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Ancient landscape reconstruction using archive data from the Pontine Plain (Italy): the Caprolace lagoon case study

Ancient landscape reconstruction using archive data from the Pontine Plain (Italy): the Caprolace lagoon case study

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Abstract. The greatest part of the documents concerning the last reclamation scheme of the Pontine Plain is now stored in a section of the state archive and in the archive of the Consorzio di Bonifica dell'Agro Pontino, both located in Latina (Italy). Detailed plans of the realised buildings, infrastructures as well as thousands of pictures of the environments before the reclamation scheme are available to the public. These data can be used to reconstruct the ancient landscape before the major changes which occurred after the spread of mechanical vehicles for earthmoving in the 1970s. The reconstruction maps can be used to set the proper background for the archaeological research in the area.

1. Introduction

In the 1930s, the Italian fascist regime completed the land reclamation of the Agro Pontino. Around 75000 ha were turned into fertile agricultural land and several towns and burgs were founded to accommodate migrants coming from northern Italy. The reclamation scheme also brought a radical change in the landscape (Barsanti, 1987; Ebanista, 2016; Martone, 2016). Before work started, in 1928, detailed 1/5000 maps of the entire area were drafted by the Italian Military Geographical Institute on behalf of the Consorzio della Bonifica di Piscinara and Consorzio della Bonificazione Pontina (Baiocchi et al., 2018). The highly detailed and accurate maps were necessary for the careful planning of the hydraulic and infrastructural systems. Moreover, in the Latina State Archive and in the Consorzio della Bonifica dell'Agro Pontino, other documents about the reclamation scheme are stored, including thousands of pictures taken during the works and the original maps and contracts between the fascist regime and the involved private companies. All this data can be used to reconstruct the appearance of the Agro Pontino before the reclamation scheme.

In 2017, an archaeological excavation in the two small islands inside the Caprolace lake, carried out by the University of Groningen, in collaboration with the University of Rome Tor Vergata, revealed a Bronze Age settlement with a salt-production area. A proper reconstruction of the Bronze Age environment was deemed necessary to successfully interpret the archaeological data and a twofold approach was adopted. Locally, a coring campaign was carried out in the excavation area (Alessandri et al., 2019). In more general terms, a reconstruction of the surrounding before the reclamation scheme was planned. The first results of the latter approach are discussed in this paper.

Figure 1. The 1928 map grid. Red square: the digitalised maps (O7 and N7) with a portion of the Caprolace lagoon

2. Materials and methods

The use of photogrammetric flights to extract altimetric information needs: some stereoscopic frames of the area available at a suitable frame scale (1:15000 at least); the calibration parameters of the employed camera and some recognizable points on the frames that can be still detected on the ground and used as Ground Control Points (GCPs). The lack of these data before the reclamation scheme makes the extraction of the elevation data from the 1/5000 IGM map the only possible outcome (Baiocchi et al., 2021). These maps can be considered the most reliable document about the elevation of the area around 1928. Their accuracy is supposed to be 1 metre in planimetry and about 1.8 metres in elevation. The Caprolace lagoon appears in sections N7 and O7 and the site appears in the N7 section, under the toponym *Boschetto dei Lucini* which means holm-oak groove (*Quercus ilex L.*). The O7 and N7 maps were digitalised at the Groningen Institute of Archaeology using ArcMap software. The greatest issue in reconstructing the DEM using data from historical cartography is the correct identification of the planimetric and altimetric datum. Unfortunately, detailed information on the IGM map datum cannot be conclusively ascertained (Mori, 1922). We then use the planimetric (Baiocchi and Lelo, 2010) and the altimetric (Alimonti et al., 2021) information used in some contemporary maps of the area of Rome. The cartography has been reprojected in the currently used datum (EPSG:7792; EPSG, 2021) and then interpolated in QGIS using an algorithm based on the TIN networks that allow estimating the terrain even in flat areas. The current morphology was deduced from LIDAR data whose measurements were acquired between 2008 and 2011 with ALTM Gemini,

