The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Volume XLVIII-M-2-2023
29th CIPA Symposium "Documenting, Understanding, Preserving Cultural Heritage:
Humanities and Digital Technologies for Shaping the Future", 25–30 June 2023, Florence, Italy

DRAWINGS FOR THE REUSE OF NINETEENTH CENTURY GREENHOUSES IN THE GARDEN OF VILLA CICOGNA MOZZONI

D. Jovanović [1]*, D. Oreni [1]

[1] Dept. of Architecture, Built Environment and Construction Engineering, Politecnico di Milano, Milan, Italy
(dina.jovanovic, daniela.oreni)@polimi.it

KEY WORDS: Technical Drawing, Villa Cicogna Mozzoni, Nineteenth-century greenhouses, Cast iron constructions, Reuse.

ABSTRACT:

The nineteenth-century greenhouses in the garden of Villa Cicogna Mozzoni are abandoned and dilapidated. Three greenhouses investigated for the research named A, B and C are positioned one above the other on the hill of the garden. They are historical examples of iron and glass structures with masonry walls leaning against the ground. They have undergone numerous modifications over time, as evidenced by archival documents. To create a preservation project for their reuse, bibliographical research was first collected. Secondly, direct and indirect surveys were carried out. The technical drawings were produced on a 1:50 scale using point clouds, orthophotos, sketches and direct measurements. Given the nature of the glass material of which these buildings are predominantly made, it was necessary to process the data obtained with the laser scanner and clean created noise points. Seemingly simple structures, greenhouses are complex buildings that require careful studies of humidity, temperature, irrigation, light and materials. For the presentation of different systems in the greenhouses, colour-coded thematical drawings were created. Detailed drawings on a 1:20 scale examine the iron fixtures and manual mechanical system of the windows. Other characteristics were presented in the drawings, such as internal and external movements and communications between greenhouses. The survey and documentation were done to serve for the reuse project which aims to bring back the shine to these greenhouses so that they can be revitalised for botanical and educational activities.

1. INTRODUCTION

Villa Cicogna Mozzoni is located in Bisuschio, province of Varese, in Italy. Listed as a national monument, this Renaissance jewel was built around 1440 as a hunting lodge for the Mozzoni family. Over time the villa was transformed into a rural *dimora di delizia*, by building new wings, decorating walls, and ceilings, expanding, and designing gardens (Wheelwright, 1914). In the nineteenth century, the villa property was enriched with the addition of new greenhouses, built according to the fashion of the time in iron and glass, allowing the cultivation of exotic and ornamental plants throughout the year (Woods and Warren, 1990). These seemingly simple structures are complex buildings that require careful studies of humidity, temperature, irrigation, light and materials. The art of making greenhouses began to occupy architects and engineers in Europe. New technologies in iron prefabrication and installation arrived at the end of the eighteenth, which accelerated the construction of larger and more complex buildings from glass. Although they were used for growing food, in the past greenhouses were considered an important decorative element in public parks and private gardens, as a symbol of prestige and technological progress.

The three investigated greenhouses of Villa Cicogna Mozzoni, greenhouses named A, B and C, are positioned on the southeast side of the hill towards Monte Rho where the garden in English style continues, while other greenhouses will be investigated subsequently (Figure 1). They are historical examples whose columns were made of cast iron to support glass roofs resting on masonry walls (Cogni, 2019). The ICOMOS-IFLA The Florence Charter for the preservation of historic gardens (ICOMOS-IFLA, 1981) states that the architectural and decorative components are an undividable part of the garden and their features need to be preserved. The composition of historic gardens consisting of natural and built elements needs careful studies for their preservation according to their natural settings. Nowadays, historic greenhouses are unique building typology that witness an evolution as cultural heritage through two distinct fields of architecture and botanical gardening.

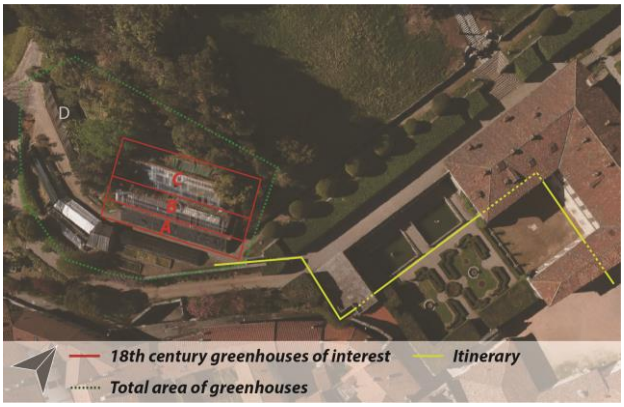

Figure 1. Location of the greenhouses area and position of the three greenhouses A, B and C (Source: http://www.ghelfi360.com/19/cicogna/, elaborated by Authors).

The historical reconstruction of the various fabrication events that have led to the present configuration of the Villa's greenhouses is complex and unclear. As is often case with the buildings of "minor" importance, which are built solely for practical purposes, accurate descriptions and drawings are hard to find. Their executions were often left to the site practices and capabilities of masons, workmen, and blacksmiths. Therefore,

* Corresponding author

in cases like this, it is essential to directly survey the buildings. Investigating geometry and materials and comparing them to the fragmented and scarce information that can be found in the archives, is the only way of documenting these complex historical buildings. The activity of surveying, knowledge collection and investigation of the structures, becomes an indispensable and fundamental tool for reconstructing the history of these buildings. Although they appear to be very simple, on the contrary, they are as delicate and complex for preservation projects. Currently, they are in disuse and poorly maintained, therefore survey and documentation carried out will be used for their reuse.

