Intensive archaeological survey at Piscina Torta

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Intensive archaeological survey at Piscina Torta: use of a low-cost RTK portable kit to materialise a UTM grid on the ground

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***Abstract* – We tested the use of a low-cost GPS RTK to set up a grid during the intensive archaeological survey of the Piscina Torta site, in the framework of the Salt and Power project of the University of Groningen. We also suggest not using a local grid but the WGS84 UTM grid and naming the single cells with the coordinates of one of its vertices. This would facilitate the use and exchange of the data (e.g. about the potsherds collected in the cell) among the scientific community.**

I. INTRODUCTION

In 1984, G. Pisani Sartorio and S. Quilici Gigli [1] found a huge amount of Iron Age potsherds scattered on a surface of about 10 ha, inside the Natural Park of the Pineta di Castel Fusano, in a locality named Piscina Torta. The potsherds, which can be dated to the VII and VI centuries BCE, all belonged to reddish jars and dolia. This type of vessel is usually associated with some specialised activities like fish processing (sauce, conservation) and/or salt production, possibly through the briquetage technique. The latter is a widespread technique all over Europe [2-4] and consists in boiling brine in a ceramic container (the reddish jars) until the salt (NaCl) precipitates due to the water evaporation. To extract the salt cake breaking the vessel is necessary: this would explain the huge amount of potsherds in those specialised sites [5-7]. Before the archaeological excavation, we decided to collect all the surface artefacts in a grid of 5x5 m. The aims were both to confirm (or modify) the chronology of the site and to obtain data that could guide us in the placement of the subsequent excavation soundings through the study of surface ceramic density. The advantages of reporting absolute geographic positions of archaeological surveys have already been debated and shown in the literature, particularly in the case of underground areas and in urban areas [8-16] here we propose a methodology to trace and materialise the grid for archaeological sites outdoors in open areas.

II. METHODS

Only a small portion of the site was surveyed using the grid system (Fig. 1 and 2) due to the vegetation cover. The 5x5m grid was set up using QGIS 3.22 and oriented following the WGS84 UTM 33N datum (EPSG 32633). It was materialised on the ground placing some Master Stakes every 20m on the grid node locations.

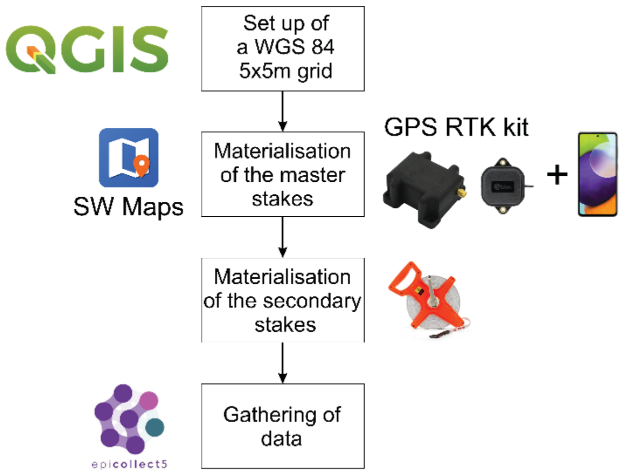

Figure 1. Gathering the data: software and hardware

The intermediate stakes were then placed using a measuring tape. To place the Master Stakes we used the ArduSimple RTK Portable Bluetooth Kit coupled with a smartphone Samsung Galaxy A52. We used the free GIS and mobile mapping app SW Maps 2.9.0.3 to process the signal from the free GNSS RTK permanent network of the Regione Lazio and we collect the data using the free mobile platform Epicollect5.

During the survey, 80% of the surface potsherds was collected and put in plastic bags. The code of the plastic bag is the NE corner of the cell from which the potsherds come (Fig. 3).