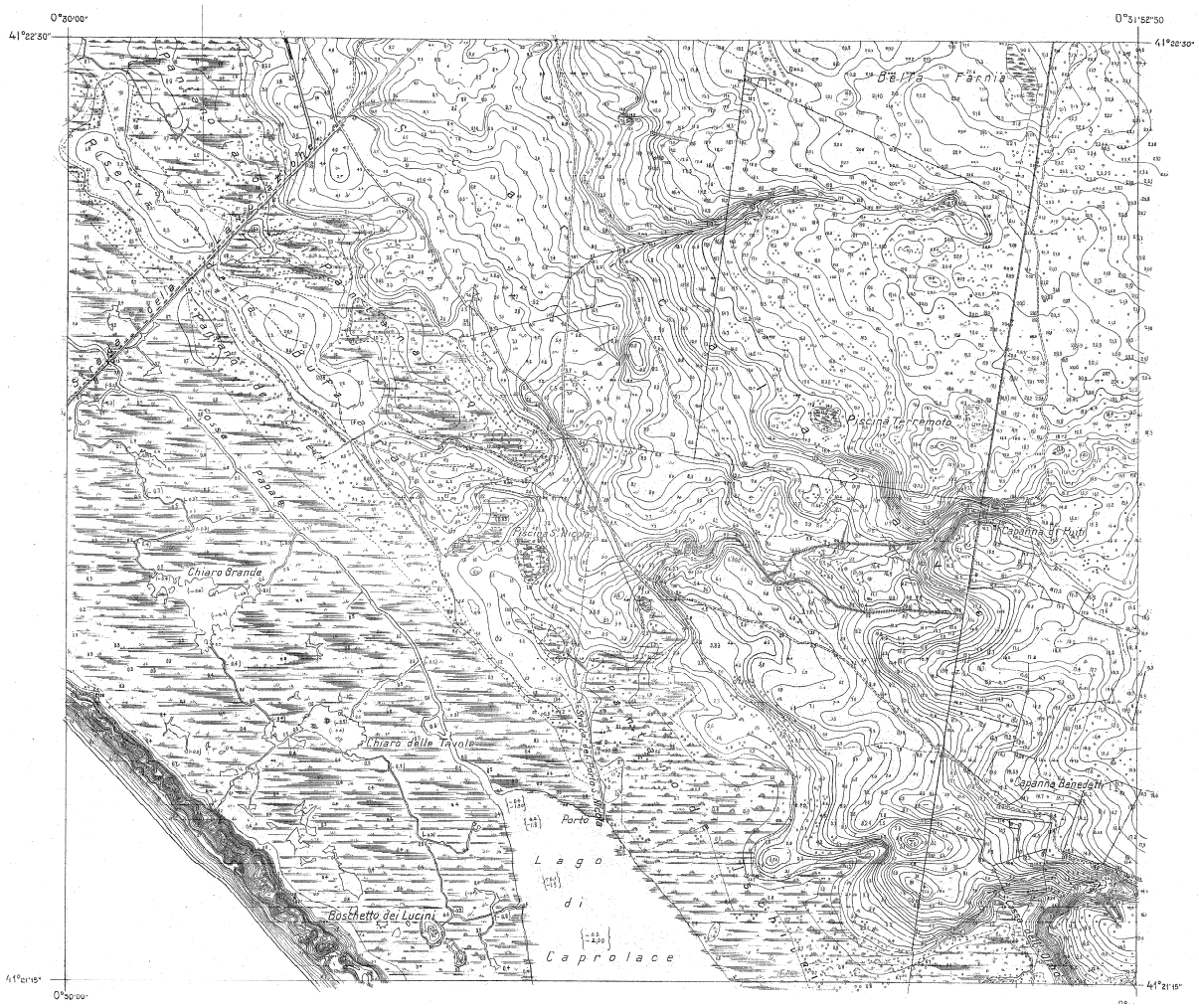

Figure 2. The 1/5000 IGM map N7. The Bronze Age site is near the South-West corner

ALTM 3100EA and Pegasus laser-scanning systems of the Canadian company Optech; the pitch is 1 metre, the positional accuracy is 0.40 metre and the equivalent scale is considered to be 1:5000 (Ministry of the Environment, 2021) and therefore compatible with the detail of the historical cartography. It must be remembered, however, that the altimetric information of a DEM extracted from cartography can be extremely different from a LIDAR DTM. The heights of cartography are generally (particularly in historical cartography) measured and reported only on the ground, while the building has often no altimetric information. In addition, the lidar "first pulse" also contains the heights of vegetation where present. In our case, the comparison between these two sources of data is however significant both because there are no structures on the maps and because we use the "last pulse" type laser. A small portion of a 1928 derived DEM encompassing the area of the Fogliano and Monaci lagoons was already compared to a 25m planimetric resolution DEM by Feiken and Van Leusen (2001). The paper could highlight some sources of errors which resulted in height differences between the two DEMs, which were not due to real change in the landscape: different scales, different resolutions, mapping errors, interpolation and datum shift. The complete 1928 derived DEM was also compared with the LiDAR DTM by Van Gorp and Sevink (2019) to check the Pontine Plain subsidence: the small scale of this work prevented detailed discussions about the Caprolace area.

