

# TRACES OF COMPLEXITY

**STUDI IN ONORE DI ARMANDO DE GUIO**  
***STUDIES IN HONOUR OF ARMANDO DE GUIO***

a cura di

LUIGI MAGNINI, CINZIA BETTINESCHI, LAURA BURIGANA

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TRACES OF COMPLEXITY.

STUDI IN ONORE DI ARMANDO DE GUIO | STUDIES IN HONOUR OF ARMANDO DE GUIO

Curatela e redazione: Luigi Magnini, Cinzia Bettineschi, Laura Burigana.

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# FORTIFIED VENICE: THE LINE OF FORTIFICATIONS AROUND VENICE AND ITS RELATION TO THE GEOMORPHOLOGY OF THE LAGOON AND THE MAINLAND

## A geographical introduction

The lagoon of Venice is located on the eastern side of the Po plain in North-Eastern Italy. It is about 55 km long and 13 km wide. The delta systems of the Po, Adige and Brenta rivers mark the limits of the lagoon to the South, as the Sile and Piave rivers do to the North. The water of Brenta and Sile poured into the lagoon in ancient times. The lagoon is separated from the sea by the two barrier islands of Lido and Pellestrina. Further South, the lagoon is separated from the sea by the left branch of the Brenta Delta. Three lagoon inlets allow seawater to flow in and out at each tide turn. Relict forms are found as positive forms within the lagoon, such as fluvial ridges, which are now either partially or completely submerged. Sections of the coastal plain are flooded by the water of the lagoon, becoming part of the lagoon bottom. Some other landforms, now incorporated within the lagoon, had a coastal origin (Bondesan, Meneghel 2004). The most common are the typical lagoon landforms. Salt marshes are flat surfaces, located few centimetres above sea level, hosting halophilic vegetation that contributes to their conservation. They match (though not always perfectly) landforms defined by the terms: salt marsh, *haute slikke* or *schorre* (Bondesan, Meneghel 2005). At a lower altitude, just below the mean sea level, are located the barren, silty flat shoals, which are only visible during the most pronounced low tides. These are recognised in international literature by the terms: tidal flats, marsh flats and *slikke*. These flat surfaces are bounded by the network of lagoon channels, which, starting from the inlets, branch off into smaller arms. Sediments from the rivers that have poured their water into the lagoon at various times have created lagoonal deltas. Among the lagoon landforms worth mentioning on account of their frequency and invasiveness are the anthropogenic forms of the reclaimed areas (created mainly between the 1920s

and the 1960s), fish farms, the international Marco Polo airport, the bridge spanning the lagoon, and the coastal defences (Caniato *et al.* 1995; Bondesan, Meneghel 2004; Bondesan, Levorato 2008; Bondesan 2017).

## The defence of the Venetian Republic from its origins to the nineteenth century

The lagoon, since the very beginning, constituted the main defensive instrument of Venice (Canal 2013). The city's inhabitants made use of the water and islands in the lagoon as a natural fortification against the invasion of the Franks in 810 A.D. (Dorigo 1983).

The Republic of Venice entrusted the military defence of its territory to the lagoon; considering itself to be well-protected against attack from the land by the impassable swamps and canals and concerning itself more with attacks from the Adriatic. Despite the long history of the Venetia settlement, a real system of defence to protect the city and its lagoon was only gradually developed by the Venetian Republic in the 16<sup>th</sup> century (D'Alpaos 2010). Starting in 1538, to counter the threat of the Ottoman Empire, a system of forts was built to protect the lagoon inlets: Fort San Felice and Fort Brondolo near Chioggia, Fort Sant'Andrea at Lido, and Fort Sant'Erasmo opposite Venice. In 1571, the Senate also issued a decree for the creation of new "octagons" (isolated bastions armed with artillery) to control the mouth of the Malamocco inlet, which had in the meantime become the most important passageway for the Venetian fleet, building the forts of Alberoni and San Pietro in Volta. Then, in 1591, the defence of the northern access to the lagoon was further strengthened with the construction of Fort San Nicolò. In 1646, during the Siege of Candia in the Cretan War, two new forts were built at Malamocco. Completed in 1726, these are Fort San Pietro and Fort Alberoni (Zanlorenzo 1997).