1.1 Historical Notes on the Construction of Greenhouses

The first detailed drawing of the garden of Villa Cicogna dates back to 1813, the year in which the plan called *Tipo dimostrante il Celebre Giardino e Palazzo dell'Ill.mo Sign.r Conte Franco Leopoldo Cicogna Mozzone* was surveyed and depicted by Della Besta Giacinto being *Agrimensore e Geometra*. The land that is now occupied by the greenhouses, known also as 'the hill', was covered with meadows, vines, and fruit trees (on the map, No.33 this reads *prato vitato con frutti*), at the base of which was a 'lemon house' (No. 24) for 'citrus fruits and flowers' and a 'small garden dug into the massif for flowers' (No. 25). Toward the north, on the boundary of the property, connected to the gardener's house (No. 30), there was a 'little house for sheltering flowers' (No. 26) which is the Villa's first greenhouse that no longer exists today (Figure 2). In historical documents from the Historical Archive Cicogna Mozzoni of Bisuschio (A. C. M.) are mentioned some minor maintenance works done on the *Limoniera* in 1853 and 1854.

Figure 2. Left: *Tipo dimostrante il Celebre Giardino* from 1813 (Source: A.C.M). Right: Detail of the Census Map of Bisuschio from 1898 (1:2000), with the indication of *Acquedotto Cicogna* (Source: Archivio di Stato di Varese). The space of the greenhouses is marked.

The *registri contabili* (accounting records) dated November 30, 1872[1] show the payments made to the masons and apprentices who had worked on the new construction of the 'flower house'. Some undated design drawings, in *braccia milanesi* measurement units, preserved in the family archive, could perhaps refer to this greenhouse. The plans show planimetric character, typologically similar to the present greenhouse A and B, considered as a part of a single structure. Nevertheless, they differ considerably in elevations and materials (e.g., brick masonry, wood/brick roofing and glass dimensions) with the absence of the internal longitudinal staircase. However, it is the design of the interior space, with the central circular element, that refers to the current plan of the greenhouse B and arouses great curiosity; today that circular element presents a spiral staircase connecting two levels, unlike the design drawings, in which the staircase has a longitudinal course, and it was located adjacent to the masonry back wall. Whether this is a design study that has never been carried out or a past greenhouse in the same location, can only be hypothesized through the research. Nonetheless, the presence of masons in the 1872 construction site would be consistent with the materiality of the buildings presented in these project drawings, which are mostly made up of masonry walls (Figure 3).

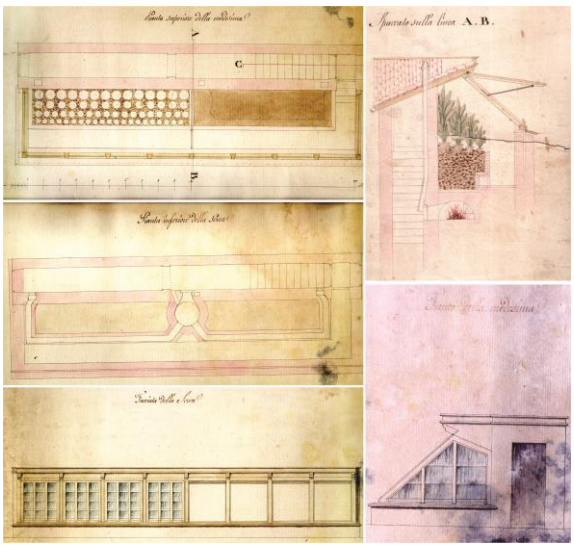

Figure 3. Undated drawings of the project for a greenhouse of Villa Cicogna Mozzoni, location and author unknown. (Source: A. C. M.)

Other archival documents from 1883 dated September 9, report the payments made by the owners of the Villa for the construction of an 'iron greenhouse'. It is not clear which greenhouse was referred to or whether it was a new project or a redevelopment of an existing building. The details extracted from the 'Bisuschio Census Map' of the *Catasto Lombardo Veneto* from 1898 shows greenhouses A and B in a plan layout similar to the present one, although the lower greenhouse (A) appears to be shorter. The 1922 plan 'The Villa Cicogna at Bisuschio' presents four or the present greenhouses, including A and B together with some open planters (Figure 4).

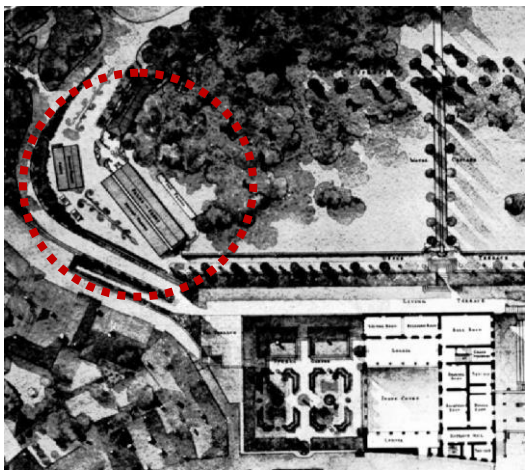

Figure 4. Plan from 1922 'The Villa Cicogna at Bisuschio' showing the greenhouses A, B and D (not part of this research), and across them open planters (Source: A. C. M.).