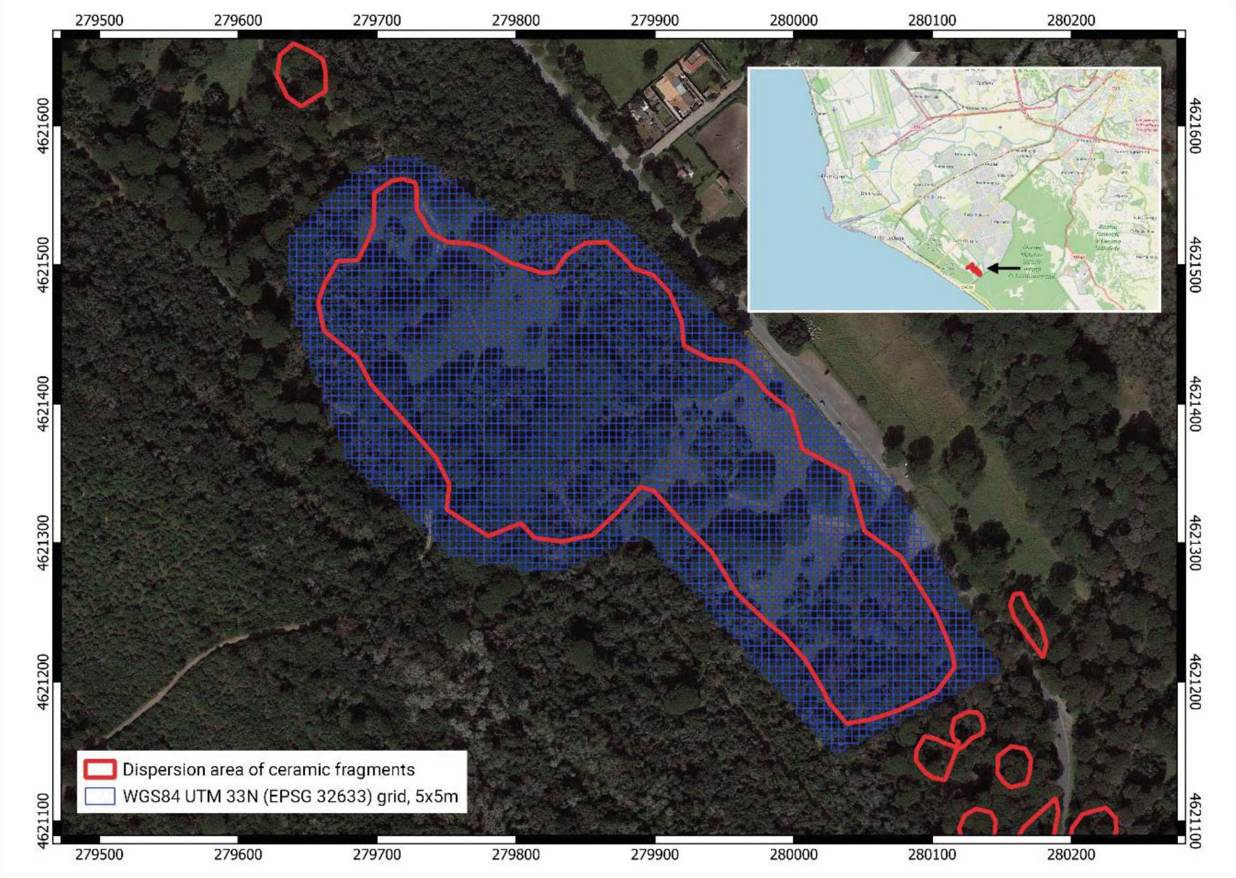

Figure 2. The UTM grid on the archaeological site

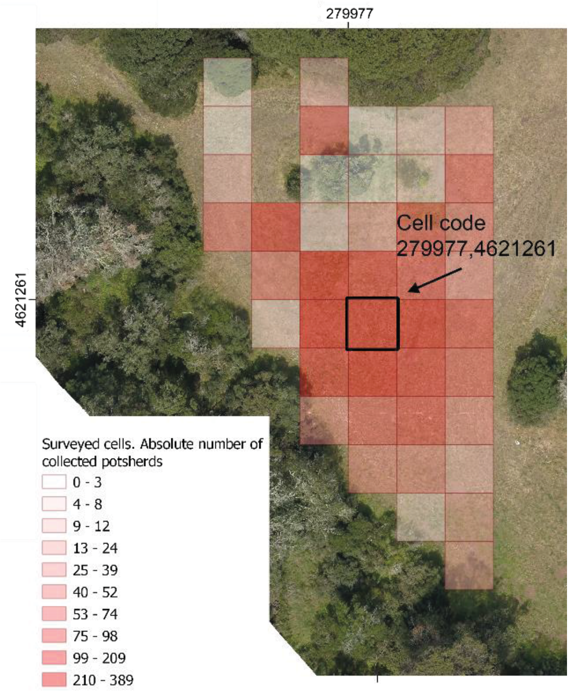

Figure 3. Cell code assignment procedure

To verify the potential of our approach and the limits of the Ardusimple receiver we compared it with a GNSS Geomax Zenith 10 receiver that acquires data from GPS and Glonass constellations in dual frequency by repeating a significant number of nodes of the grid (Fig. 4 and 5).