Starting from the north, the system was organized as follows:

Port of Lido:	Port of Malamocco:	Port of Chioggia:
Fort Sant'Erasmus	Fort Alberoni	Fort San Felice
Fort Sant'Andrea	Fort San Pietro	Fort Brondolo
Fort San Nicolò	Alberoni Octagon	
	Ca' Roman Octagon	
	San Pietro Octagon	
	Campana Octagon	
	Poveglia Octagon	

Tab. 1. Austrian (former Venetian) defensive system of fortresses along the coast during the 18<sup>th</sup> century.

In the early nineteenth century the fortification system of the lagoon was still based on these five defensive forts: Fort San Felice in Chioggia, the forts of the Malamocco inlet (San Pietro and Alberoni), and the fortifications of San Nicolò at Lido and Sant'Andrea. With the Treaty of Campo Formio in 1797, Venice was turned over to the Austrian Empire. The Habsburg military, fearing the threat on the mainland from the French Empire, began to overhaul the lagoon defences, reinforcing the side facing the mainland. In 1805, the French replaced the Austrians until the final demise of Napoleon and the return of Austria in 1814.

The Franco-Austrian fortified complex also strengthened existing defences in the Venetian lagoon and along the coast.

Sea defence system (from the north):	Inner-lagoon defence system (from the north):
Fort Treporti (1845)	Battery Trezze
Maximilian Tower (1811-1830)	Battery Buel del Lovo
Battery Quattro Fontane (1835)	Redoubt of Mazzorbo (1881)
Battery Casabianca (1881)	Fort Mazzorbetto (1807)
Fort Malamocco (1847)	Battery Carbonera
Battery Rocchetta (1850)	Battery Tessera
Battery Podo (1881)	Battery Campalto
	Fort San Secondo
	Fort San Giorgio in Alga (1847)
	Fort Sant'Angelo della Polvere
	Battery Campana
	Battery Poveglia
	Battery Fisolo

Tab. 2. Austrian defensive system of fortresses along the coast during the 19<sup>th</sup> century.

The defensive structure of Chioggia was strengthened; eight batteries were built on stilts to guard the main channels from the mainland to Venice, along with some other coastal and island defences. In July 1805, the Austrians began to build a strong pentagonal fortress at the head of the Canal Salso in Marghera along the edge of the lagoon. Fort Marghera was located less than four kilometres from Venice and became the largest of the numerous military forts in the Venetian lagoon (Foffano, Lugato 1987). The fortress used its location in the middle of the swamps and floodplains of the Osellino river to great advantage; it could not be attacked from the Venetian side, with which, in case of siege, it could keep communication lines open for the transport of troops, ammunition and supplies. By the end of French rule, the fort was already in its present form. Under Austrian rule (1814 to 1866) the fort underwent no substantial changes.

In 1809, when the fort was not yet completed, the French garrison took refuge there and was placed under siege by the Austrians; a second siege took place in 1813. The most well-known siege was that of the Republic of San Marco from June 1848 to 24 May 1849 conducted by the Austrian army encamped at Mestre. General Haynau pressed the siege against the fort with an army of 30,000 men against 2,500 volunteers. The fort was subjected to an intense bombardment that forced the Venetian troops to abandon it. The advances of modern artillery had revealed all the structural defects of the fortress (Bombieri, Ghesini 1999).

Construction of the Entrenched Camp of Mestre, in which Fort Marghera occupied a key position, was begun after 1880. However, by the time of the outbreak of the First World War, further developments in artillery had already rendered Fort Marghera obsolete along with the entire Entrenched Camp of Mestre. Its 12 forts were later turned to use as warehouses or logistics facilities until the early 1980s. Fort Marghera, however, continued to be used as the North-East logistics management facility for the Italian army up until 1995. In June 1996, after a year of transition, it was finally abandoned by the army altogether (Anoè, Brunello 1988; Zanlorenzo 1997).

### Modern artillery and the crisis of the Entrenched Camps

In 1870, the Prussian army, using rifled artillery for the first time, dispatched the French system of fortifications with little difficulty and quickly arrived in Paris. Modern guns and new explosives were challenging the old concept of the entrenched camp consisting of a wall ar-



