling

Following years of near-total abandonment, dense vegetation has colonized both naturally accumulated sediments and areas filled with reclaimed materials, as well as modern and historical structures. Today, the vegetative cover represents a defining landscape element of the site, including in zones of archaeological interest such as the *Polvorín San Antonio* itself. In relation to the coexistence of anthropogenic and natural elements, Norwegian architect Christian Norberg-Schulz wrote in *Genius Loci*: "We must nonetheless repeat that a place means more than just a location. Within the landscape, there are both subordinate places and natural

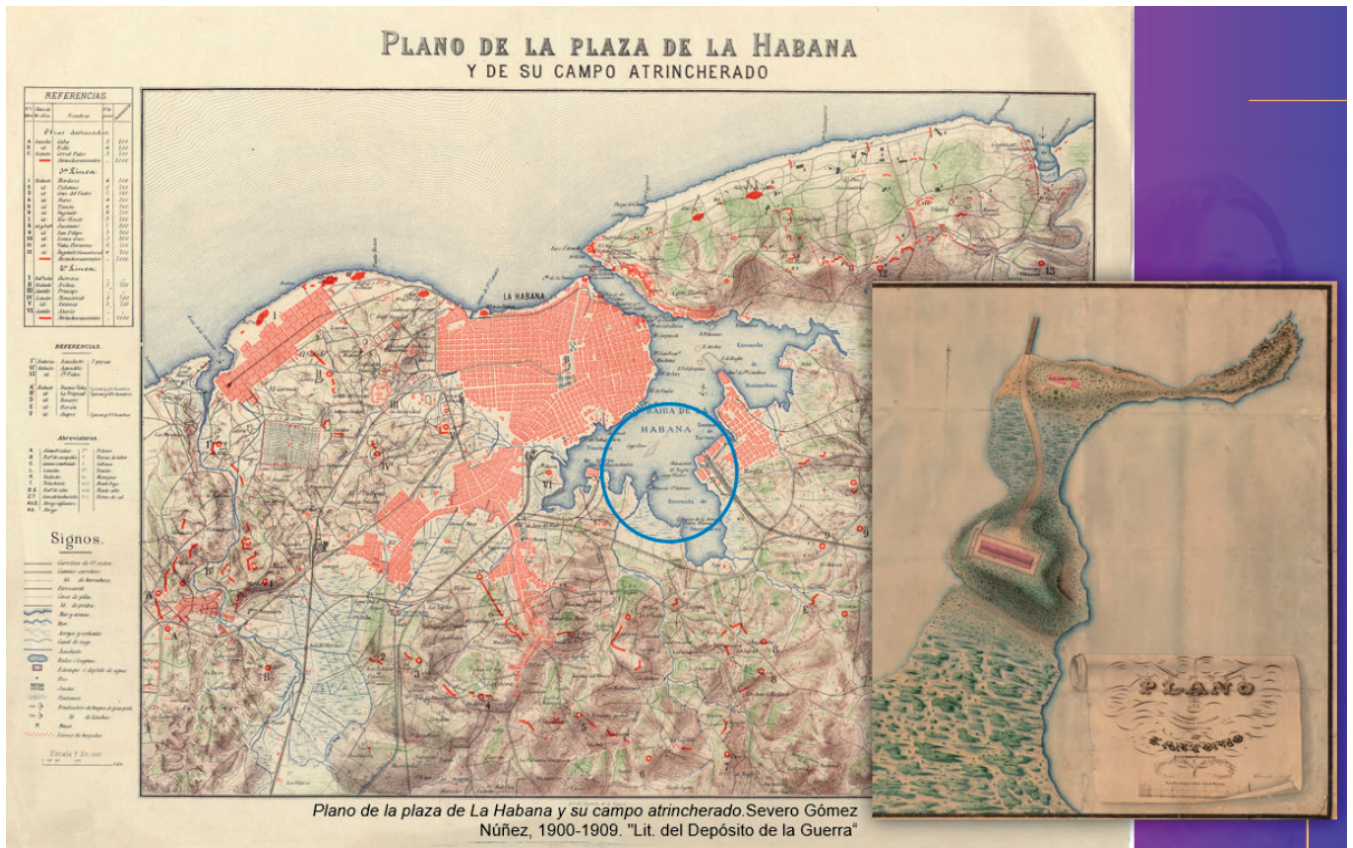


Figure 1. 1909 Map of Havana Showing the Location of the Cayo Blanco Site. In the map on the right, the outline of the *Polvorin* is clearly visible, along with the accumulation of fill material that led to the connection of the small island to the mainland.



