

Towards a catalogue of Sardinian WWII Heritage. The protection of Quartu Sant'Elena and its territory

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Abstract. The essay shows the results of a research aimed at building a digital database of Sardinian military architectures of Second World War. Following an activity of knowledge and cataloguing entrusted to digital survey methods already employed in other case studies, this contribute analyses the IIWW heritage placed in territory of Quartu Sant'Elena, a centre close to Cagliari in the south coast of the island. Many examples of these "sentinels" are positioned along the coastline and the country road and within the actual urban context; these architectures follow the indication of design models indicated by the archival documents using square and circle shape often modified and adapted to achieve a complete mimesis in the landscape that host them. In our case study we found bunkers that seems little churches, houses and water tanks located in a restricted area close to the *Simbirizzi* lake, in which an integrated (direct, instrumental, and photogrammetric) survey has been carried out.

1. Sardinian II WW military heritage and its protection.

The fortifications (bunkers and batteries) erected during the Second World War and the network of defensive architecture built from the 16th to the mid-18th century characterise Sardinia's coastal landscape. Both are at the same time an architectural, landscape and cultural heritage, as they bear witness to our past; however, while the coastal towers are protected and the subject of major restoration and enhancement works, the bunkers - apart from their inclusion among the identity assets identified by Sardinia's PPR - are not involved in enhancement programmes, even though they represent the oldest ruins of reinforced concrete in 20th century modern architecture [1].

This system of small bunkers shows similar criteria of design, position, functionality, and materiality with the "network of sentinels" erected by Christian kingdoms in the Modern Age (16th-18th centuries) for the defence of the Mediterranean coast. However, the differences between the two design experiences are evident since the towers have strong volumes that emerge from the profile of the terrain while bunkers and batteries (although with similar geometric models) are mimetically integrated with the topography of the places where they are located. Both are a design expression of considerable interest and quality, the result of the application of the most modern construction techniques of their time, functional pieces of a complex system of territorial control, industrial models in reinforced concrete that are almost indestructible, so much so that, despite their abandonment, they resist human neglect and the fury of the elements thanks to their constituent material: natural or artificial stone.



These contemporary sentinels are still present, silent, and immobile along the sandy coasts and the edges of the ponds, apparently still guarding the isolated creeks and rural routes, controlling the communication routes of land and sea, hidden and intent on scanning the sky.

Their presence does not cause a disturbance in the perception of the landscape, its forms, and its signs, and we can accept the presence of these architectures because we consider them a piece of the land; this is because they are objects designed to become part of it, placed in the places that man has occupied to watch over and defend the territory, the same positions that he would reoccupy today for the same reason. Their preservation and maintenance can lead to a different reuse from the original one, that of witnesses to an age of madness, transforming them into terraces and balconies with panoramic views of land and sea, or even privileged observation points for the nature, geology, fauna, and flora of these places. These concrete construction sites can become guardians of their landscapes.

Their position, mostly along the coastline or intelligently inserted into the contours of the land, makes the bunkers and batteries the most significant stages in the rural and coastal landscape, which acquires personality and is embellished by them through the use of forms that tend to blend chameleon-like with it.

Therefore, today, in an era of sustainable progress and recovery of the historical built heritage, perhaps the time is right for these architectures -so anchored to the territory as if they were a part of it- to be reused as places of observation that scanned the horizon; a horizon inhabited by armies of people who now cross it without a conquering spirit. In order to lay the foundations for a reuse, it is necessary to define a complete cognitive framework of the existing heritage with a cataloguing work that has already provided results under the historical-cultural aspect [2] and their census [3,4] and under the architectural-landscape aspect in the most recent period through a research involving Spanish researchers and the heritage inherited from the Civil War (1936-1939). The case studies of Bosa and Cagliari [5,6,7,9] are followed by the present contribution, which focuses on the survey of works carried out in the territory of Quartu Sant'Elena, an important urban centre near Cagliari.

