ISSN 1828-5961

The compositional model of Santo Domingo and Cartagena fortifications between old and new world

The work of the Antonelli family has determined the constructive characteristics of Spanish fortifications in the new world. Their fame is due to Giovanni Battista, the military and hydraulic engineer of Italian origin, and training in the Spanish Crown service. During the second half of the sixteenth century, he designed and built the defense of the Iberian Peninsula's borders, taking care of Cartagena's port city, the coast of the Kingdom of Valencia, and the African ports of Oran and Mazalquivir. An extensive work, whose characters are taken from the younger brother, Battista Antonelli, planned the defensive system of fortresses and walls in the Caribbean and, more generally, in the Spanish colonies of Central America. In the first decades of the seventeenth century, the New World was a destination for explorations and observations by the great monarchies of the old continent: the English, French, Dutch, and Spanish fought over lands and businesses on a Caribbean sea that became international. In 1586 Philip II of Spain nominated Battista Antonelli as his engineer, with the specific aim of structuring the defense of the lands of the Corona overseas. Over the years, Antonelli inspects and presents design proposals for many cities in Central America, working from Colombia, Panama, Chile, the Dominican Republic, Cuba. The text addresses, in particular, the description of Cartagena de Indias and Santo Domingo, comparing them through the narration of two analysis, training, and documentation projects conducted here by the DAda LAB Research Laboratory.

Anna Dell'Amico
PhD Student in Architecture, address in Survey and Representation of Architecture and Environment, since 2015 she collaborates with DAda Lab – Drawing Architecture DocumentAction Laboratory. She participates in national and international activities, seminars and workshops. Expert in BIM modeling, she is technical coordinator of a research mission in the Alhambra complex functional to the development of H-BIM systems in collaboration with University of Granada.

Silvia La Placa
PhD student in Design, Modelling and Simulation in Engineering, cycle XXXV, her research is developed in the field of documentation of artificial water channels and representations on a territorial and architectural scale, with particular attention to the census and processing of digital databases. She collaborates in the experimental scientific research activities of DAdA Lab both in national and international projects.

Keywords:
Fortified Architecture; 3D Survey; Cultural Heritage; Antonelli; Latin America

DOI: https://doi.org/10.20365/disegnarecon.25.2020.22

ISSN 1828-5961

1. FROM EAST TO WEST: A DEFENSE PROJECT FOR THE COLONIES OF THE CARIBBEAN SEA

Between the 16th and 17th centuries, ships sailed to the West Indies from the coasts of the European continent, to occupy territories and islands to guarantee prestige and commercial wealth for the motherland. The navigation from East to West, along the route leading to the Caribbean Sea ports, lasted about 14 days. The dispute over the sea and the coasts find its primary development in piracy, with the emergence of figures such as Sir Francis Drake (late 16th century) and Sir Henry Morgan (17th century). To maintain dominion over the routes and the conquered areas, the Spanish Crown starts the construction of numerous coastal ports and fortified cities, regulating new river routes. These systems, connecting the new and the old continent, have led to the evolution of an imposing commercial network while promoting an autonomous cultural and social development of the colonies. (Parrinello & Picchio, 2017) In Central America, defensive systems developed hand in hand with the inhabited nuclei, marking the shape and image of the cities so that they appeared firm to discourage pirates and invaders and at the same time underlined the power of the empire. Characteristic elements of this defensive jersey were towers and batteries designed to contain and use heavy artillery. For the definition and positioning of these architectural typologies, the military engineer meticulously studied the orography of the land and the seabed, to make use of any natural defenses to cope with the attack actions in the most appropriate way. This also happens for Cartagena de Indias and Santo Domingo, for which Antonelli structures two coeval and yet very different defensive projects, in response to orographic and military defense needs (fig. 1).
The redrawing and modernization of the Caribbean fortifications began in the late sixteenth century when Philip II of Spain entrusted Battista Antonelli with the defense of overseas colonies. The military studies and engineering training of Antonelli, acquired by working at the Viceroy of Valencia, profoundly affected the architectural and territorial planning choices of the Caribbean cities. In 1586, during his second trip to the New Continent [1], Antonelli began the inspection of several sites indicated to him by the king. When he returned to Spain, only in 1588, he got approval to carry out

Fig. 1 - Historical maps, Siege of Drake in Santo Domingo and Cartagena De Indias, 1586. Source: Library Of Congress - Jay I. Kislak Collection.

DOI: https://doi.org/10.20365/disegnarecon.25.2020.22

ISSN 1828-5961

some of his projects, including the one for Santo Domingo. Battista's third journey to America began in 1589 and lasted ten years. Upon arrival in Santo Domingo, the first American capital, founded in 1498, had already been subject to the siege of Drake [2]. To welcome Antonelli on the Ozama River, the homonymous Fortaleza, built between 1502 and 1507 at the behest of the governor Nicolas de Ovando to protect the city, the first European fortress and the first military building in America. However, the commercial and political importance of Santo Domingo had waned in favor of new ports, and the perimeter project for the walls was disproportionate, based on a hypothesis of continuous urban growth that had not taken place. The first settlement was located in the eastern area of the Ozama river, but within a few years, to improve its defense strategies, the city had been transferred to the other side, where the main nucleus remains and where the fortified works persist.
The defensive structures emerge only partially, as punctual traces, to surround the colonial city, and the whole design is imaginable only starting from the remaining portions (fig. 2).
The wall designed by Antonelli was to protect the city to the North-West from any incursions from inside the island to the east and south from attacks by river and sea, exploiting where the natural rock wall is present.
Antonelli rethought the design of the walls, placing the perimeter on the center of the city and strengthening its defense with the addition of bastions, strongholds, and gunboats suitably distributed. The walls, thus redesigned, were lower and enriched by an external moat to amplify the ramparts' dramatic effect. An alternating series of watchtowers, bastions for grazing shooting, and fortified gates leave today only to imagine the overall design of the fortified system of Santo Domingo. Antonelli did not attend the works, engaged in the defense works of the other Caribbean coasts. Nowadays, there is no certainty of which portions were made on his project and which instead are remains of defensive systems built-in later eras, based on the new perimeter defined by the Italian engineer. The technical parameters and criteria

Fig.2 - Historical map of Santo Domingo. The image shows the two defensive projects, the first larger and the second, more circumscribed, conceived by Antonelli.