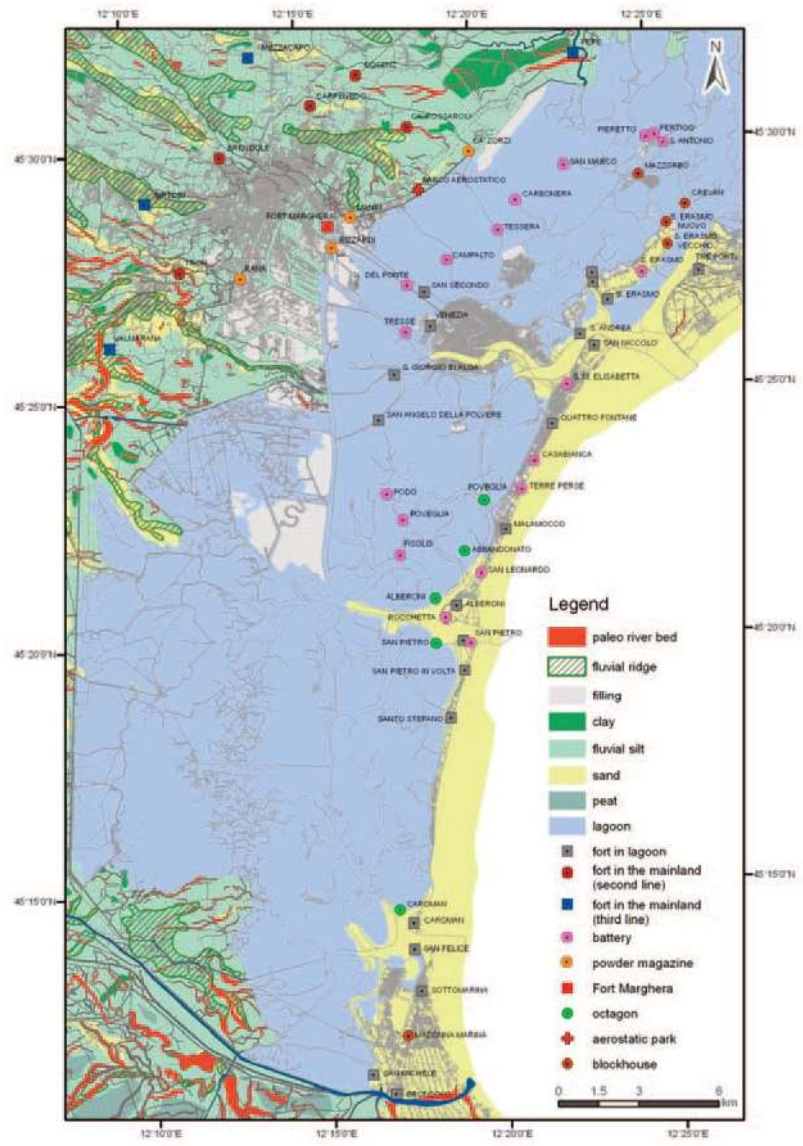


Fig. 1. Geomorphological and military map of the lagoon of Venice.

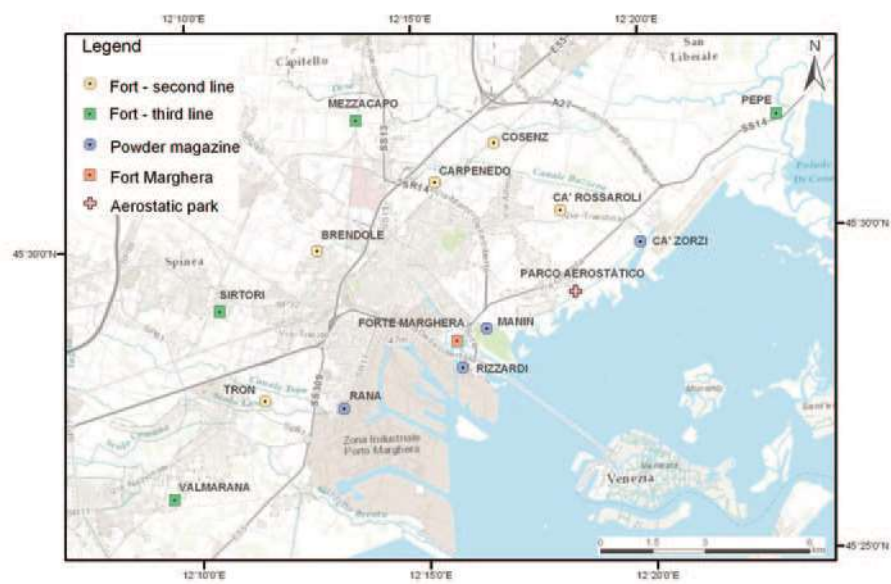


Fig. 2. Map of the Entrenched Camp of Mestre, defending Venice from the mainland.