Figure 2. Current Satellite Image from Google Earth with Overlay of the Former Islet of Cayo Blanco. The image also shows the Luyanó River and the adjacent industrial area extending toward the municipality of Regla.

things” (Norberg-Schulz, 1992). Building on this reflection, one may argue that in any site, even those characterized primarily by historical and archaeological features, vegetation can also be a defining component of the “spirit of place,” or *Genius loci*. This intangible quality contributes to what makes a site unique and distinguishable from all others. In this sense, the plant component, often comprising well-defined phytocoenoses of ecological interest, should be considered part of the site’s botanical heritage. Beyond its role in narrating the site’s ecological and historical evolution, this component may include valuable species that deserve to be preserved and appreciated on par with historical and archaeological elements. These considerations underpin the multidisciplinary methodological framework adopted by the *Archeo-Cuba* project since its inception. Thus, alongside the collection of historical and archival data, and the study and cataloging of material evidence and findings from the target sites, the research phase also focused on the botanical elements present within the project areas. These elements were analyzed not only for their potential to support the interpretation of the site’s historical stratigraphy but also to ensure their proper conservation and to explore



Figure 3. Seedlings of *Avicennia germinans* (black mangrove) among debris carried by storm surges.

their potential as cultural and tourist attractors, serving the broader functions and objectives of archaeologically significant areas. To achieve these aims, it was essential first to document the local flora and vegetation. In the specific case of Cayo Blanco, where no prior floristic or vegetation studies existed, field surveys were carried out with the support of local botanists to identify plant species. A floristic inventory was compiled and subsequently analyzed to distinguish native from exotic species, identify invasive taxa (Oviedo & González-Oliva, 2015), and highlight species of conservation interest, with reference to national protection lists (González-Torres et al., 2016).

RESULTS AND DISCUSSION

Floristic-vegetation analysis of the Cayo Blanco area

1. The floristic-vegetation survey of the area identified six main environmental contexts and corresponding vegetation formations:
2. Ruderal and exotic tree-shrub formations, mostly surrounding the *Polvorín San Antonio* and landfilled zones.
3. Relict patches of black mangrove (*Avicennia germinans*), occupying surfaces periodically submerged by tidal activity.
4. Sclerophyllous-dominated tree-shrub formations, growing on calcarenite outcrops near the tip of Cayo Blanco.
5. Pioneer native vegetation, including *Ficus citrifolia* and *F. crocata*, which has colonized built structures, including the *Polvorín San Antonio*.
6. Halophilic vegetation, found on open surfaces affected by wave action.
7. Ruderal herbaceous and weedy commensal vegetation, within remnants of agricultural land.

Understanding the species that compose these communities, their ecological roles, and biogeographic significance has enabled an initial reconstruction of the site’s historical evolution. For instance, the ruderal communities rich in exotic species surrounding the *Polvorín San Antonio* and those in areas associated with industrial development indicate that these soils are primarily recent and anthropogenic in origin. Such substrates, formed largely by landfilling, are highly favorable to ruderal and invasive exotic species, which outcompete native flora, an interpretation also corroborated by historical cartography (Fig. 2). Among the many invasive species now established in Cuba, several have found ideal conditions for



Figure 4. *Leucaena leucocephala* a species native to Mexico and Central America, recognized by the IUCN's Invasive Species Specialist Group as one of the world's 100 most invasive species.
Figure 5. *Agave offoyana*, a native plant species occurring the Cayo Blanco area

growth and spread in the Cayo Blanco area. One of the most widespread and problematic is *Leucaena leucocephala* (Fig. 4), a species native to Mexico and Central America, recognized by the IUCN's Invasive Species Specialist Group as one of the world's 100 most invasive species.