of military engineering of that historical moment were also applied to Cartagena de Indias [3]. The project consisted of strengthening the entrance of the bay of Cartagena along the Bocagrande route, building two forts controlling the ends of the mouth, one south of Bocagrande, in the site called Punta de Los Icacos, another in the northern part of the island of Carex (now Tierra Bomba) (fig. 3). The system, based on the positioning of forts in strategic points of action, made it possible to spot fires in the Bocagrande channel. In 1586 Cartagena suffered the same fate as Santo Domingo and several Spanish colonial ports, being sacked by the English pirate Sir Francis Drake. The latter leaves a first description of the post-founding period: "it is possible to count about 625 lots made up of isolated buildings and houses built with bahareque walls or boards, thatched roofs or tiles" [4].
The design of the urban jersey of the city is modified with the arrival of Battista Antonelli who elaborates, for the Spanish Crown, a new defense plan with an "irregular" and "modern" shape (fig. 4). Compared to the Dominican project, the differences in terms of sketch quality, disposition of layouts, plans, cuts, facades, isometric, and perspective representation, as well as improved techniques of representation of the city at an aerial level, are appreciable. Battista Antonelli devoted

DOI: https://doi.org/10.20365/disegnarecon.25.2020.22

ISSN 1828-5961

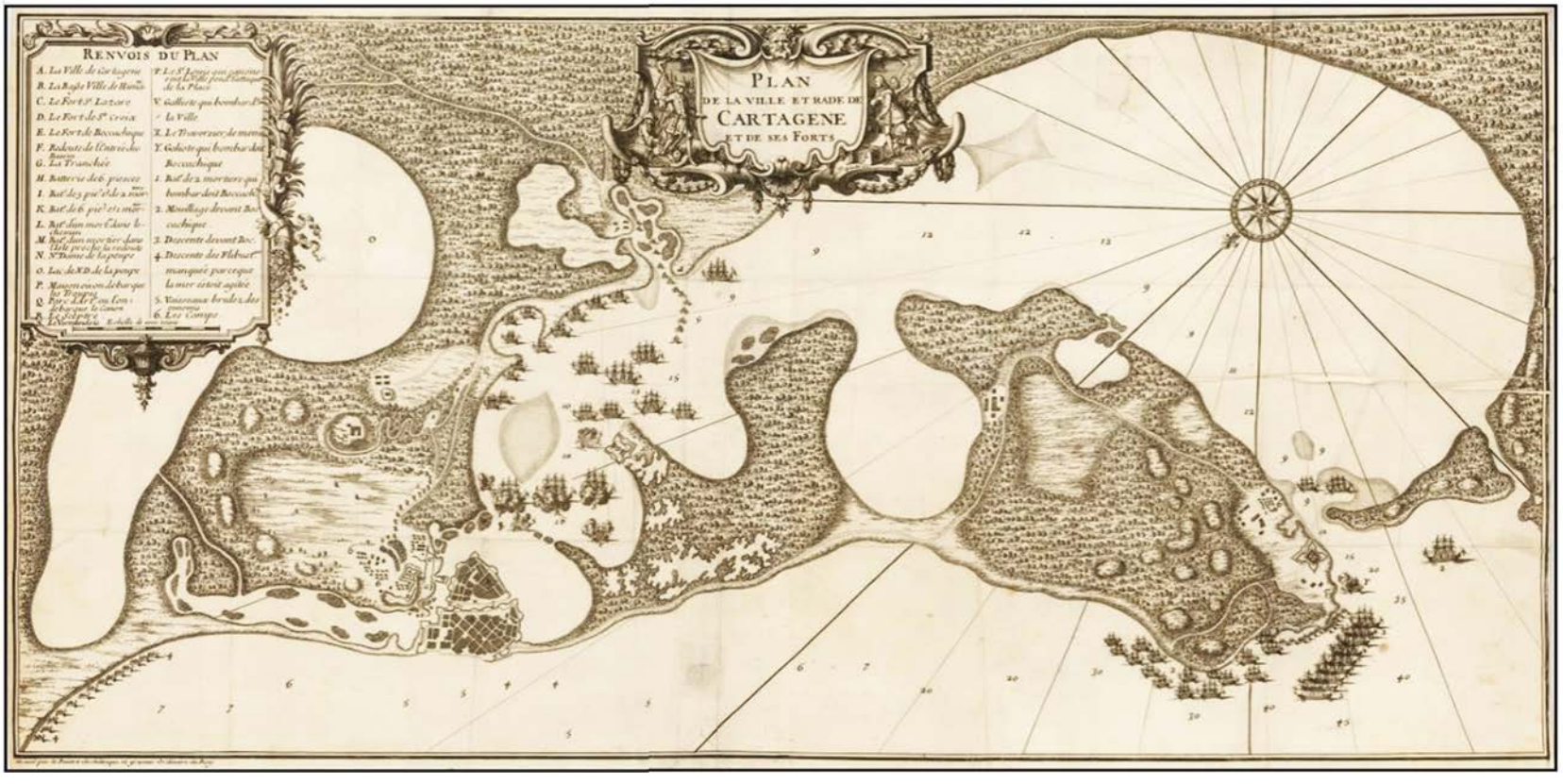

Fig.3 - Plan de la ville et rade de Cartagene et de ses Forts, Paris 1698. Source: Barry Lawrence Ruderman Antique Maps Inc.

himself to designing the walls in 1595, devising a fortified system, lower than the previous one but with a robust and irregular section, consisting of bulwarks, ramparts, and sentry boxes, suitable for resisting attacks by firearms.
The essence of Antonelli's thought is reflected in the defensive proposed for the stronghold, which consists in surrounding the city with a wall made up of twelve bastions. The Italian engineer decides to use all the already erected fortifications and with them tries to form a fortified square inscribed in a regular polygon with twelve sides. However, in adapting his project to existing blocks and roads, an irregular polygon limited to the city resulted. The construction work on the walls began only in 1608 with the construction site of the San Felipe Bastion, today known with the name of Santo Domingo bastion, and with the ramparts of Santiago and the Holy Cross. The reconstruction was entrusted to Cristoforo Roda, Battista's grandson, according to the new design that the engineering Tiburzio Spannocchi had adapted to Antonelli's previous one. The wall structure, composed of homogeneous blocks in rusticated local stone called "caliza", encompassed the entire city. Between 1614 and 1630 the ramparts of Santo Domingo, the Baluarte of Santiago Apostol, and the Baluarte of Santa Cruz were built on one side to defend the Boca Grande peninsula; on the other, the Baluarts of Santa Catalina and San Lucas, implementing a modification to Antonelli's original project.
The walls which, along the stretch that included the bastion of Santa Catalina and the bastion of San Lucas, from the project followed the perimeter line, were advanced, increasing the fortified surface, annexing a portion of fertile soil useful for