III. RESULTS

The results obtained are surprising, in particular the deviations between the same points measured with the Ardusimple receiver and the Geomax receiver are very small despite the different antenna quality, probably due to the greater number of constellations that the Ardusimple can acquire. For what has been said, and for reasons of space, these results will not be reported in detail; also with regard to the verification of the accuracy of the proposed method, i.e. the deviation between the planned positions of the grid nodes and their actual position in the field re-measured with Ardusimple, the results show maximum deviations of 20 cm (Fig.5).

In detail they ranged from a few mm (white or light red triangles) up to 20 cm (dark red triangles). The remarkable accuracy is probably due to the proximity of the permanent stations operated by the Lazio Region administration, the flat morphology, but also to the large number of observable satellites. Their layout (still fig. 5) suggests that both the physiological lower accuracy of the points identified with the metric tape and the obstructions of the trees, mainly those to the south, have an influence.

Figure 4. The survey with the Geomax receiver where the tree cover issue is evident

These results on the one hand greatly encourage our proposed procedure and on the other hand draw our attention to the effects of obstructions and vegetation cover.

IV. DISCUSSION

The multidisciplinary approach of this contribution has made it possible to study a methodology for the definition of field grids. This approach was made possible by the very recent availability of handheld receivers and smartphones [17] with a significantly smaller footprint and lower cost than 'classical' differential receivers. These new receivers, in turn, benefit from the recent completion of the four major GNSS constellations (particularly Galileo and Beidou), which have only recently made it possible to acquire even at sites where it was until recently impossible to operate with conventional GPS/GNSS receivers.

The basic idea is to create filed grids in a plane map reference system such as the UTM that is used worldwide and, for example, can also be set up on the well-known Google Earth platform.

The advantages of this approach are mainly two: the geometric correctness of the grid itself in terms of shape and size, and its repeatability. As far as the first aspect is concerned, it is easy to see that points surveyed with receivers that have potentially centimetric accuracies on an absolute grid (such as the UTM grid) will make it possible to obtain a final grid with a much more regular and reliable geometry, making the results statistically much more significant. Furthermore, the possibility of being able to replicate the same grid with no margin of error even years later is of considerable interest. Once again, this allows for greater reliability and significance of the data but also makes it possible to finish and resume the research work without uncertainty even after days or in subsequent campaigns, even years apart.

Figure 5. Absolute deviations of coordinates measured with handheld receiver from integer coordinates of nodes

The proposed methodology does not require every single node of the grid to be surveyed with the GPS/GNSS receiver, especially if the area is flat as in the case under study, but it may be sufficient to survey a few notable points and from those create the rest of the grid with the measuring tape as is traditionally done. In some cases this methodology, which we could call 'hybrid', is the one we would recommend, not so much for speed (the tested GPS/GNSS receiver, once correctly configured, acquires a point in just a few seconds) but because some nodes often fall in areas with intense tree cover and, in that situation, the GPS/GNSS receiver could give largely erroneous results because of the well-known 'multipath' effect, due to the reflection of the GPS signal on surfaces close to the antenna receiver. In particular, the 'multipath' effect should be greater with 'handheld' receivers that have less shielded antennas, compared to the antennas of (bulkier) professional receivers that have specific shielding. In this regard, it should be remembered that no receiver is however exempt from the risk of 'multipath' and therefore it is always best to consider that a measurement made near obstacles could contain gross errors, whichever receiver is used.

Before the availability on the market of low-cost RTK kits, the grids supporting the archaeological surveys were locally made using a total station. Afterwards, some stakes would have been measured (usually the ones on the corners) to georeference the grid. An expensive GPS and trained people were then needed. The alternative was to use the smartphone built-in GPS with a 20-10 m precision. This usually resulted in a quite imprecise localization of the grids, especially when it is necessary to locate already surveyed cells on the ground again. The availability of very intuitive RTK kits with centimetre accuracy opens interesting new possibilities. The grid can be decided in advance and based on the corresponding national grid or some worldwide datum, like the WGS84. During the survey, the potsherd bags from each cell are named with a code. The latter is usually a consecutive number which is also the name of the cell. Using a code made from the coordinates of the NE corner of each cell (like for example 279977,4621261) would make the content of every single bag “georeferenced” even if the corresponding maps are lost.

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