[1] Source: *Altri Registri contabili. Quaderni dei conti del fabbro*. 1852-1875, 414 (A. C. M.)

Photography from the 1910s demonstrates a very different exterior configuration of greenhouse B from the present one. It shows a gabled roof, smaller dimensions and changed glass design, and doors that could be opened on the terrace. Following are photographs taken in the 1940s, that present the same situation and highlight the front characterised by opening glass doors, which no longer exist today (Figure 5). The drawings from 1952 on the scale of 1:50 display the actual state of the greenhouses in those years and were accompanied by thermal calculations. The presentation of the façade and the inclination of the glass roof show a similar situation of greenhouse B compared to the present one, dating *post quem* the replacement work of the external panels, therefore carried out between the 1940s and 1950s. In recent times, interventions carried out on these greenhouses have been limited to maintenance works. To this date the greenhouses are mostly unused and in very poor condition: much glass is missing and metal frames are largely oxidised (Figure 6).

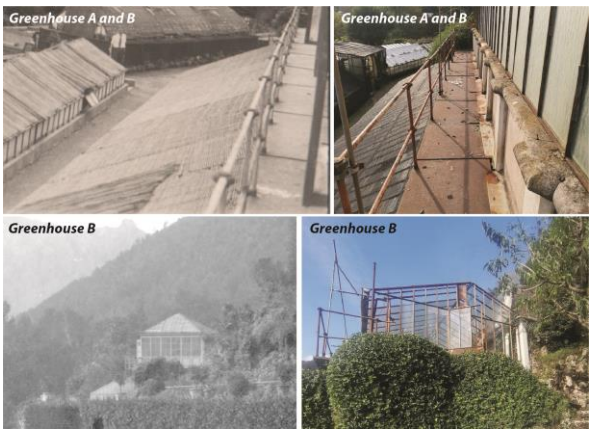

Figure 5. Above: The greenhouses A and B, historical photo from the 1940s and today (Source: A. C. M., Authors). Below: The greenhouse B, historical photo from 1910s and present (Source: A. C. M, Authors)

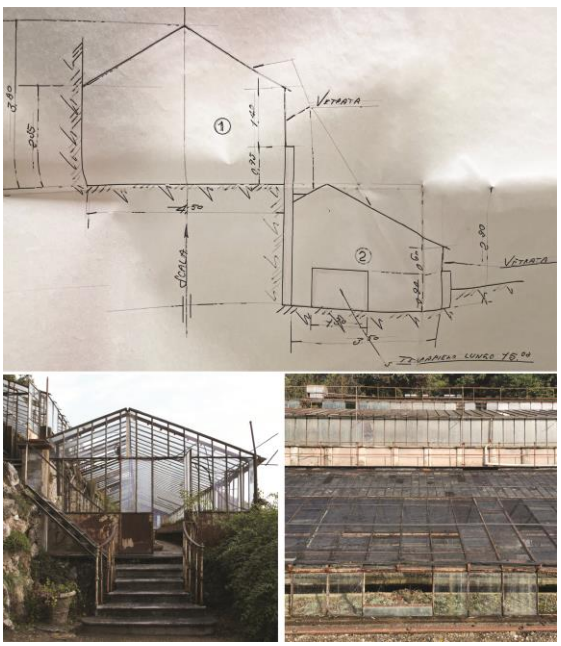

Figure 6. Above: The 1952 survey of greenhouses A and B (Source: A. C. M.). Below: The current state of mentioned greenhouses (Source: Authors).

1.2 Related Projects and Recommendations

A major part of historical greenhouses in Lombardy was in disuse. Due to the lack of maintenance, these structures lay abandoned in the gardens of villas without any function. In the past years, there were several initiatives and projects which aimed to bring back the new shine to greenhouses, introducing new activities and functions for their better adaptation to modern requirements. Greenhouses are buildings with suitable light conditions and often elongated-shaped plans, they can be converted into multipurpose spaces that can serve the public. Examples of nineteenth-century greenhouses and their revitalisation projects are important to analyse, thus contributing to the proposal for the reuse of the Villa Cicogna greenhouses.

The project of requalification of the park and greenhouse of Villa Fedora in Baveno, provided examples of potential revitalisation activities. The villa was finished in 1857 and greenhouses were in the last decade of the nineteenth century. One of the rare examples of greenhouses located in the public gardens on Lake Maggiore. The curvilinear roof is resting on the masonry wall and the central part is interrupted by the volume with three large windows and a terrace on the flat roof. It has an intrinsic cultural heritage value which will be brought back to the community after the completion of the works. The space has been imagined as multifunctional, capable to host various activities for all age groups, from educational workshops to exhibitions and small conferences.

Another example of a project in development is the reuse of greenhouses of Villa Olmo in Como. The project aims to reuse these currently abandoned spaces for educational activities. They were constructed during the renovation of the villa, starting in 1883, by the design of the architect Emilio Alemagna[2]. Constructed of iron and glass, by the style, size and planimetry resemble the ones of interest for the research paper. Although there is no information in the archives about who built the greenhouses of Villa Cicogna Mozzoni, in the related bibliographic sources two important Lombard architects are mentioned: Emilio Alemagna and Giuseppe Balzaretto. The works on the gargantuan funeral chapel of the Cicogna Mazzoni family started in 1860 by Balzaretto which Alemagna finished in 1867. Moreover, there is a certainty that Alemagna built the Municipal House in Bisuschio in 1862 (Cogni, 2019). These two architects, Alemagna who previously studied prefabricated iron structures and systems for heating, plumbing and electricity, and Balzaretto, a neoclassical architect famous for designing English gardens, together created many important projects (Luna, 2022). Both central greenhouses of Villa Olmo and Villa Cicogna Mozzoni have spiral staircases positioned in the middle of the plan and aligned with the water fountain, they also share the similar appearance of the iron terrace balustrade and the use of the same materials. They have the same aperture system and, in most places, the iron profile of the window frame. The major difference between these two greenhouses is the proportion and position of doors and windows.