DOI: https://doi.org/10.20365/disegnarecon.25.2020.22

ISSN 1828-5961

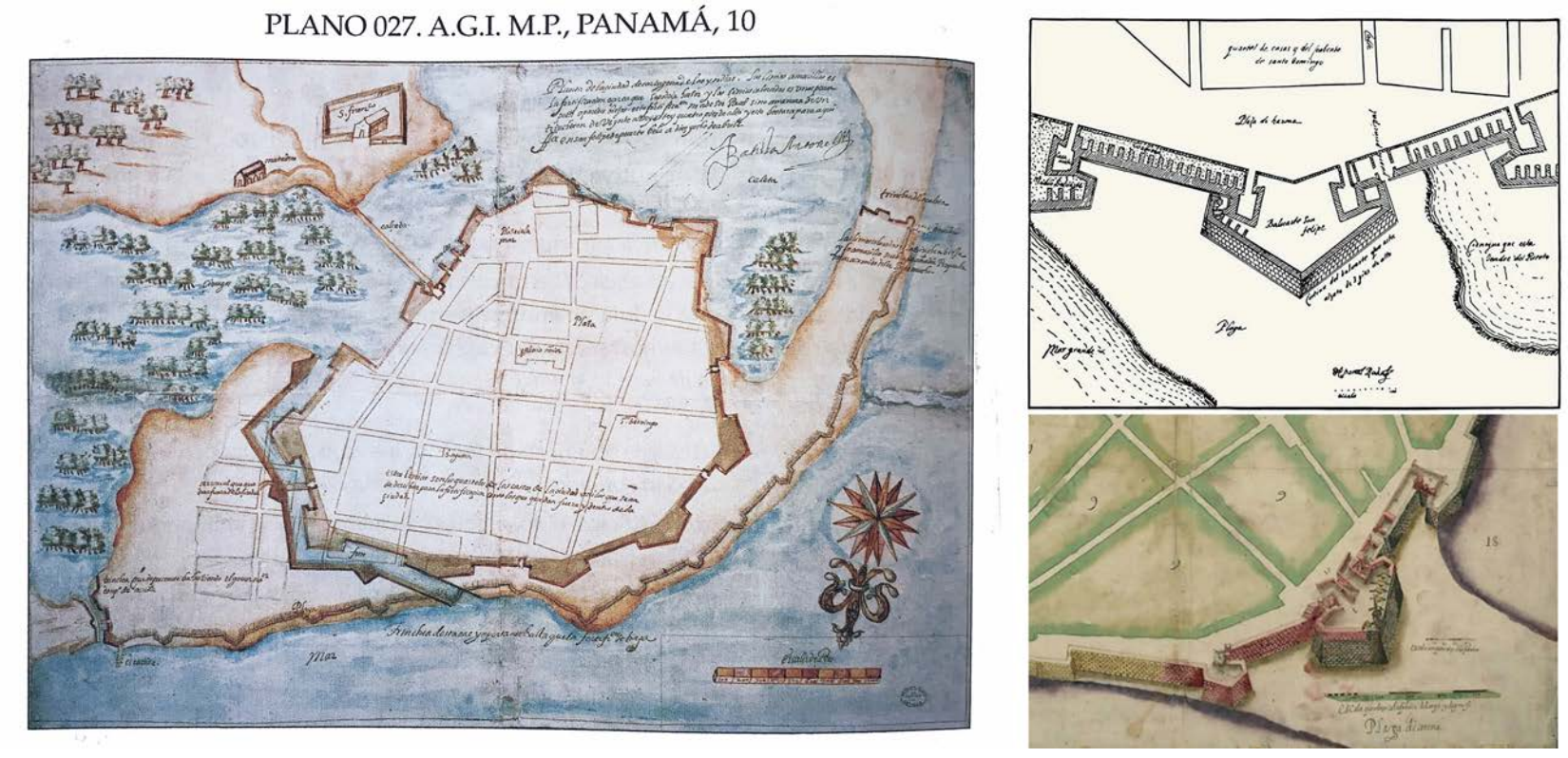

Fig. 4 - Some historical drawings of Cartagena de Indias made by Battista Antonelli. 1594. Archivo General de Indias, Siviglia.

any livelihood during the siege periods. The only access to the city was located between the Bastion of San Juan Evangelista and San Pedro Apostol. There was a drawbridge near the Boca del Puente, the gateway to the town. In 1631, with Francisco De Murga, the original design was further modified, along the stretch between the Baluarte of St. Francisco and St. Ignatius. The construction of a Jesuit college was allowed by ignoring part of the walls and compromising the defensive effectiveness of the wall. In the stretch between San Josè and Santa Barbara, there was the Puerta de la Media Luna and the homonymous Rivellino, which, at the time, was the only point of access and contact between the city and the mainland. In 1636, with the death of De Murga, the idea of fortifying the Cerro di San Làzaro was born, moreover, the elevation of the land at Bocagrande changes the defense project of the Bay, going to secure the new access point in the area of Boca Chica. In 1656 a second wall was built to defend the Jesuit college. La Boca del Puente was destroyed in 1697 following a battle and later rebuilt with more elegant lines. Between 1741 and 1798, after San Felipe was finished, the layout of the San Carlos bastion was modified because the sea's repeated action had degraded the walls. The Rivellino del Cabrero and a breakwater perpendicular to the existing masonry of the Baluarte of St. Catalina, later called "La Tenaza", are built, to strengthen the defense and attenuate the action of marine motions on the walls. In 1798, with Las Bóvedas de St. Clara, the wall perimeter was finished, and the city was impregnable. In 1810 there was a turnaround: the Colombian people began an act of rebellion from the Spanish domination seeking independence, a clash against the

DOI: https://doi.org/10.20365/disegnarecon.25.2020.22

ISSN 1828-5961

Fig. 5 - Carrying out of survey activities with Laser Scanner and drones at the Antonellian defense system. From left: low battery of the *Fortaleza de Ozama*, the Fuerte de la Conception, the "walled garden" of the *Fortaleza de Ozama*.

Crown that lasted until 1820 when the independence of Colombia was proclaimed. In the subsequent Republican period, the fortifications were wrapped in a dichotomy of love and hate. After the first phase of independence in 1811, the emancipation from the Spanish Crown began, which lasted from 1821-1823, culminating in the second definitive independence of New Granada. At that time, the fortresses, which until then had been a symbol of security, again identified the Iberian power, the population wanted to demolish them as a testimony of a past to be forgotten. The importance of their legacy persists since it is deeply correlated to the architectural complex's value that has protected a population for almost five hundred years. Therefore, they embody an ordinary meaning in the collective imagination. It is essential to understand the theme of the fortifications of Cartagena de Indias to understand that all the fortifications were adapted in their historical moment to defined parameters and polymorphic concepts. The demolition of the bulwarks, as well as new buildings and adjustments along the walls, reflect changes in urban dynamics and historical processes no longer compatible with the old fortified system. From the second half of the twentieth century, the restoration works of the walls began as local historical heritage. UNESCO has recognized the fortification systems of overseas colonies as a World Heritage Site. In 1984 the Cartagena system was recognized, and in 1990 the Colonial area of Santo Domingo was the only area where the original design of the defensive system remains.