This plant is abundant in the study area, along with other invasive exotics such as *Albizia lebbbeck*, *Vachellia farnesiana*, *Ricinus communis*, *Mimosa pigra*, and *Schinus terebinthifolius*. These findings underscore how vegetation analysis can contribute to reconstructing the “historical stratigraphy” of a site. In this sense, the botanical elements present at Cayo Blanco should also be integrated into interpretive frameworks, enhancing the site's value as a cultural and touristic destination, alongside its archaeological, historical, and landscape features. In contrast, the portion of Cayo Blanco corresponding to the former island (Fig. 2) hosts sclerophyll-dominated vegetation, a relict plant community of significant documentary and conservation interest. Native to the site and now disappeared from the rest of Havana Bay, this community suggests that the area has been less disturbed and retains elements of Cuba's original flora. This vegetation is closely linked to the calcarenite substrate, which gives the site its name, *Cayo Blanco*. The species making up this phytocoenosis are all native, including *Ateleia cubensis*, *Exostema caribaeum*, *Opuntia stricta*, *Bourreria succulenta*, *Stigmaphyllon sagranum*, *Smilax havanensis*, *Crossopetalum aquifolium*, and *Agave offoyana* (Fig. 5) (García-Beltrán, 2024).

Exotic species are nearly absent here, in stark contrast to the other areas previously described. This provides insight into the typical zonal environments and the potential natural

vegetation of this part of Havana Bay and is essential for defining the plant species to be used in future environmental restoration projects in the area. This aligns with the goals of the “*Plan Perspectivo de Desarrollo de la Bahía de La Habana*”, which includes reclaiming a substantial portion of the bay for public use, progressively shifting it away from industrial exploitation.

Another important plant community identified in the Cayo Blanco area is found in open surfaces subject to wave action and constant exposure to marine aerosol. These soils are characterized by high sodium chloride (NaCl) concentrations, selecting for halotolerant or halophytic species, which store water in their leaves. Notable examples include *Heliotropium curassavicum* and *Borrichia × cubana*. The latter species was previously only known from the northern coast of Havana, and Cayo Blanco now represents the first documented occurrence in this southern sector.

In front of the tip of Cayo Blanco lies a wetland area dominated by black mangrove (*Avicennia germinans*) (Fig. 6), forming a valuable mangrove stand. While such formations were likely common in Havana Bay historically, they have now been reduced to a few relict patches, making



Figure 5. *Agave offoyana*, a native plant species occurring the Cayo Blanco area

this remnant ecologically and historically significant. Mangroves, encompassing species of *Avicennia*, *Rhizophora*, and *Laguncularia*, are tropical and subtropical coastal trees. They are adapted to saline or brackish waters, tidal currents, strong winds, and muddy anoxic soils. Their survival in such extreme environments is facilitated by specialized structures such as pneumatophores: vertical aerial roots that emerge from the soil and absorb atmospheric oxygen to support respiration in oxygen-poor substrates (Fig. 6).

Mangroves also play a critical role in mitigating the effects of climate change. These dense coastal forests protect shorelines from wave erosion by stabilizing sediments with their trunks and root systems, encouraging the deposition of mud and sand. Additionally, organic matter from the mangroves, fallen leaves and dead branches, accumulates and helps form new landmasses. In the context of rising sea levels, this ecosystem service is especially crucial, as many coastal areas and small islands are increasingly vulnerable to submersion. For these reasons, there are now global efforts to restore and expand mangrove forests in high-risk coastal zones. Mangrove forests also function

as biodiversity hotspots, serving as habitat and nurseries for a wide range of animal species (Guzmán Menéndez & Menéndez Carrera, 2006). Given this ecological and cultural importance, the mangrove fragment at Cayo Blanco should be prioritized for conservation and enhancement, including serving as a source of propagative material for establishing new mangrove stands within Havana Bay. Such efforts will require the development of a waste removal plan, as the area is currently inundated with debris. This cleanup must be carefully executed, as many viable *Avicennia germinans* seedlings are found among the refuse and deserve to be preserved and cultivated (Fig. 3). These seedlings, along with seeds and propagules of other native species such as *Thespesia populnea*, could form the basis for a pilot native plant nursery, supporting future restoration initiatives across the bay. Given the proximity of *Polvorín San Antonio* and the pre-Columbian sites of *Guasabacoa I and II*, both now threatened by sea-level rise, the expansion of the mangrove belt could also serve as a natural coastal buffer to protect these valuable archaeological assets. Such intervention would be a practical example of a Nature-Based Solution (NBS) within the Havana Bay area, directly aligned with one of the primary objectives of the *Archeo-Cuba* project: to identify and implement strategies to mitigate the adverse impacts of climate change on cultural heritage. Due to the site's low elevation, it is particularly vulnerable to sea-level rise, which exacerbates erosive processes, especially in the absence of natural barriers like mangroves.