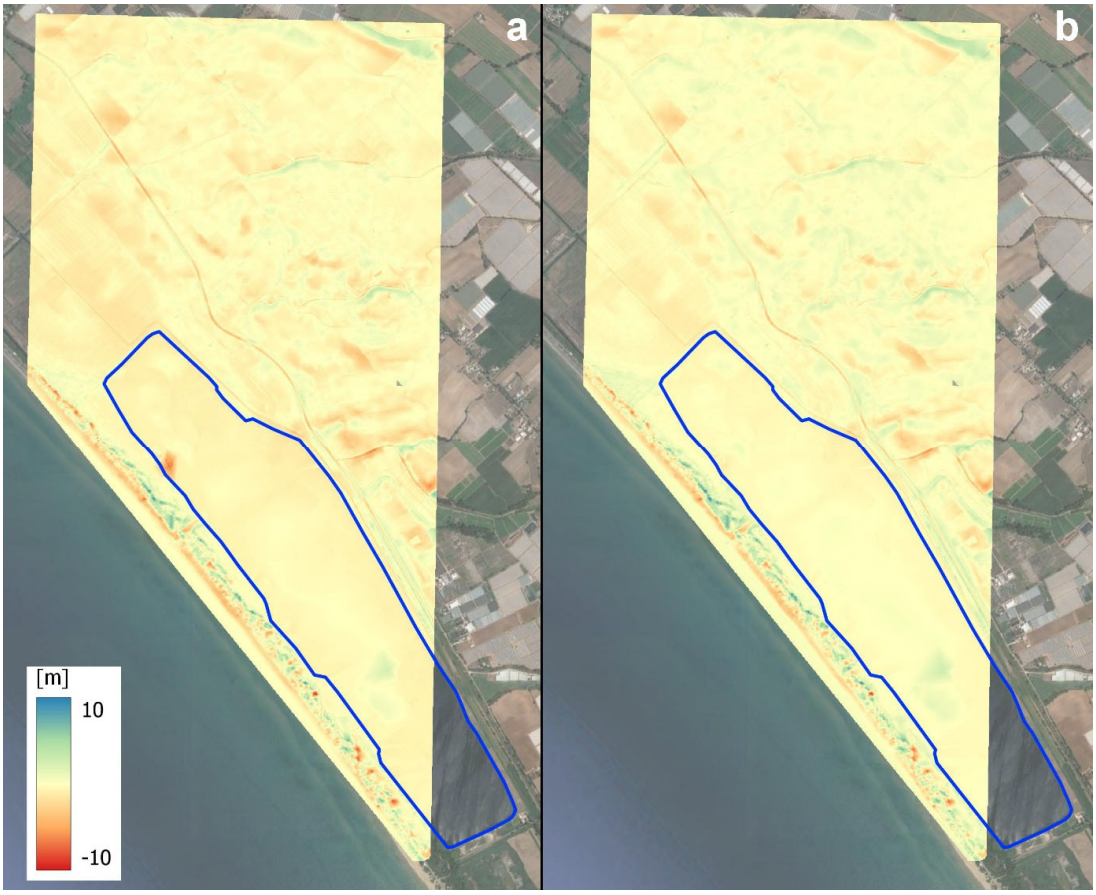

Figure 3: The difference in height between the 1928 DEM and the LIDAR DTM; a) without the height shift, b) with the height shift. The blue line is the contour of the modern Caprolace lake.

3. Results and discussion

The comparison between the two DEMs shows modifications both in excavation and in backfill as expected. The maximum differences are contained in few metres. Generally, a good agreement is observed, even higher than expected, considering the accuracy of about 1.8 metres assumed for the cartography and that of 0.4 metres declared for the laser scanning. In figure 3 it is possible to observe the contribution of the proper correction of the altimetry due to the different datum used then and now (42cm added to the IGM DEM; Alimonti et al., 2021). After the correction, the area where virtually no difference could be observed and the values were close to 0 becomes much larger. The differences in elevation of the actual lake are not to be considered. While the elevations measured by laser on the water are considered unreliable, the historical cartography shows only a few measurements of the bottom of the lake.

As far as the planimetric datum is concerned, it seems possible to observe a residual shift, particularly along the coastal dune, which could also be due to a shift of the dune itself. Unfortunately, there are no buildings or road infrastructures still existing in the area and therefore it is not possible to verify the hypothesis of a possible residual shift between the two planimetric datums. This hypothesis will be verified in a subsequent phase of the research by enlarging the investigated area to include other elements of the same cartography that contain still existing buildings or transport infrastructures.