2. READING METHODOLOGIES OF THE ANTONELLIAN FORTIFIED SYSTEMS OF SANTO DOMINGO AND CARTAGENA DE INDIAS.

Knowing and documenting the architectural heritage in Central America today takes on particular importance in consideration of two factors. First of all, from the study of fortified architecture it is possible to read the historical and urban evolution of colonial centers; secondly, having taken note of the unsuitable state of conservation of some of these monuments, it seems more significant than ever to be able to pass these identity places on to the generations to follow. In response to this documentary need, the research projects dealt with see the first phase of the archival study and a second application on the field of drawing and survey tools. In this sense, the digital transposition of the heritage, in its current maintenance conditions, through metrically reliable three-dimensional models, is made possible by the studied use of diversified detection instruments. The two case studies treated by the researchers of the DAda LAB laboratory of the DICAr,, differing in size and architectural typologies present, were evaluated with suitably diversified methodologies. In consideration of the morphology, surface, time of the mission, but above all of the set goals, an integrated survey was carried out for both, using range based tools [5] and SfM methodologies with the use of remote piloted systems [6]. The acquisition of data has made it possible to define knowledge and management products for complex environments or structures included within an uncontrolled urban sprawl. The investigations conducted thus led to the definition of a digital database of the fortified heritage created by Battista Antonelli in the two sites. This digital heritage is applied, as well as for the deepening and historical-architectural analysis, in the support for the determination of development strategies related to its knowledge, safeguard, and enhancement.
The research activities in Santo Domingo started from the testing of technologies for the survey to the architectural and landscape representation, concerned certain portions of the colonial defense system, chosen for historical importance

DOI: https://doi.org/10.20365/disegnarecon.25.2020.22

ISSN 1828-5961

Fig. 6 - Point cloud obtained from the acquisition with TLS systems.

DOI: https://doi.org/10.20365/disegnarecon.25.2020.22

ISSN 1828-5961

Fig. 7 - Point cloud obtained from the acquisition with UAV systems. Above the *Fortaleza de Ozama*, below: on the left the *Bastion of the Invincible*, on the right the *Fuerte de la Conception.*

and distribution on the city perimeter, to understand better the effective measure of the wall designed by Antonelli. The documentation project [7] digitally reconstructed the phantom perimeter of the defensive wall: in a clockwise direction, starting from the southeast, the various fortified structures present were found. The first to be encountered, by order and date of construction, is the Fortaleza de Ozama, erected in the early 16th century near the mouth of the river to defend the southeast entrance to the colonial city. At the expense of changes and extensions, the "medieval character" of the structure remains intact, making it unique among the fortresses of Central America. The complex is structured on several levels: the main building insists on a natural rock wall, elevating it from the river. A stone wall separates the latter from the low battery, located to the right of the fortress, and connected to it by a large ramp that runs linearly to the island's rocky profile. Upon further closure of the complex, around 1950, the battery was separated from the riverbed by a concrete curtain, responding to the taste of the time and needs of its use as a prison. The main body consists of thick walls made of local coral stone and develops on three levels with different lookout points. Above all, touching the 18 meters, the crenelated structure of the Torre del Homenaje (Tower of Homage), from which ships entering the port were greeted. Behind the fortress building, there is a large fenced green area, which divides the military complex from the urban core, except for the Puerta de Carlos III, only access built-in 1797. This "walled garden" is equipped with a series of stations for cannons, in superior defense of the battery. The detection methods were defined by the distribution of the complex over several heights, the extension, and the desire to obtain a faithful reproduction from a colorimetric point of view. The Fortress has been documented with over 60 scans, performed with the FARO CAM2 S150 set with an active color profile, for the definition of a point cloud capable of restoring the material aspect as well (fig. 5). To integrate this data, a photogrammetric campaign was conducted with DJI Phantom 4 Pro drone [8]. Continuing from the Fortress along the course of the Ozama river and then parallel to the coast, you will find portions of walls and bastions of the colonial city, not richly documented as the Fortaleza and therefore not precisely datable.
Imagining to move above the perimeter of Battista Antonelli, near the Fuerte de San Gil, this fold to the north. The trace of the walls can be seen alternately, up to the Puerta de la Misericordia which maintains its connection with the Fuerte de la Concepción thanks to the sign of the walls left visible on the driveway. The Fort looks like an isolated monument between busy streets, protected by a low fence that does not, however, exempt it from improper use. The detection operations were carried out with TLS instrumentation, positioning the laser to form two circuits, one above the monument to cover its surface and a wider one all around. This method has been defined to minimize the drift error in the post-production phase. The Fort was simultaneously detected also with UAV systems [9], to integrate and compare the acquired data, always with a view to a reliable and high metric quality material return. Continuing east, the wall becomes visible near the Ruinas de La Caridad. The bastion was connected to nearby San Miguel by a section of walls of which the whole lower portion remains intact. A series of residential buildings have been added to this, as well as to the two bastions, which is why the detection operations have insisted in particular on the side of access to the ramparts, left free despite urban transformations. Continuing along the phantom wall of Antonelli, the fortified route becomes appreciable again near the Ermita de San Antón. Over the years, the same name's bastion has been flanked by a reconstruction of the walls that bind it to the Catedral Castrense Santa Bárbara. Battista's project continued from the Cathedral to the Ozama River, defining a ring of curtains, small forts, and doors, which were only partially preserved.The methodological and instrumentation choices, applied on a case by case basis to the surveying actions, were both an op-

DOI: https://doi.org/10.20365/disegnarecon.25.2020.22

ISSN 1828-5961

portunity for research and training. The documentation project developed on the Antonelliana wall was a reason for cultural exchange and integration between teachers and students of two Universities, which made very distant cognitive panoramas a point of strength and interaction. As well as for the acquisition phases in the field, a profitable comparison on the diversified use of software and their integration was also possible in the subsequent processing of the data (fig. 6). The point cloud obtained by the laser was recorded with the SCENE program, in automatic and manual mode, when the complexity or extension of the environments required the operator's precision. The maximum error found was always less than 1 cm, thus responding to the predetermined initial need to obtain a qualitatively valid product as well as aesthetically faithful to reality.

The data acquired with the two drones were instead handled in parallel with different programs [10], thus allowing a significant comparison to being made in terms of timing and metric and colorimetric quality of the elaborate (fig. 7).

Unlike the Dominican city in Cartagena de Indias, the traces of the historical system of the fortified system are still a distinguishable sign by observing the urban plan (fig. 8). The fortified system has become an integral part of the city, changing its destination from a defensive system to a delimitation and access system to the historic center.

The digital acquisition project [11] was based on the extensive nature of the 5 km route that surrounds the city. They have been carefully evaluated which technologies could be the most effective to obtain, in a few operating days, a result capable of describing the walls at different levels of detail: territorial-architectural scale, and the detail of the wall texture (fig.9).