In the past, other projects were successfully conducted. In 2018 the greenhouses of the Museum Meina on Lake Maggiore were reopened to the public after sixty years of inactivity[3]. They were built in the park of Villa Faraggiana at the end of the nineteenth and beginning of the twentieth century, by their

[2] *Villa Olmo.* https://www.villaolmocomo.it/serre/
[3] *Museo Meina di Villa Faraggiana.* https://www.museomeina.it/serre-di-villa-faraggiana/

position and characteristics they are unique for this territory. However, they have a system for opening windows, iron fixtures and levers similar to that of Villa Cicogna, due to the prefabrication of widely used iron elements. Today the greenhouses host botanical exhibitions, educational-laboratory activities, and other cultural events. A similar example is a mid-nineteenth-century greenhouse of the Villa del Grumello on Lake Como, which was recovered in 2012, enhancing the relationship between environment and landscape. The project implemented a new air conditioning system which allowed the use of the space throughout the year for various cultural events and workshops [4]. The early twenty-century greenhouses situated in the Garden Margherita in Bologna were transformed in 2014 into a creative HUB, which includes cultural and commercial activities, a kitchen, a coworking space and vegetable gardens. Furthermore, they are promoting activities for children and adults, encouraging them to live sustainably[5]. Not all the revitalisation projects turned greenhouses into multimedia and didactic function. The impressive Liberty-style greenhouses of Villa Visconti Borromeo Litta in Lainate were restored in 2016 and continue to attract public attention while retaining their initial purpose of protecting orchids from weather conditions[6].

These examples, like many others in Europe, are demonstrating that the restoration of greenhouses is mainly related to their functional changes, rather than to the spatial organisation. The projects focus on the alternation of the greenhouses for three main uses: maintaining their past function, proposing a new botanical activity, or providing multifunctional space. The requirements for their preservation and repurposing are demonstrated across Europe, sustaining their past aesthetics and meanings (Belousova, 2020). To survey, evaluate the current state and propose a new function for the greenhouse, the guidelines and recommendations were developed. They are providing a set of standardised approaches to follow for the investigation of these complex structures.

The 'Guidelines and Technical Standards for the Restoration of Historical Gardens' developed by the Italian Ministry of Culture and APGI[7], have included greenhouses as particular historical-artistic artefacts present in historical gardens and parks. The general norms describe methods of direct and indirect survey (e.g., laser scanner and photogrammetry) for the production of technical drawings on a scale of 1:50. The survey has been divided into five parts which include architectural survey, infrastructure, water elements, decorative and furnishing survey, and installations. The graphical representations should have a reference to the specific materials that are important for the restoration work of these historic buildings. The data collection consists of information on fixtures, doors and windows, metal furnishings, and everything concerning the use and function of a greenhouse. In addition to the architectural and structural surveys, the heating and ventilation systems must be documented (Gruppo di lavoro, 2021). Following these recommendations and standards, the research study was performed.

[4] *Villa del Grumello.* https://www.villadelgrumello.it/luogo-2/luogo/serra/

[5] *Le Serre dei Giardini a Bologna.* https://leserredeigiardini.it/chi-siamo/

[6] *Parco Storico di Villa Visconti Borromeo Litta.* https://www.villalittalainate.it/page.php?id=21&title=Parco%20Storico

[7] *Associazione Parchi e Giardini d'Italia* (Engl. Italian Parks and Gardens Association)

2. METHODOLOGY

2.1 Indirect and Direct Survey of Greenhouses

The indirect survey of nineteenth-century greenhouses was done with the laser scanner FARO 3D CAM 2 Focus. In total, twenty-two scans were obtained in the first survey of three, the oldest, greenhouses of interest and forty-three in the second survey of remaining greenhouses, on which the focus will be in the next period. They were later manually registered in ReCap Pro using checkerboard and sphere targets. The survey of greenhouses, which predominantly have glass, results in the creation of noise points due to the properties of the material and the proximity of one glass plane to another. The diffraction of laser beams as they pass through transparent surfaces gives inaccurate results. There were several research proposals to solve the issue of the instrument and prepare the space for surveying, but they are not dealing with glass buildings, and therefore these approaches would not be suitable for this case study (Käshammer and Nüchter, 2015; Valero et al., 2022). Nevertheless, there are two simple procedures in ReCap Pro for reducing noise in obtained data to improve the visualisation of the details. Firstly, applying the 'aggressive option' while importing the scan files can eliminate some of the points which are not part of an object or a surface. Secondly, by using the 'plane' tool that allows a selection of surfaces manually, and after clipping them, unwanted noise points can be deleted (Figure 7).