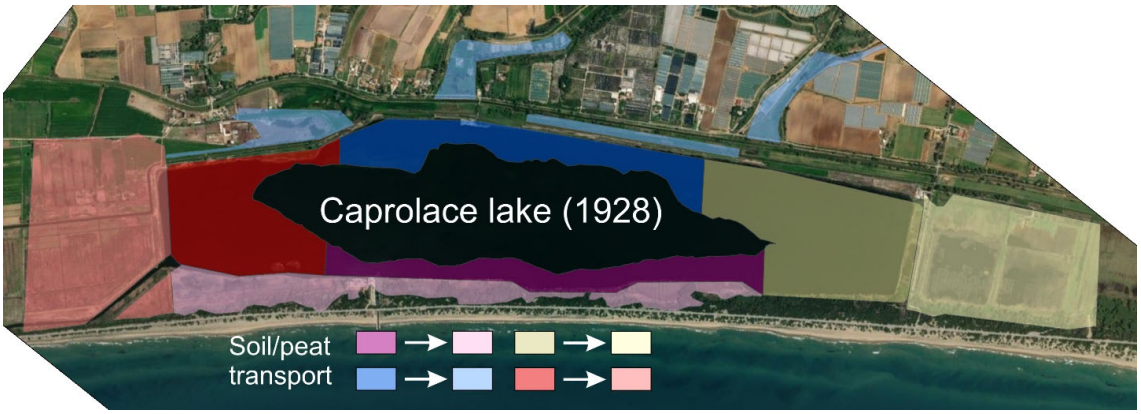

Figure 4: The digitalisation of the executive project for the realisation of the lake embarkments. The soil/peat was planned to be extracted from the dark areas and place in the equivalent light areas.

In the State Archive in Latina, the executive project for the building of the present-day lake embankments is conserved (*Sistemazione del Lago di Caprolace. Scavo delle Sponde del Lago*. May 1935). In the attached map, both the areas where they planned to remove the soil/peat (fig. 4, dark colours) and the areas where they planned to place the resulting amount of soil/peat (fig. 4, light colours) are indicated. The plan was to lower the lake bottom, to allow better water oxygenation, and to increase the lake surface building new and stable embankments. Since the LIDAR data in the present-day lake surface cannot be used, we could only check the outside areas, where deposition of soil/peat was planned. Indeed, the only areas where the planned deposition of soil/peat took place are the northern side of the dune system and a triangle of about 5 ha, NW of the lake (fig. 5, green arrows). Differently from the planned project, there is also evidence of terrain surface lowering on the north-eastern side of the lake (fig. 5, red arrows), together with a possible filling of the small ditches, likely due to subsequent agriculture activities.

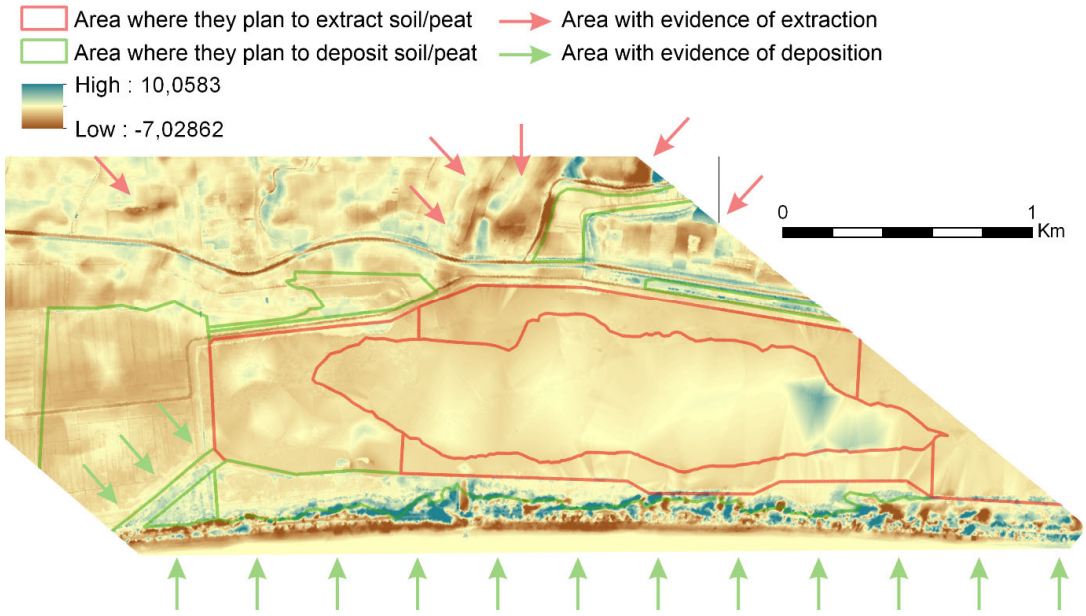

Figure 5: area where soil/peat extraction and deposition were planned in the 1935, compared with the area where they indeed took place.

4. Conclusions

The IGM 1/5000 maps proved to be a reliable collection of data to reconstruct a pre-bonifica DEM and to assess the subsequent land transformation. The comparison with the old executive project shows that the planned activities did not always take place or at least they did not completely adhere to the projects. The next steps will be to enlarge the area of interest and to improve the 1928 DEM accuracy with the identification of GCP.

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