Based on a comparison between the size of the data to be collected and the time available for the recovery actions, a flexible fast recovery system was chosen: a mobile laser scanner which used

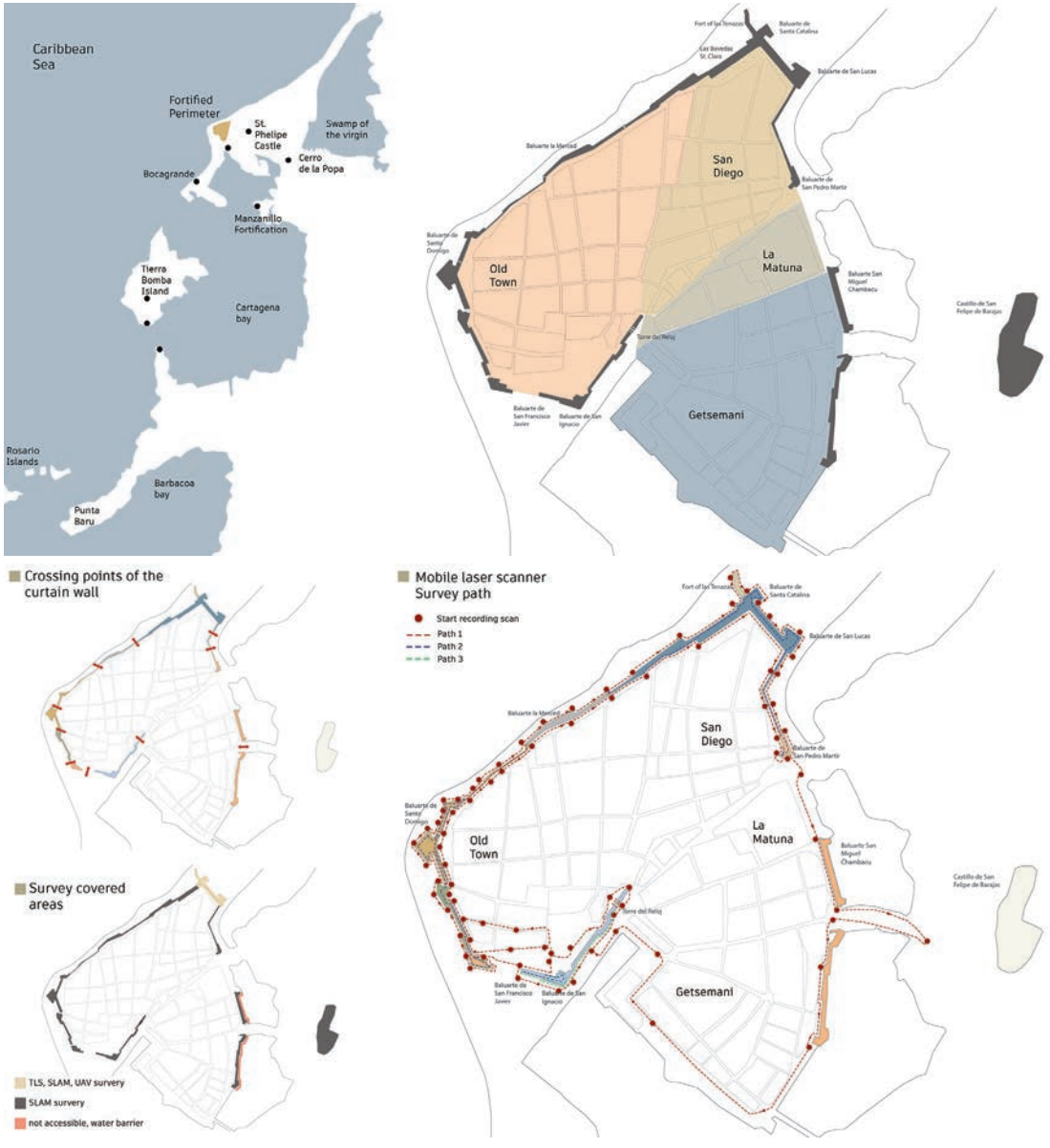

Fig. 8 - The fortified system of Cartagena de Indias.

Fig. 9 - Cartagena walls survey acquisition project.

DOI: https://doi.org/10.20365/disegnarecon.25.2020.22

ISSN 1828-5961

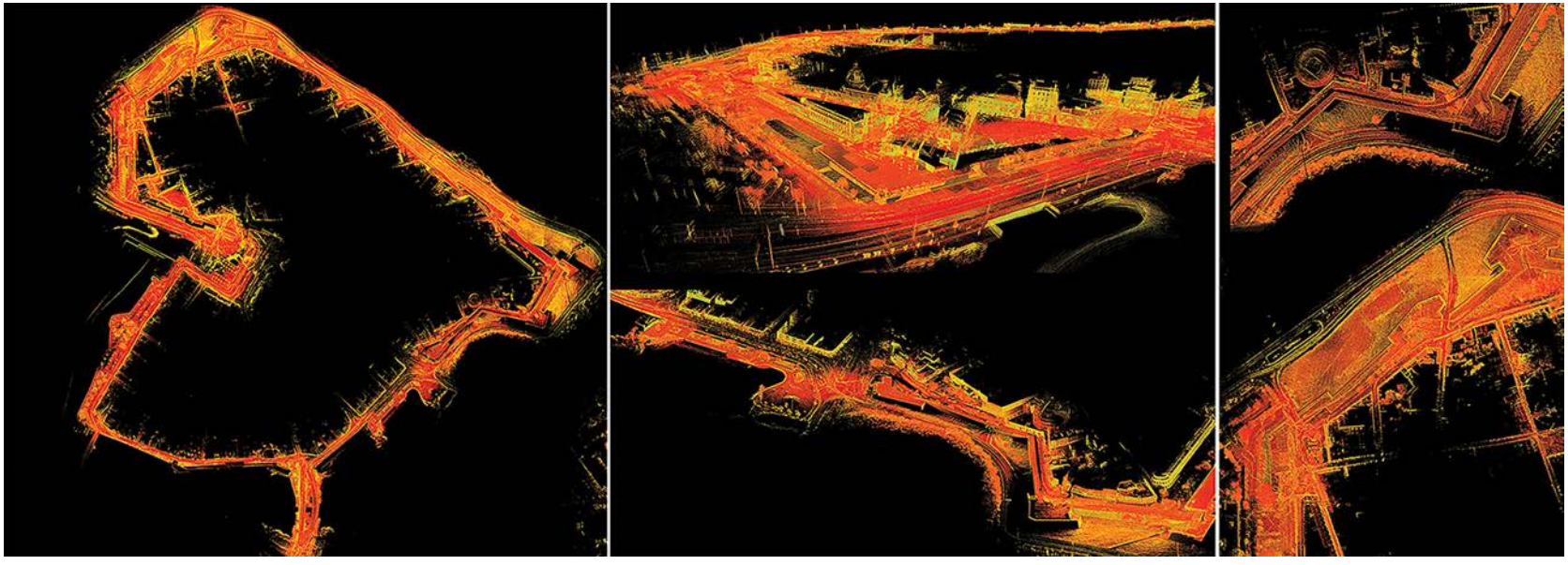

Fig. 10 - Recording results of the entire wall city perimeter data acquired with the mobile laser scanner Stencil KAARTA, some views of Torre del Reloj and the area between St. Domingo and St. Catalina bastions.