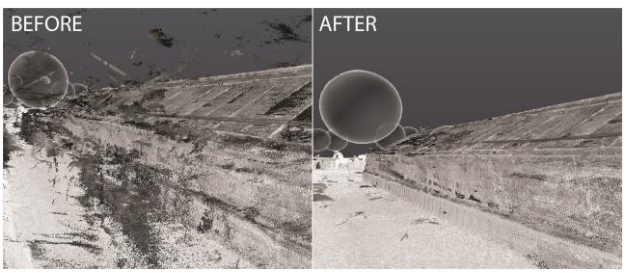

Figure 7. Points are creating noise because of the properties of the glass material. Cleaning these points is crucial before using a point cloud for technical drawings (Source: Authors).

Photographic material has been divided into two parts. The first regards documentation of details, surroundings, and used equipment and the second part that concerns photo acquiring for the application of photogrammetry techniques. The software Agisoft Metashape Pro was used to texturize mesh models and build dense point clouds to finally obtain orthophotos. The environment (i.e., very bright interior, reflecting and transparent surfaces, overgrown vegetation) and typology of these buildings presented a constraint in creating complete orthophotos. For the glass surfaces and iron elements, direct measures were taken and photographs are acquired, while the orthophotos were reserved for other features made from non-transparent materials, such as iron or stone, with a distinguished geometry (Historic England, 2011). The orthophotos were produced for some of the particular decorative and furnishing elements, mechanical systems for opening the windows, and cast-iron staircase railings columns. The brick masonry wall inside greenhouse B is covered with spongy tuff stones with playful black stone lines imitating the vines. The pavement is decorated in white and black pebbles, imitating the vine with leaves, going around in an elongated oval shape on the whole plan. Photo acquisition, direct measuring and hand sketching were done *in situ*. This approach is following the guidelines for surveying greenhouses

and their decorative finishing features, by mapping materials, colours, and damages (Figure 8).

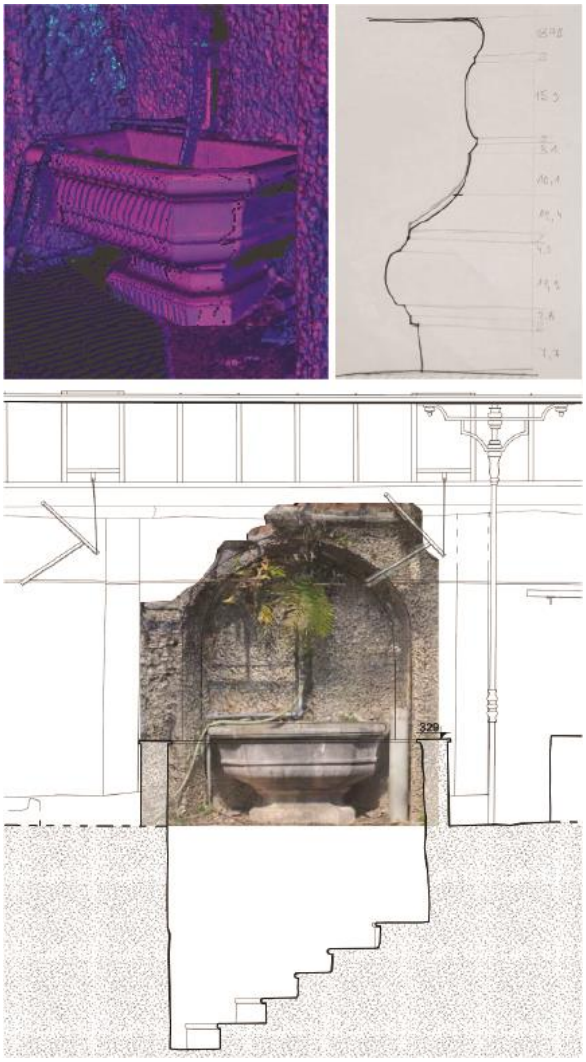

Figure 8. Orthophoto created in Agisoft Metashape was integrated into a technical drawing to show different materials. Sketches and photographs are helping in the creation of better drawings (Source: Authors).

Technical drawings were produced on a scale of 1 to 50, examining the plans, sections, and elevations of the three mentioned buildings. The first greenhouse (A) below the ground level is directly connected to the one on the first floor (B) by an internal spiral staircase in the middle of the plan. The third glass house (C), the highest situated on the hill, is situated above the second one (B) with access from the external staircases on both sides. The drawings were made with the point cloud, drawings and direct measures obtained on the site.

2.2 Characteristics of Greenhouses: Structure

The nineteenth-century greenhouses in Europe were made of glazed roofs with ridges, columns in cast iron, spiral staircases, and decorations in the manner of eclecticism (Maggia et al., 2002). The study of the main technological elements is important for the description of greenhouses: main structure, degree of inclination, glazing, heating, cooling, and shading systems (Neumann, 1846). All three are linear-type greenhouses with uneven spans and cast-iron structures. There are recognisable changes in the structure, glazing and organisation of all three greenhouses, but except for the photographs retrieved from the family archive, there are no other technical drawings, plans or descriptions of alterations on these buildings. Certain hypotheses can be made based on the dimensions of elements and systems applied.

The smallest and presumably the oldest greenhouse A is 3.5m wide and 22m long with a total of approximately 75 m2. From here is possible to reach upper ground greenhouse B with the central spiral staircase, which is 4.5m wide and 22m long being approximately 100 m2 large. The biggest greenhouse C, and probably the most recently built compared to the other two, has a surface of 110m2, slightly shorter because of the west staircase making it 19.5m long but 5.5m wide. This is the only greenhouse on three levels accessible from the internal central staircase, which makes the movement and distribution of the plan different from the previous two.