2. A digital database for knowledge and enhancement. The territory of Quartu Sant'Elena

Analysis of historical cartography, survey of existing structures and cataloguing of dimensional, constructional and landscape characteristics are some of the steps required for correct cataloguing [9] of remaining constructions. As for the case studies already dealt with, the IGM-based maps constitute an important documentary source that precedes the field operations. An initial check reveals that the planning of the network of small reinforced concrete bunkers was aimed at protecting the inhabited centre of Quartu Sant'Elena along the coastline (fig. 1) and along the main communication routes with the territory. These are mainly small-scale architectures, designed starting from the models provided by the Genio Militare, and adapted to tactical needs and mimesis. The latter necessity determined the creation of unique design solutions and thus the interest of the research. Rural houses, reservoirs, small religious buildings are some of the uses that these small defensive architectures "seem" to have; solutions that we find in the countryside of Quartu Sant'Elena near Lake Simbirizzi and along the communication routes between the urban centre and the cultivated fields to the east.

On the other hand, the models built along the coastline, ready to oppose an Allied landing, propose simpler models that combine circular or quadrangular shapes (also different from those indicated in the archive documents) with the only exception of particular interest represented by the reuse of the ancient Carcangiolas tower on the Poetto beach and the Diana *nuraghe* in the locality of Is Mortorius.

The variety of solutions and their grouping into sectors also directs the operational procedures in the field, which suggest the creation of several compartments; the first is that of Lake Simbirizzi with 24 bunkers located along a north-south axis that runs from the hills of Pitz'e Serra to the sea and is the subject of this contribution.

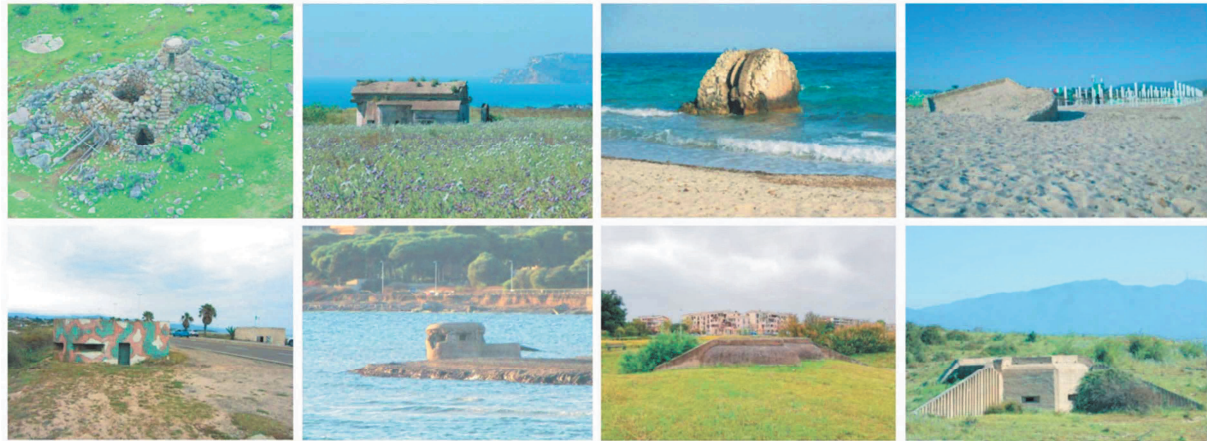


Figure 1: A selection of images of bunkers in the Quartu Sant'Elena area.

2.1. Creation of the digital database

At the moment there is a lack of attention for the Sardinian military architectures of Second World War, with a subsequent lack of planning for their preservation and valorisation. For this reason the first and the most important step of the research is to create a tool –the digital database– to support the process of knowledge about these “lost architectures”, in order to highlight their important rules in the characterization and understanding of the landscape they were built in.

To this aim it is necessary to identify what kind of data is needed and which tools can be used to achieve the desired results. In this case the information has to be such as to provide a description as complete as possible of every single object as well as their relations with the landscape context. Necessary information includes dimensional and geometric data, materials, state of decay, the geographic position and other points of interest near the single bunker (fig.2).

A well-established tool for collecting, managing and analysing data is surely that of relational databases, which are capable not only of containing the various data but also their links. In particular, involving spatial data and objects, and because of the need to carry out spatial analyses, what is needed is a geodatabase. Nowadays, there are numerous tools for creation and management of geodatabase, such as GIS instruments or DBMS (DataBase Management Systems).

With a view to the future communication of information to a wider audience, it was decided to use tools that are as flexible as possible, in order to allow future implementations that may allow the use of online tools such as WEBGIS platforms. For this reason, it was decided to create the database through the tool PostgreSQL, a free and open-source relational database management system; to implement spatial features the expansion PostGIS was used.