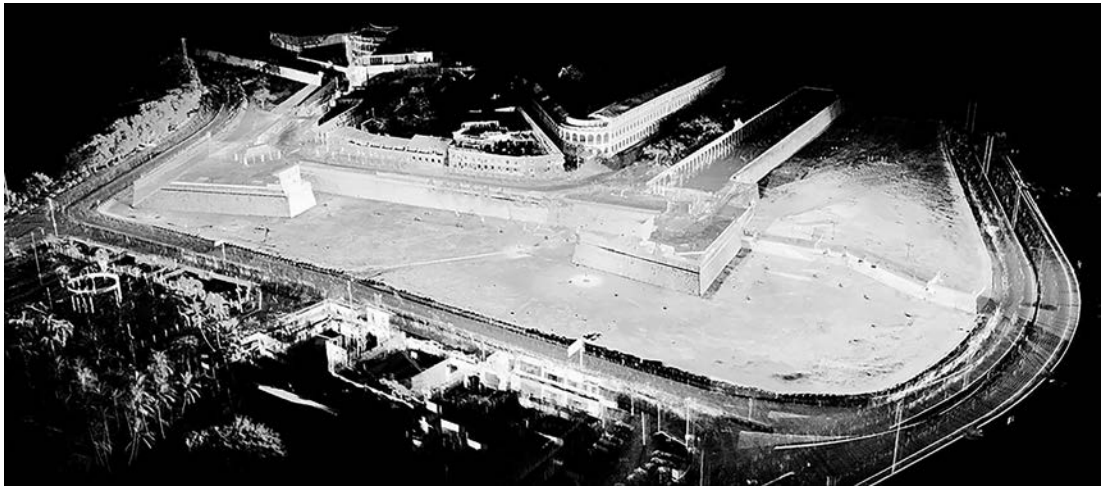

Fig. 11 - Recording results of the data acquired with the FARO S150 of St. Catalina and St. Lucas bastions.

the KAARTA Stencil model [12]. Before starting the acquisition operations with mobile laser, the macro-system, object of the survey, was defined. The walls were ideally broken down into subsystems, which were detected as individual units. The routes, to be carried out, were identified through the study of the morphology of the fortified system, analyzing the physical limits and permeable points (such as the presence of the access gates to the city, or the breaches in the curtain walls). Twelve portions were identified, crossed by three macro paths based on which the secondary circuits, aimed at integrating the data acquisition, were then inserted (fig. 10).

The first route follows the external perimeter of the walls, the second runs along the internal boundary, and finally, the third follows, where possible, the walkway above the walls. During the subsequent data recording phase, the connection between the different portions was guaranteed, providing for the acquisition phase an overlap of

DOI: https://doi.org/10.20365/disegnarecon.25.2020.22

ISSN 1828-5961

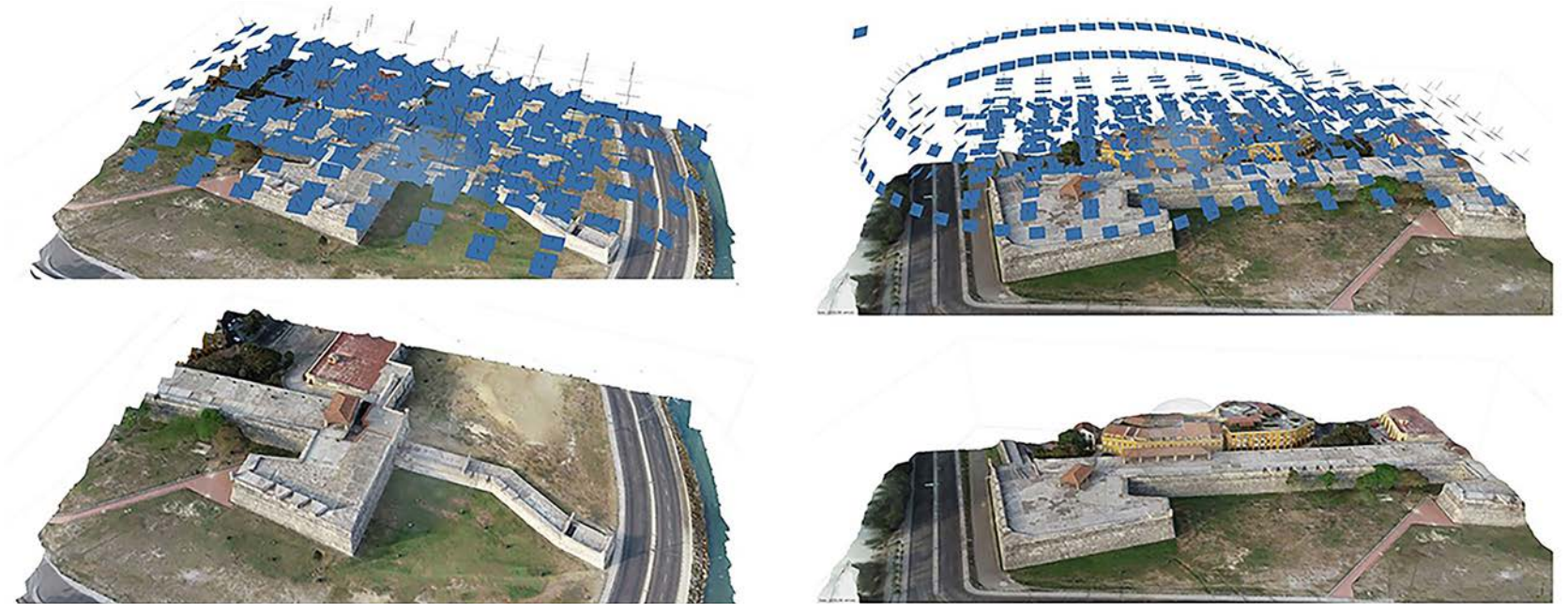

Fig. 12 - Acquisition and shooting methods with UAV systems of St. Catalina bastions.

about 20% between the adjacent portions. The use of the mobile laser imposes the need to pay particular attention to the surveyed area's climatic and environmental conditions. Direct sunlight during the hours of highest intensity or the presence of ponds, as in Cartagena de Indias, can lead to acquisition errors. The data may be replicated, causing a registration error. In these cases, the instrument signals this through the blocking of the recording but there is a risk of compromising the accuracy of the metric data during the alignment of the scans. The acquisition operations were carried out by a single operator during three working days, for a total of 15 h of data acquisition in the field. A total of 113 scans were acquired, subsequently processed with software dedicated to recording point clouds [13]. This data recording process has enabled us to obtain a complete descriptive database of the entire route that delimits the perimeter of the city of Cartagena with a maximum registration error of the order of 10 cm.