1	Fort Bazzera	north-east, at the mouth of Dese at Tessera, completed in 1911
2	Fort Rossarol	north-east, at Tessera, completed in 1907
3	Fort Pepe	north-east, Ca' Noghera, at the confluence of Zero in Dese, along the road to Trieste, which was completed in 1909
4	Fort Cosenz	north, at Dese, along the railway line to Trieste, which was completed in 1911
5	Fort Mezzacapo	north-west, at Morocco, along the railway line to Treviso, completed in 1911
6	Fort Sirtori	west, at Spinea, to control the railway to Trent, Padua and the way to Castelfranco, completed in 1911
7	Fort Poerio	south-west, at Oriago, along the railway to Adria and the way to Ravenna, completed in 1910

Tab. 3. New forts built at the beginning of 20<sup>th</sup> century.

ranged around a nucleus, and an outer circle of forts. Across Europe, in order to keep pace with technological innovations, military engineers gradually increased the distance between the perimeter of forts and the city walls, strengthened the thickness of the walls and roofs of the buildings by means of large sections of earth and started using layers of concrete and steel (Botti 1980). After the unification of Italy, the new Italian state identified strategic positions that needed to be strengthened (Castellano 1983). Venice took on a central role as a fortress and operating point of an army corps. The city started construction of the first part of the Entrenched Camp of Mestre by building three large independent mobile batteries. In 1883, work began on the construction of the fortresses. Initially six were planned, but this number was later reduced to three on account of the costs involved. They are: 1) Fort Carpenedo to the north, on the way to Treviso, completed in 1887; 2) Fort Gazzera to the north-west, on the road to Castelfranco, completed in 1886, and 3) Fort Tron to the south-west, on the way to Padua, completed in 1887. The three fortresses were constructed in an identical, polygonal shape, and placed at a distance of 3500-4500 m from Fort Marghera, which was to protect them from the rear. Each fort was equipped with twenty medium-calibre artillery pieces placed on 12 pitches in the open, with positions for mortars, machine guns and fusiliers all around. Thus, the hinterland of Venice was enclosed by a defensive system that stretched just over 18 km (Anoè, Brunello 1988; Bertini, 2001, Scroccaro 2011).

Growing tensions led to the Great War, and the further evolution of artillery with greater shooting and destruction abilities brought about a review of the defensive system of Mestre in the first years of the 20<sup>th</sup> century. A new outer belt of fortifications consisting of seven new fortresses was built, making use of the natural defence formed by the Dese River to the north. With the exception of Fort Rossarol, which was built on two floors, all the other second-generation forts were single level, with

a very low profile to the ground, and were armed at four or six positions with a line of 149 mm guns (Zanlorenzo 1997).

When the camp was completely fortified it accounted for about 150 positions and about 600 guns. In September 1915, the batteries protecting Venice were ordered to be dismantled and sent to reinforce the front, while four airfields were laid down (San Nicolò del Lido, Marcon, Tessera and Malcontenta) (Flocchini 1994; Scroccaro 2015). During the Cold War, these facilities were gradually transformed into barracks, powder magazines and storehouses wedged into the system defending the borders with Yugoslavia. Beginning in the 1960s a gradual disbanding process was begun that first saw the facilities on the islands in the lagoon stand empty and then the others, until all of them were finally abandoned in the 1980s. During the 1990s, the process of reclaiming began after the forts were transferred from the Italian Army to the City of Venice. They are now for use by the public as places of historic and cultural interest or community centres (Scroccaro 2015).

### The defence of Venice by sea and land

The possibility of an attack on the city had been studied by the Austrian General Staff (Zanlorenzo 1997; Bertini 2001), which evaluated the weaknesses and strengths of the defences. It is necessary to consider the two possible fronts of attack by sea and land from the military point of view.

An attack by sea would be particularly difficult on account of the morphology of the beaches. There was in fact a shortage of berths and natural harbours. The lagoon and coastal waters were very shallow, so big ships were forced to anchor offshore. Consequently, it was very difficult to approach within 2000-4000 m of the coast, so the coastal perimeter was outside the range of most average naval guns. In general, it was difficult to



Fig. 3. Satellite image of Forte Marghera today (© Google Earth, 2020).

enter the lagoon, while the system of dams and coastal dunes offered easy cover for the troops defending the coasts. The coast also proved to be unsuitable for the landing of troops. Entrance to the lagoon in the centre of Venice was made by three lagoon inlets, which were protected and could be easily closed if necessary. The shores of Venice were also well defended by numerous well-fortified and protected coastal batteries (Lazzarini, Clerici 1997).