Roof inclinations are one of the most important and delicate points in designing greenhouses, where the geometry of the roof can capture more or fewer sun rays and heat, depending on the slope it makes with the horizontal line. Moreover, inclinations are predetermined by the position, local climate, and type of plants preserved in the greenhouses. Greenhouses B and C have inculcation of around 20° to 22° degrees while building A inclines 26°. These are average inclinations, suitable for dry and humid hothouses, preserving the medium size plants, such as orchids and other flowers, often held only in individual pots (Loudon, 1817). The form and orientation of a greenhouse will determine their use and movement inside these buildings, suitable to keep plants and perform botanical activities. Respectively in all three greenhouses, movement is different due to their distinguished characteristics (Figure 9).

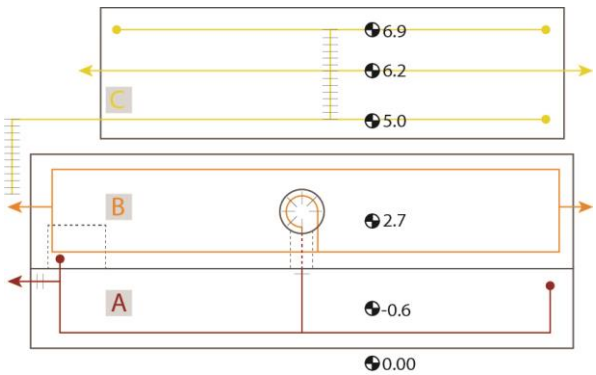

Figure 9. Accessibility and movement in three greenhouses of interest. Entrances (arrow), paths (circle) and staircases (lines) are marked (Source: Authors).

Three buildings are made from cast iron frames and glass, while on the back are supporting masonry walls. Greenhouse B has structural columns supporting the roof ridge which are sometimes used as rainwater pipes, connected to the gutters on the top (Hix, 1996). Comparing the photographs from the 1910s and 1940s, the iron frame structure and glazing have been changed in the past, but there are still shreds of evidence of the past glazing positions. Due to technology and cost, older glass panes are smaller - like in Greenhouse A where they are approximately 25cm by 64cm. Greenhouse B has different glass size ratios - on the south façade, glass panes measure 38cm by 110cm, while on the north façade are 28cm by 112cm. In the last, the highest positioned greenhouse, the windows have different arrangement, not symmetrical organisation on the

entrance sides (i.e. shorter side) The observations lead again to the conclusion that this greenhouse was added the last. These glasses have 50cm and more wide frames, with 1m in height. To prevent water from penetrating between two panes of glass, thin lead blades were used as a sealing effect, to which special resins up to four or five millimetres thick were subsequently added (Tod, 1823).

2.3 Characteristics of Greenhouses: Systems

Various systems are integral parts of the functioning of a greenhouse. Heating, irrigation, cooling, shading, and water systems are carefully designed to provide optimal ambience for plants. The archive documents state that heating tubes were installed in 1883, positioned along parameter walls under the shelf counters. The nineteenth century brought innovations in cast iron construction, providing more sunlight on the inside, but also it adopted novelties of heating systems by hot vapour or water. These centralised heating systems allowed the creation of a suitable microclimate for growing plants (Manfredi, 2013). In 1952 another archival document is referring to the project of the implementation of an electro-burner for dense naphtha with thermosiphon. Thermal calculations were done (calories per hour for each greenhouse) to size the heating system with natural circulation radiators with the external boiler. This system can still be visible today. It ensured the preservation of a minimum temperature of +8℃ in greenhouse B (until the 1970s was used for orchids) and + 15℃ in greenhouse A.

To regulate the heat, some windows can be opened to provide air circulation. In greenhouse B they can be found on the façade and on the roof where every sixth roof window is connected with the rope to the cylinder with a handle situated next to the north entrance (Figure 10). In greenhouse A, façade windows can be opened using comb-like polls with a push system which can determine the level of aperture, while all roof windows are fixed. In the third building, the roof window can be opened only in the middle of the greenhouse, using an iron bar with a joint system. Every fourth window on the façade on the southeast façade can be moved with another type of iron pull-push system, adjusting the levels of the aperture.

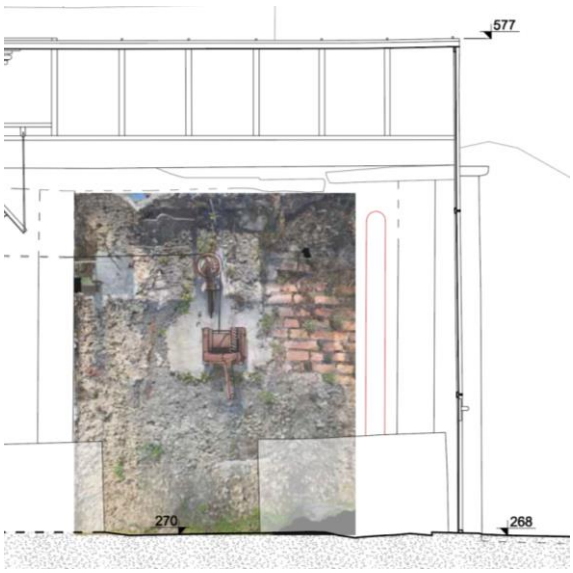

Figure 10. The system for opening the roof windows in greenhouse B, technical drawing and orthophoto (Source: Authors).