The portion of walls between the Bastione di San Lucas and the Bastione di Santa Catalina was also the subject of a detailed integrated survey using UAVs and TLS acquisition systems. The laser scanner acquisition campaign was operated through the FARO S150 series instrument, through an acquisition project based on the structure's morphology. The acquisition with a total of 244 scans, without the colorimetric data, including the entire complex of the bastion of Santa Catalina and San Lucas that were recorded, with a measurement error of less than 4 mm, through the use of the proprietary software FARO SCENE (fig. 11).

To describe the texture of the building blocks, an aerial photogrammetric survey of the area in question was carried out. The area was acquired by planning two different acquisition paths: one based on a planar flight plan set on a routing grid, the other based on a helical flight plan referred to the setting of a point of shooting interest. A flight plan was set up both for the portion of the bastion of Santa Catalina, which counted the acquisition of 401 photographs and for the bastion of San Lucas, for which 561 photographic shots were taken (fig. 12). The two models were developed with the Metashepe software, with an alignment error of 6 mm (fig. 13) (Parrinello et al., 2019).

3. SIGNS AND TRACES OF THE ANTONELLIAN ARCHITECTURAL IDENTITY IN THE DEVELOPMENT OF THE MODERN CITY

Places of economic as well as cultural encounters, the fortified colonial cities of Antonelli still live a peculiar dimension, isolated and at the

DOI: https://doi.org/10.20365/disegnarecon.25.2020.22

ISSN 1828-5961

Fig. 13 - St. Catalina and St. Lucas bastions in a comparison of different level of point cloud detail: TLS, SLAM and UAV acquisition.

same time centralizing, concerning the housing and identity expansion that has grown around it. Both projects are developed based on the idea of generating or recovering a cultural connection, manifested in the architectural identity of these sites, between east and west (fig. 14). Hence the importance of exchange actions not only scientific and research, but of training and teaching. Nowadays, the walls in both cities constitute a real filter of urban permeability, and through their conversion, they identify themselves not only as a tourist attraction but also as a place of socio-cultural aggregation for the local population. In the case of Cartagena, the city walls contributed as a catalyst for tourist flows. In Santo Domingo, the uncontrolled growth of hotels and infrastructures for mass reception has incorporated and put the perimeter of the colonial city at risk.

Thus, it becomes increasingly important to consider the development of fortified architecture models, to safeguard and enhance them through knowledge. Of the defensive systems of Santo Domingo, only the Ozama Fortress is maintained with a spirit of safeguard. Used for different uses until the end of the 1960s, it has since been visited and hosts cultural and educational events in its spaces. To the detriment of its conservation, a museum or enhancement project that guides the tourist in the various environments and knows how to communicate the importance of this work for Central America is lacking for it. Ramparts and fortified portions north-west of the city walls (Ruinas de la Caridad, San Miguel, and San Antón), on the other hand, require greater precautions, hence the desire to develop integrated systems for the protection of the artistic and cultural heritage. The population does not know them as monuments of historical and architectural value, ending up making an improper and even harmful use for their maintenance. The bastion of San Antón, raised above the road and hollow at various points, due to the wear and tear of time, is used as an open-air deposit of waste material. No different is the case of the reconstruction of the section of walls that leads to the Catedral Castrense Santa Bárbara. However, other portions have had better luck, becoming an occasion for bivouac and illicit exchange (Fuerte de la Concepción). An excellent example of architectural reuse is the pentagonal bastion of San Miguel. Favored perhaps by its position and the altitude equal to the driveway, San Miguel has been transformed into a basketball court by local children. The continuous presence of young people redevelops its architecture, preventing it from being vandalized or forgotten. The neighborhood had already experienced the importance of a shrewd residential design, dating back to the 80s when the construction of a series of condominiums set back from the road had allowed the maintenance of a low portion of the walls. Unlike the Dominican case in Cartagena, walking through the streets, one can still perceive how much the defensive system is the city's identity, recognized by the local administration and citizens. Today's walls delimit access to the historic center of the city, dividing it from the neighborhoods that were born following the urban expansion of the last few years. This devel-

DOI: https://doi.org/10.20365/disegnarecon.25.2020.22

ISSN 1828-5961

Fig. 14 - Santo Domingo (on top) and Cartagena De Indias (on bottom): tourist flows and unregulated urbanization.

oped along the Troncal del Caribe communication corridor, which connects Cartagena with Turbo in Antioquia and Paraguachón on the border with Venezuela. However, the entire defensive system is accessible and can be visited along its entire route without any information tourist signs. This means that the tourist flows are not homogeneous along the whole route of the walls, generating more degraded sections. Tourists are catalyzed in the sections of walls that have been re-functionalized with commercial activities in places of socio-cultural aggregation. The Plaza del Torre del Le Reloj, the gateway to the historic city, is the stretch where the flow of people during the day is most dense. Once past the Santo Domingo bastion, the flow tends to decrease until it stops and then returns to repopulate near the Baluarte de Santa Catalina, where there are some commercial activities and where the only museum was set up along the path dedicated to fortress history. The rest of the route winds along the edge of the city, losing the capacity of tourist attraction that is found once you reach the fortress of San Felipe, which has become one of the must-see tourist destinations in the city. The two cases highlight how, to promote the entire building route, the city's historical heritage, and an analysis of the fortified system's components is necessary. This becomes an essential basis for the design of new attractive poles that can generate a network of paths for the promotion of the system, the redistribution of tourist flows, and citizen's education in the value of the historical heritage.

DOI: https://doi.org/10.20365/disegnarecon.25.2020.22

ISSN 1828-5961

Fig. 15 - Cultural exchange activities in Santo Domingo and Cartagena de Indias.

4. CONCLUSIONS

In addition to addressing scientific and cultural aspects, the two research projects had a purely educational and academic nature (fig. 15). The participation in the surveying activities of the students of the Universidad Nacional Pedro Henríquez Ureña (Santo Domingo) and the organization of a seminar involving Italian and Colombian students, researchers and doctoral students (Cartagena de Indias), motivated the interest on the topics of the fortified architecture, arousing curiosity in the representation, study, and conservation of the architectural heritage.
This condition becomes more important than ever, manifesting itself in meetings with Universities, research centers, and public institutions in Central America, especially with a view to future development, which may include joint projects with the European reality and openings and connections renewed starting from the common thread of architecture. The punctual and extensive acquisition activities and the subsequent stages of processing and returning the data made it possible to appreciate the planning, the geometries, and the links between the defensive architectures. In this sense, the drawing and survey tools are among the most valid systems of representation and promotion of monumental complexes. Urban growth and uncontrolled social evolution support the need to safeguard the historical, identity, and cultural traces, which are being lost within the city's macro development. Opening the first dialogue on the design of diversified safeguard actions aimed at both knowledge of the entire defense system and territorial promotion.