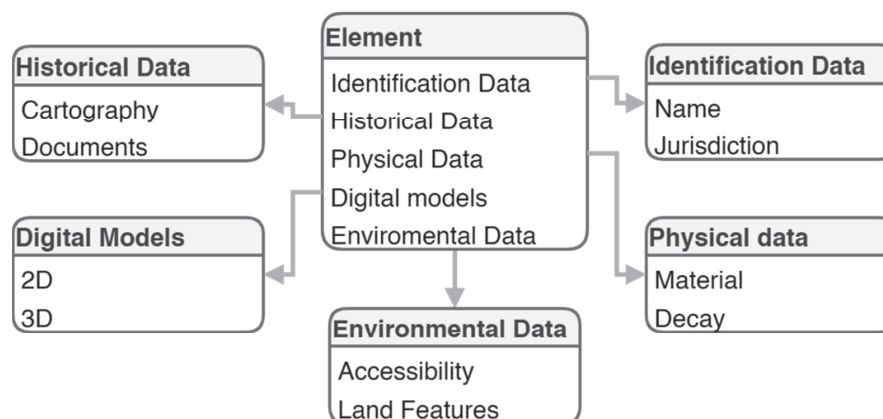


Figure 2: Schematization of the structure of the database (design by Andrea Pirinu and Raffaele Argiolas).

2.2. From the Simbirizzi Lake to the coastline. Survey and representation of IIWW heritage

The sector identified is of particular interest due to the variety of design solutions and the landscape context in which they are currently located: inside the urban fabric, located in the countryside or along communication routes, close to the lake or along the shoreline (fig.3).

For practical reasons related to surveying and cataloguing, the sector can in turn be subdivided into sectors with the first S1 comprising the bunkers built along the beach and the first line of defence against an Allied landing. There are five very simple models using combined circular and quadrangular shapes. The solutions become more elaborate in sectors S2-S7 with polygonal shapes that are mostly pentagonal, or plastically adapted to morphology and mimesis requirements. Proceeding from south to north in the direction of Lake Simbirizzi, the design of these architectures leads to polygonal forms with small buttresses that recall a use as a reservoir and a small church, the latter with the external finish of the perimeter walls that echoes the design of the bricks although made of reinforced concrete.

All the examples identified and accessible (some are placed inside private property) are the subject of an integrated survey (fig.4) aimed at the realisation of the catalogue that brings together the plan solutions adopted and is completed by digital models extended to the landscape surroundings (fig.5).

Direct survey has been applied to acquire the dimension of internal space and a photogrammetric survey is been applied to a complete documentation of external surfaces of single bunker and to extend the survey area to the landscape context.

About technical information, photogrammetric survey was carried out with a DJI Spark drone, equipped with a 12.4 Mpx camera with a 4:3 aspect ratio. The lens is a 4.49mm f/2.6, corresponding to 25mm on the Full Frame format (35mm).

To get at least 1 cm of GSD, nadiral shots have been taken at a constant flight altitude of 15 meters above the ground, while the oblique photos have been taken at 10 meters from the surfaces.

Once the field operations have been completed, the acquired data was processed with Agisoft Metashape Professional software. With the "Structure from motion" process the recognizable elements (key points) were identified, and the matching points (tie points) were defined; a sparse cloud was obtained and treated so that all the images inserted in the process were correctly aligned.

The data processing produced a Sparse Cloud of 650.000 points and a dense cloud of 24.000.000. The dense cloud was then processed with Cloud Compare software with subsample, noise reduction and SOR Filter tools.

At the end of the process a digital model of single bunkers has defined as showed in figure 5 for a bunker located in the area S5 close to the border of the lake.