From the mainland, military operations would have to be conducted in the open, on a coastal plain with a very slight incline and no natural obstacles. The main points to consider therefore were buildings, especially the bell towers, the levees and the road and railway embankments. It was, however, a very low elevation of just a few metres. Movement of the troops would be hampered by the numerous rivers that crossed the plains, rice plantations (very common at the time), swamps and marshes, forests and intensive cultivation. Defence against a possible enemy attack would also be hampered by the thick forest cover in the area (which, however, would also

hinder the movement of enemy forces). However, the number of forts was sufficiently high and their armament powerful enough to cope with possible attacks. The plain has a sub-surface aquifer, the level of which is just a few decimetres from the surface, which frequently created problems with the positioning and construction of batteries. In fact, the low slopes, poorly drained soil and the large amount of surface water caused waterlogging and flooding.

From the military point of view, the weak points lay in the general inadequacy of the fortifications to provide protection owing to the introduction of ever more powerful artillery, and difficult mutual protection between the forts themselves, as they were separated by a fairly great distance.

Based on their studies, the Austrian commanders concluded that the city could be forced to surrender through a combined land and sea attack and a bombardment (Zanlorenzo 1997). A possible attack would have to include a naval assault at the mouth of the lagoon to allow the naval bombardment of the city from a

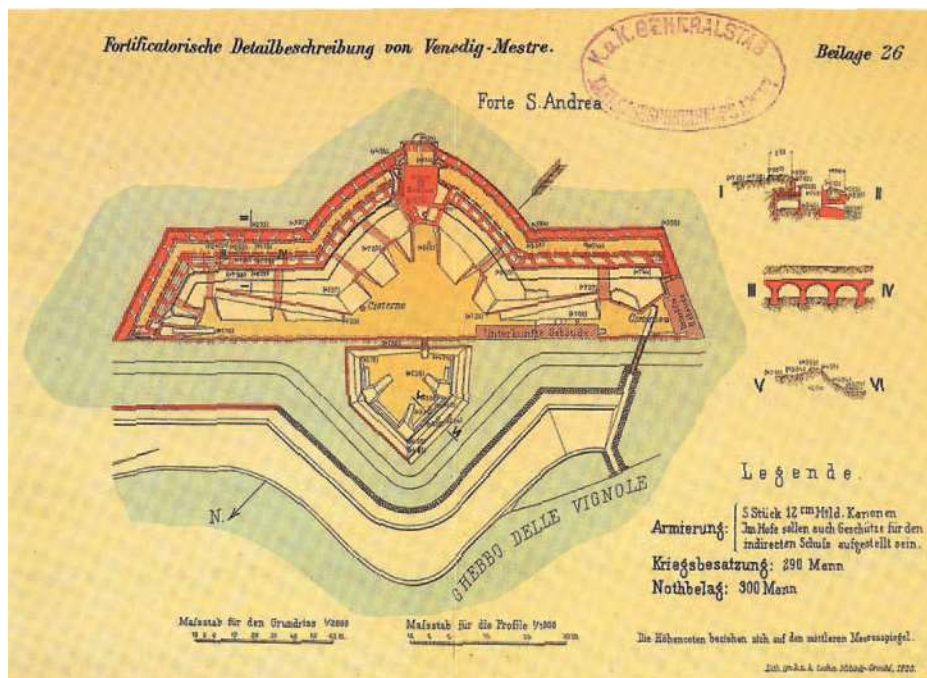


Fig. 4. Austrian plan of the Forte San Andrea (from SMGA 1900).

relatively close position. Thus, an attack on Malamocco (allowing greater protection for attackers) seemed likely, while the Lido was considered difficult to sail by ship due to the silting of the estuary. On the land side, a bombardment could come by taking over the area of Campalto-Campo di Pietra, the closest point to the city still far enough away from the big Fort Marghera. The Austrians were also aware that a land attack would still have been hampered by the lagoon wetlands and lowland forests still widespread at the time.