To protect the plants from direct sunlight and glass from the weather conditions such as hail and rain, there was a system of arranged wattle rolls anchored to its top and manoeuvred by a worker from the walkway along the roof’s ridge protected by an iron balustrade or, as in the case of the greenhouse A, terrace above. In the photographs from the 1940s shading system is visible. Today, these panels are substituted with the PCV grid, but all iron elements that held the rolls, detached to the iron window frame are still present, testifying to the past shading systems. The creation of ridge on the roof, support columns in cast iron, spiral staircase, and decorations in the manner of eclecticism, became the standard practice spread throughout Europe, including Italy.

3. TECHNICAL DRAWINGS

Technical drawings were used as a traditional tool to describe and document cultural heritage for many centuries. Although they are 2D graphical representations, they are also a system of knowledge which can immortalise heritage. In the case of investigated greenhouses, where the structure seems thin and fragile, the exterior and interior are exposed to the influences of the weather, due to the lack of glazing, and buildings are slowly absorbed by the overgrown vegetation, technical drawings are necessary for the preservation of their unique character. For this research, technical drawings were produced on a scale of 1:50 as a standard practice for surveying and presenting cultural heritage. Special attention is paid to systems for opening and closing the windows, heating, and water features, which were later drawn on a scale of 1:20. The cast iron joints and fixtures were surveyed through the point cloud, hand drawing and direct measuring. The technical elaboration of these elements is important so that they can be appropriately documented and catalogued for further projects of preservation and reuse. Longitudinal and transversal cross-sections were done for all three greenhouses to better study their interconnectivity, and position on the hill and individual structural elements. Additionally, plans were produced respectively, emphasising the geometry of the greenhouse, internal movements, and planting spots (Figure 11).

Italian guidelines for surveying and documenting buildings which are an integral part of the historic gardens, state that producing technical drawings presenting buildings of interest needs to be accompanied by the description and survey of all communications, internal and external. The staircases and paths connecting different levels were studied and documented. External connections which are incorporated into nature and are part of the design of the garden are presented in the plans and sections, providing an understanding of movement in the garden and between greenhouses. The study of the accessibility, entrances, passages, and visual perceptions enhances the experience of the garden in the particular setting of these buildings. The main characteristic of greenhouses, being transparent with many glazed surfaces, subsequently indicates that they have a strong link with plants that are kept inside and vegetation that surround them, thus surrounding investigation is taken into consideration while making drawings of the current state for their future preservation.

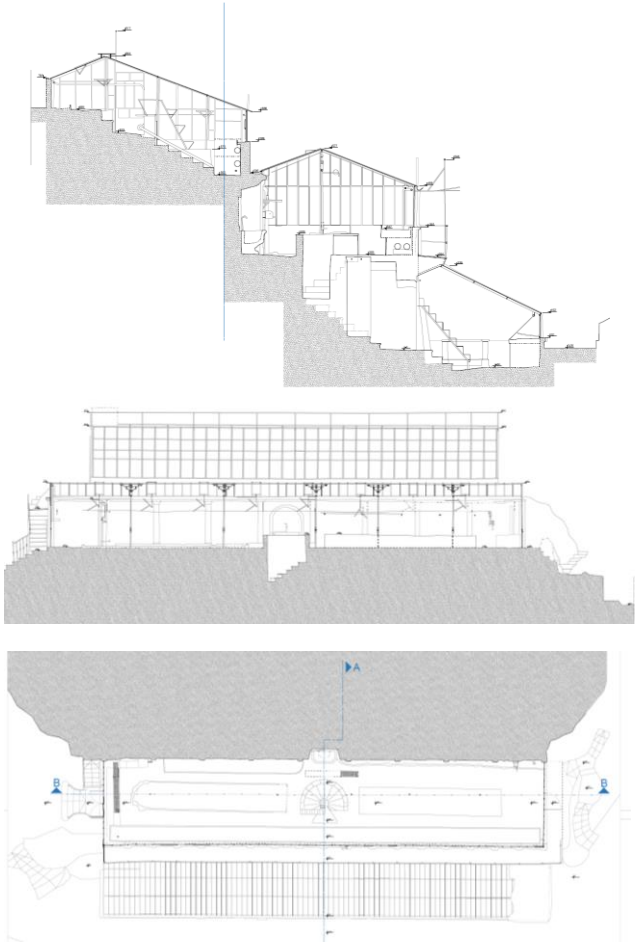

Figure 11. Technical drawings of greenhouses. Above: Transversal section through the greenhouses A, B and C; Middle and below: Longitudinal section and plan of greenhouse B (Source: Authors).

3.1 Details and Thematical Drawings

Iron fixtures and structural systems are complex to understand and document. Often because of their characteristics, they are only partially surveyed with the laser scanner. Here the crucial importance has photographic documentation, direct measuring, and sketching. To be able to understand iron intersections, which are now oxidised and covered with various types of decay, an in-depth study is necessary (Figure 12). Along the structure of the investigated greenhouses, not all the elements are the same and they should be treated separately.