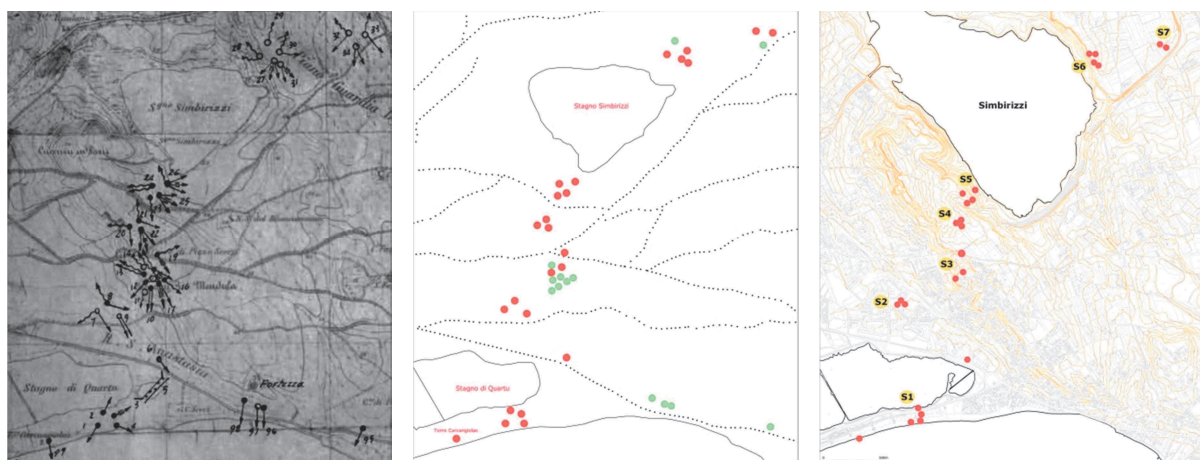


Figure 3: Extract and graphic synthesis of the map "Fortification works and military roads in the Quartu-S. Isidoro-Sinnai beach sector" describing the works planned in the Quartu Sant'Elena area (Documentary Archive of the Army Infrastructure Department) and identification of the bunkers surveyed (in red) on a CTR basis (graphic elaboration by Andrea Pirinu).

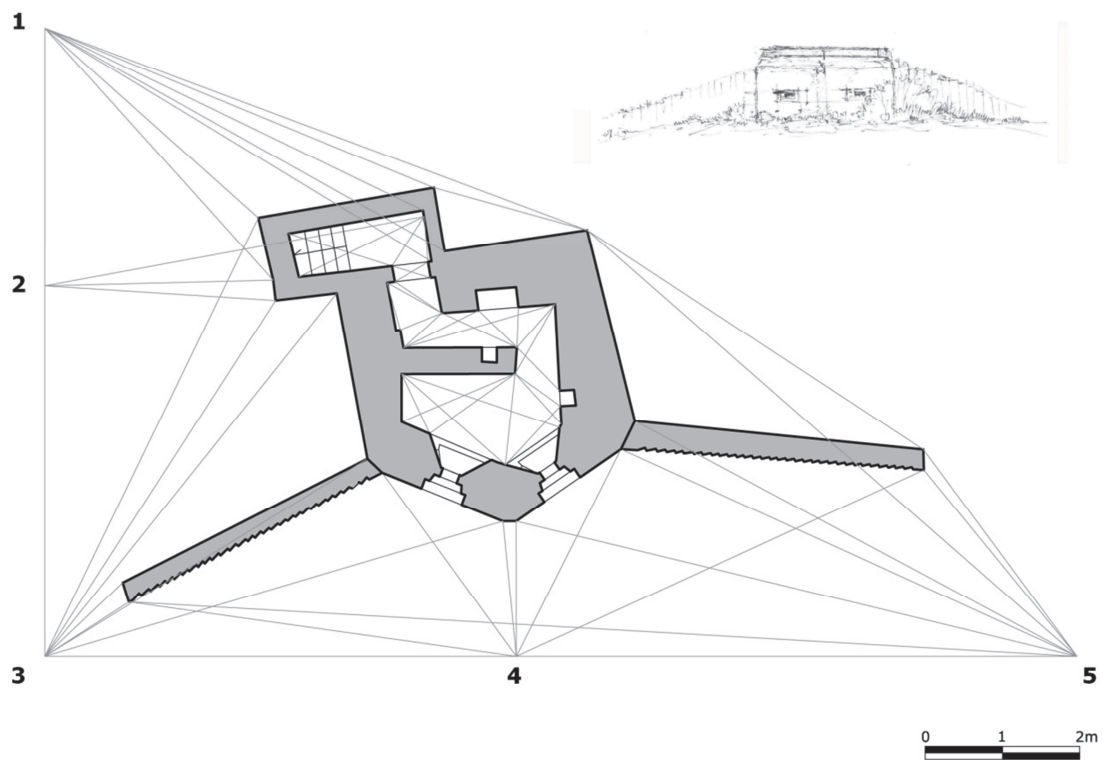


Figure 4: Instrumental and direct measures for the survey of a bunker located in the Sector 5 [10].



Figure 5: Digital models of a bunker located near the Lake Simbirizzi (sector S5). Photogrammetric survey and C.G.I. by Nicola Paba.

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