As part of the planning for a proposed Archaeological Park at Cayo Blanco, this NBS example should be accompanied by other ecological remediation strategies. Key among them is the reduction of the pollution coming from the nearby Río Luyanó, which empties near the tip of Cayo Blanco, and soil contamination throughout the bay, both legacies of industrial activity. These issues can also be addressed through targeted NBS approaches such as phytoremediation and constructed wetlands for wastewater treatment. A suitable wetland site for a future phytotreatment facility has already been identified on the opposite side of the river.

Botanical attractors: conservation and valorization

The floristic survey of the Cayo Blanco area has made it possible to identify plant species of greatest biogeographical and conservation interest, particularly those endemic to Cuba, as well as rare species (at local, regional, or national levels) and those included in national lists of protected plants, such as the Red Lists (González-Torres et al., 2016). By comparing the results of these investigations in Cuba with numerous scientific studies conducted at archaeological sites in Italy—especially within the Roman area—it becomes evident that the presence of a wide variety of plant species of conservation



Figure 6. Mangrove stand of *Avicennia germinans*

interest (Ceschin et al., 2006; Ceschin et al., 2012) is often a shared characteristic of places where traces of the past are preserved. This suggests that, beyond scientific relevance, the highlighting of rare, endemic, or protected plant species can also serve tourism development, turning these species into genuine cultural attractors. In addition, the study of the area's plant elements was extended to explore the compelling relationship between botany and cultural anthropology through the lens of ethnobotany. Traditional uses of the plant species identified at Cayo Blanco were investigated in the context of Cuban communities. These include medicinal, culinary, domestic, artisanal, apicultural, recreational, ritual-religious, and magical uses—knowledge documented in ethnobotanical research conducted across the island by Cabrera (1954), Roig (1974), Fuentes Fiallo (1999; 2001; 2002a; 2002b; 2003; 2004–2005; 2011–2012), Fuentes Fiallo and Castro (2000), Velázquez D. et al. (2014) and Carlomagno et al. (2015). A review of this rich bibliography reveals that many of the plant species recorded in the Cayo Blanco area are still in use today by the Cuban population. For instance, *Guazuma ulmifolia*, known locally as “guasima” (Roig, 2014), is used for its timber; others serve culinary purposes, such as *Portulaca oleracea* and *Phyllostylon rhamnoides*; but it is especially in the medicinal realm that ethnobotanical knowledge is most richly represented. Medicinal plants include *Koanophyllon villosum*, *Cynophalla flexuosa*, *Turnera ulmifolia*, *Varronia globosa* (known as yerba de la sangre), *Turnera ulmifolia* (marilope), and *Morinda royoc* (raíz de indio). A significant number of species recorded in the study area have recognized ethnomedicinal applications (Roig, 1974), and a full list is provided in Table 1.

Table 1 - Species with ethnomedicine uses recorded in Cayo Blanco.

<i>Agave offoyana</i> Jacobi
<i>Avicennia germinans</i> (L.) L.
<i>Cecropia schreberiana</i> subsp. <i>antillarum</i> (Snehl.) C. C. Berg & P. Franco
<i>Cynophalla flexuosa</i> (L.) J. Presl
<i>Exostema caribaeum</i> (Jacq.) Roem. & Schult.
<i>Guazuma ulmifolia</i> Lam.
<i>Heliotropium angiospermum</i> Murray
<i>Koanophyllon villosum</i> (Sw.) R. M. King & H. Rob.
<i>Lantana aculeata</i> L.
<i>Leucaena leucocephala</i> (Lam.) de Wit
<i>Morinda royoc</i> L.
<i>Petiveria alliacea</i> L.
<i>Thespesia populnea</i> (L.) Sol. ex Corrêa
<i>Turnera ulmifolia</i> L.
<i>Vachellia farnesiana</i> (L.) Wight & Arn.
<i>Varronia globosa</i> Jacq.
<i>Viguiera dentata</i> (Cav.) Spreng.