Observing the systems like heating, cooling (i.e., windows that can open), staircases, and communications it was possible to make ‘thematic drawings’ which are colour coded. This is particularly useful when the structure is made of other iron or glass elements which have different properties and highlighting them with different colours makes the drawing reading easier (Figure 13). To be able to produce knowledge-based and scientific-analytical drawings within the measurable system, the part of the artistic drawings or documents was used. This means that the historical study through photographs, illustrations, and paintings, were considered as important to date changes done on the greenhouses, differences in style and systems used, so they can be included in the thematical drawing. Moreover, they can give a perception of past uses of the space and the quality of the surroundings. This is valuable when the restoration projects need to take place, deciding on a precedency which elements need special attention to be kept or, for those added later that changed the initial aesthetics (e.g., PVC pipes, cables, knock-together solutions, etc.), to be removed, to enhance perceptive and functional qualities.

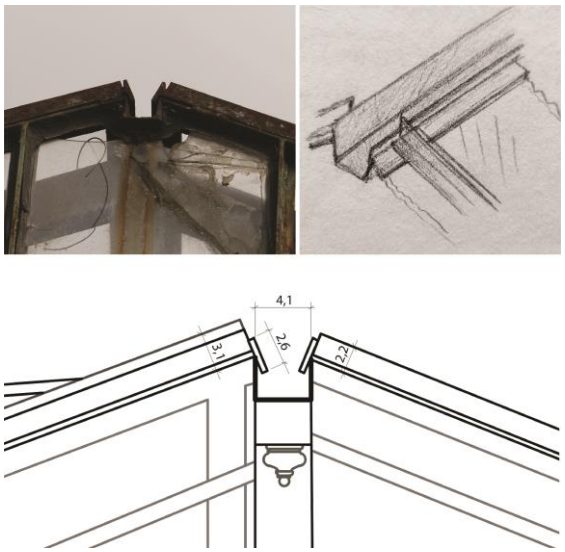

Figure 12. Roof ridge of greenhouse B. Detail of the fixture and iron glass frame (Source: Authors).

Figure 13. Thematical technical drawing. Detail of the longitudinal section of the greenhouse B. Colour scheme distinguishes different functional elements (Source: Authors).

4. CONCLUSIONS: CONSERVATION AND REUSE

The particularity of the structure of a greenhouse (e.g., materials, exposure, ventilation, etc.) does not allow completely free choice of a new or combined functions. The project for conservation needs to start with the analysis of specific features of these buildings and studying their relationship with the context to be able to suggest a compatible use. Therefore, there is a need for sustainable interventions to which knowledge is a fundamental and initial point. Although technical drawing is the most common tool, it can serve as a knowledge system to valorise these complex structures.

Greenhouses are generally used as a service object, and there is little attention paid to their preservation. Since they are part of the historic gardens and are located in an area of natural cultural heritage that is constantly changing, the approach for their enhancement and maintenance needs to be different than for-

other types of buildings. A small number of nineteenth-century greenhouses that remained in Lombardy were regarded as ‘minor’ buildings and there is no vast amount of information on their construction changes. To indirect and direct surveys of investigated greenhouses historical research was added, as an integral part of the preparation of technical documents for reuse. Various historical maps, photographs, and written documents were consulted to formulate hypotheses on remaining elements of the past. Learning for related projects of preservation of greenhouses, the qualities of a greenhouse should be taken into consideration and should not lose its primary purpose of housing plants, as a priority of the projects is to secure that the building remains an element of the garden where it is situated. By their architecture and materials, they are particular objects, with large amounts of light, which should be used to bring back the initial functions. Many greenhouses are transformed into multifunctional spaces which can host a variety of activities and where interior design and architectural values can come to the fore without altering the space form. Moreover, the greenhouses are influenced by the type, size, and life cycle of plants they are made for and restoring, at least partially, the combined purpose of these buildings will contribute to the enhancement of their cultural values and original use.

The greenhouses of Villa Cicogna Mozzoni are mostly abandoned or partially used for the winter shelter of potted plants. They were used until the 1980s for the cultivation of orchids. The comparison between drawings and documents from the archive, the 20th-century photos, and the conducted survey highlighted a series of transformations that have taken place from the 19th century to today. The detailed analysis of the construction systems, iron fixtures and installations, allows us to partially reconstruct the history of these buildings. This is fundamental for thinking and planning an intervention for the conservation and reuse of greenhouses. The owners intend to repurpose these spaces for the creation of multifunctional classrooms for children to be used mainly for botanical educational activities and workshops. There are examples of fundraising activities made to collect donations and bring these peculiar structures closer to the community. They demonstrate the opportunity to present the greenhouse, becoming an essential part of experiencing the garden that will contribute to its active maintenance (König, 2022).

Furthermore, extensive material tests need to be done to control the structural condition. Existing levers and mechanisms for opening roof and façade windows should be restored to their full functionality. Glazing and heating system can be substituted with modern ones, to raise the efficiency of the whole building, and create pleasurable ambient for new functions. Potentially, the BIM can be created from the existing technical drawings and point clouds, which is beneficial for documentation, 3D visualisation of iron fixtures and systems, and additionally, to calculate the energy efficiency.

ACKNOWLEDGEMENTS

We express gratitude to Jacopo Maria Mozzoni Cicogna, that recognised the importance of greenhouses on his property, shared archival material with us and proposed their further reuse. There has been signed a research contract between scientific supervisor Prof. Daniela Oreni from Politecnico di Milano and the Foundation ‘Maria Cristina Cicogna Mozzoni ONLUS’ for the study, analysis and geometric survey of the nineteenth-century greenhouses of Villa Cicogna Mozzoni. Additionally, we want to thank Professor Branka Cuca for her engagement and help in the first part of the survey.

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