The particular geomorphology of the lowlands and the lagoon strongly influenced the choices in the Venetian defensive system. The mainland side had long been neglected because the coastal marshes and wetlands were a natural bulwark. The batteries were concentrated in a defensive belt located inside the lagoon surrounding the city of Venice, often reclaiming salt marshes or creating artificial islands. On the coastal side, the defences were concentrated around the three main entrances to the lagoon, around the inlets of Lido, Malamocco and Chioggia. Over time, interaction between the fortifications and nature has produced considerable effects. On the coast it is important to consider the effect of erosion and sedimentation at the lagoon inlets, which frequently created serious difficulties for ships entering due to the shallow water. The trend of coastal erosion, the effects of which have been recorded for centuries, has often caused a decline in the coastal edge with extremely pronounced coastal erosion on the places where batteries were in-

stalled. Even within the lagoon, the batteries were often placed on artificial islands, others are now heavily eroded and some of which have disappeared. In contrast, forts built near the mouth were set farther back due to the strong advance of the beaches in the upstream sectors caused by the coastal dykes built at the end of the 19<sup>th</sup> century.

On the mainland side, Fort Marghera was the barycentre of the entrenched camp, which was strategically positioned for the defence of the city of Venice. The micro-morphology of the lower coastal plain, the presence of rivers and spring water, and very shallow ground water (along with the pattern of the main roads) determined the choice of location of the fortifications. The lagoon banks were linear elements upon which the entire defensive line of forts was oriented, with the powder stores and the back lines on the edge of the lagoon.

## Conclusions

The Venetian lagoon has always offered a valuable and effective natural defence since Venice was founded some 1300 years ago. Venice was founded based on a clear plan of defence against enemy attacks and exploitation of the islands, around which the first settlement rose. The continual advancement of technology over time created the need to adopt stronger defences. The increased artillery range and greater explosive force of the shells de-

veloped in the 19<sup>th</sup> century led to defensive rings being widened and defences being strengthened until armed technological progress in the early 20<sup>th</sup> century made fixed defensive positions obsolete. The forts were decommissioned during the First World War and the facilities were used as magazines up until the 1980s.

The organisation of the defensive system had always to take into account the lagoon's hydrology, coastal geography (especially with respect to access to the lagoon), lower coastal plain morphology (with its low dip), and the extensive wetlands (especially along the edge of the lagoon). Waterways flowing into the lagoon influenced

the movement of troops and the arrangement of the fortifications was also determined by the possible attack directions.

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## ABSTRACT

Starting in the 16<sup>th</sup> century, and throughout the Austrian occupation of Venice, fortifications were built on many of the outlying islands of the Venetian lagoon and on the mainland, creating a fortified Venice that few are aware of today. Only part of the city's huge and complex defensive system has survived to the present. For decades this valuable group of buildings was used exclusively for military purposes and little was known about them. Since the military authorities have relinquished their control over a good many of these forts, they have been converted into cultural sites and places of interest for tourists. These now included in some of the new historical-environmental tours around the lagoon and the hinterland and make for very extensive and extremely picturesque sight-seeing excursions.

An historical map analysis was undertaken to identify the main defensive constructions. Each fortification was described and georeferenced and then placed into its specific topographical and geomorphological context, taking into consideration its strategic importance.

*A partire dal XVI secolo, e durante tutta l'occupazione austriaca di Venezia, furono costruite fortificazioni su molte delle isole periferiche della laguna veneziana e sulla terraferma, creando una Venezia fortificata di cui pochi oggi sono a conoscenza. Solo una parte dell'esteso e complesso sistema difensivo della città è sopravvissuta fino ad oggi. Per decenni questo prezioso apparato di edifici è stato utilizzato esclusivamente per scopi militari e di essi si sapeva poco. Da quando le autorità militari hanno ceduto il controllo su molti di questi forti, questi sono stati convertiti in siti culturali e luoghi di interesse turistico. Questi sono ormai inseriti in alcuni dei nuovi percorsi storico-ambientali della laguna e dell'entroterra e consentono escursioni turistiche estremamente suggestive.*

*È stata condotta un'analisi storico-cartografica per identificare le principali opere difensive. Ciascuna fortificazione è stata descritta, georeferenziata e inserita nel suo specifico contesto topografico e geomorfologico, in funzione della sua importanza strategica.*

## KEYWORDS

Military geoscience, fortifications, WWI, lagoon of Venice.

*Geoscienze militari, campo trincerato di Mestre, Prima guerra mondiale, laguna di Venezia.*

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