Figure 7. *Ficus citrifolia* along the walls of the Polvorin San Antonio

In light of these findings, the Cayo Blanco–Guasabacoa area emerges as a compelling model of interdisciplinary integration, where elements of historical and archaeological heritage are closely interwoven with botanical and ethnobotanical components, contributing to the creation of a richer, more layered cultural and educational offering. This setting serves as an exemplary case of how history, archaeology, nature, and plant knowledge can be effectively combined, enhancing the site's cultural value and broadening its potential as a resource for education, tourism, and community engagement.

Management Plan for the Cayo Blanco Area

The results of the floristic–vegetational and ethnobotanical studies, combined with the historical and archaeological knowledge gained largely through the investigations carried out under the Archeo-Cuba Project, were fundamental to the development of a Management Plan for the Cayo Blanco area, aimed primarily at the appropriate conservation and valorization of the site. The Plan, developed collaboratively

with archaeologists from the Oficina del Historiador de la Ciudad de La Habana and planners from the Ministerio de la Construcción also included the reuse and reinterpretation of residual or abandoned structural elements onsite, such as reinforced concrete blocks, iron beams, and sheet metal. This approach is emblematic of the Archeo-Cuba methodology, which seeks to valorize even these modern remnants as part of the site's recent historical narrative.

The Plan further incorporates the enhancement of the site's agricultural landscape, especially the section near the entrance bordered on the left by the Luyanó River. This area is currently used for the cultivation of edible plants such as banana (*Musa × paradisiaca*), Cuban oregano (*Plectranthus amboinicus*), cassava (*Manihot esculenta*), and sweet potato (*Ipomoea batatas*). This zone lies on an alluvial substrate, deeper, moist, and fertile, making it particularly suitable for agriculture. From a design standpoint, and in light of the educational potential of the Cayo Blanco site, it is essential to preserve, expand, and enhance this cultivated strip, not only to familiarize visitors with local crops but also to emphasize the importance of agrobiodiversity conservation in Cuba, and to highlight the relevance of self-production practices, especially critical in a context heavily burdened by the economic embargo. With respect to the native pioneer vegetation, particularly *Ficus citrifolia* and *F. crocata*, which have colonized the masonry of the Polvorin San Antonio (Fig. 7), a site of great historical and archaeological interest, management decisions must balance conservation needs and ecological realities.

While these plants may represent a threat to the structural integrity of the architecture, complete removal is not recommended, particularly for mature individuals, for two main reasons:

Structural concern: Simply cutting back large specimens would not prevent regrowth. Effective removal would require chemical herbicides such as glyphosate or triclopyr. However, the subsequent decomposition of the embedded root biomass could destabilize the masonry, posing a serious risk to the structural conservation of the building.

Cultural–ecological value: In line with the “conservative approach” adopted by the Archeo-Cuba Project, the natural evolution of vegetation is considered part of the site's history and spirit. Even recent plant colonization processes can serve as indicators of the genius loci, contributing to a layered reading of the site over time.

CONCLUSIONS

The Archeo-Cuba Project has offered a valuable opportunity for international collaboration and capacity-building focused

on the relationship between cultural heritage and sustainable intervention strategies in areas vulnerable to climate change. Italian expertise, widely recognized for its integrated approach to cultural heritage, from natural landscapes to anthropized environments, has supported interdisciplinary exchange, particularly through the educational program and on-site workshops carried out with Cuban professionals. Specifically, the floristic–vegetational and ethnobotanical studies conducted in the Cayo Blanco area, along with the historical and archaeological findings largely derived from the same project, have contributed not only to enriching the site's cultural offering but also to addressing key environmental and management challenges. These studies were essential in the drafting of the Cayo Blanco Management Plan, whose primary goal is the proper stewardship and enhancement of the site. An important final output of the project will be the definition of guidelines for replicating the Archeo-Cuba model, already considered a best practice with the potential to be scaled and adapted to other Cuban heritage sites. The results of these georeferenced surveys have been integrated into a Web-GIS platform (<https://webgis.archeocuba.com/>), developed as a technological hub for project information and content—open-access and consultable, supporting further research, monitoring, and decision-making.

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