DOI: https://doi.org/10.20365/disegnarecon.25.2020.22

ISSN 1828-5961

NOTE

[1] Antonelli went to the New World for the first time, to Brazil, in 1581 with the fleet of Admiral Álvaro Flores de Valdés. However, the mission proved to be a failure due to various difficulties that arose during the long journey (see antonelligatteo.altervista.org).

[2] In 1586 the island had been invaded by the English pirate Francis Drake, who razed the city to the ground (see Sánchez Mulet E., Yoni C. 2002).

[3] The city, founded by Pedro de Heredia in 1533, takes its name from the homonymous town in Spanish Murcia.

[4] Cfr. Cabrera Cruz, A. R. (2017). El patrimonio arquitectónico y fortificaciones en Cartagena de Indias. Identidad, significado cultural y prospectiva. (Doctoral dissertation). University of Granada, Spain.

[5] In particular: a FARO Cam 2 Focus S150 terrestrial laser scanner (TLS) for the acquisition of point clouds with high precision and data quality and a mobile laser (MLS), with KAARTA Stencil technology (SLAM), for localization and simultaneous mapping and for rapid coverage of large areas. Both instruments were made available by the PLAY Laboratory, DICAr (Unipv).

[6] UAVs tools were used for aerial shots of the fortresses of Santo Domingo and Cartagena de Indias: DJI Phantom 4 Pro, made available by the Universidad Nacional Pedro Henríquez Ureña of Santo Domingo, and DJI Mavic of the DAda LAB Laboratory, DICAr of the University of Pavia. For the photogrammetric shots of the Bastion of St. Catalina and St. Lucas in Cartagena, DJI Phantom 4 Pro, and DJI Spark were used, made available by the DAda LAB Laboratory, DICAr (Unipv).

[7] The project was conducted in January 2020, on the occasion of the conference "Experiencias de investigation of the experimental laboratory Dada LAB de la Universidad de Pavia: La documentacion y mejora del Patrimonio Arquitectonico y el estudio de trabajo de Gli Antonelli en America Central" held by Prof. Parrinello at the Universidad Nacional Pedro Henríquez Ureña. The detection actions were carried out under the responsibility of Prof. Parrinello and PhD student Silvia La Placa (Unipv), with the participation of students from the University of Santo Domingo.

[8] The UAVs survey was conducted by the student Anderson Batista (UNPHU), under the supervision of Prof. Parrinello (UNIPV).

[9] In particular, two DJI instruments were used: the Mavic 2 Pro (UNIPV) and the Phantom 4 Pro (UNPHU).

[10] The photographic images have been processed with the Pix4D-mapper and Agisoft Metashape programs. The latter has proven faster and more manageable and has produced better quality results.

[11] The survey activities were conducted by the staff of the DAda LAB laboratory on the occasion of the II International Seminar SiLepArq 2019. In particular, the activities were coordinated by Prof. Sandro Parrinello, while Prof. Francesca Picchio was responsible for the survey through remote piloting UAVs, Ph.D. stud. Anna Dell'Amico was responsible for the SLAM survey and Ing. Chiara Malusardi was responsible for the TLS survey. The seminar was organized by Prof. Massimo Leserri, University of Bolivarian Pontifical headquarters of Monteria, together with Prof. Ricardo Zabaleta, University of San Buevantura and Tadeo of Cartagena de Indias. The seminar was attended by Italian and Colombian teachers, researchers, and students.

[12] Stencil KAARTA is a mobile type laser scanner based on a reworking of LIDAR and IMU data for localization.

[13] Reference is made to the open-source software Cloud Compare, and the Cyclone software from the Leica company.

REFERENCES

Bertacchi, S. (2012). *Modelli compositivi per la difesa alla moderna. L'esperienza di Giovanni Battista Antonelli.* (Doctoral dissertation). University of Florence, Italy.

Bertocci, S., Parrinello, S., & Pancani, G. (2012). *Between Est and West. Transportation of Cultural System and Military Technology of Fortified Landscapes*. Firenze: Edifir.

Braudel, F. (2017). *La Méditerranée et le monde méditerranéen à l'époque de Philippe II-Tome 3: 3. Les événements, la politique et les hommes (Vol. 3).* Malakoff: Armand Colin.

Cabrera Cruz, A. R. (2017). *El patrimonio arquitectónico y fortificaciones en Cartagena de Indias. Identidad, significado cultural y prospectiva*. (Doctoral dissertation). University of Granada, Spain.

Leserri, M., Rossi, G. (2020). La Torre del Reloj de Cartagena de Indias. Estudio sobre las transformaciones arquitectónicas por medio del Levantamiento de la permanencia y ausencia. *EGA. REVISTA DE EXPRESIÓN GRÁFICA ARQUITECTÓNICA, 25(38)*:7, 78-89.

Maggiorotti, L.A. (1939). *L'opera del genio ital. all'estero. Vol. III Architetti e architetture militari, III, Gli architetti militari italiani nella Spagna, nel Portogallo e nelle loro colonie.* Roma: Libreria di stato.

Parrinello S., & Picchio F. (2019). L*e fortezze di Portobello e del Rio Chargres a Panama. Un progetto di documentazione per la tutela del patrimonio e lo sviluppo di siti UNESCO*. Firenze: Edifir.

Parrinello, S., Picchio, F., Dell'Amico, A. & Malusardi, C. (2020). Le mura di Cartagena de Indias tra sperimentazione metodologica e protocolli operativi. Strumentazioni digitali a confronto per lo studio del sistema difensivo antonelliano. In *Proceedings of International Conference on Fortifications of the Mediterranean Coast, Defensive Architecture of the Mediterranean*, edited by Navarro Palazón, J. and Luis José García-Pulido (Vol. X, 415-422). Granada: Universidad de Granada, Universitat Politècnica de València, Patronato de la Alhambra y Generalife.

Parrinello, S., & Picchio, F. (2017). *Sistemi di documentazione per l'analisi ed il progetto di recupero del forte San Lorenzo el Real del Chagre, Colón, Panama*. Restauro Archeologico, 25(1), 54-73.

Picchio, F., De Marco, R., Dell'Amico, A., Doria, E., Galasso, F., La Placa, S., & Miceli, A. (2020). Procedure di analisi e modellazione urbana per la gestione dei centri storici. Betlemme, Solikamsk, Cattaro e Santo Domingo. *Paesaggio Urbano* (2(2020),102-115).

Sánchez Mulet E., & Yoni C. (2002). *Santo Domingo. Fragmentos de patria.* Santo Domingo: Editora Universal.

Segovia, R. (2009). *The fortifications of Cartagena de Indias, Strategy and History*. Bogotà: El ancora editores.

DOI: https://doi.org/10.20365/disegnarecon.25.2020.22