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From ancient maps to Web-GIS systems for the future of *Tabula Imperii Romani*

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Abstract

This paper traces the history of the International Map of the World (IMW), starting from the first attempts made by humans to represent the world in which they lived, including the difficulties faced in representing the spherical earth (Anaximander), until the well-known *Tabula Peutingeriana*, a map which documents the *oikoumene*. In 1928 Crawford highlighted the importance of a European historical map, choosing the *International Map of the World* (*IMW*) as the cartographic base for the *Tabula Imperii Romani*, subdividing this into sheets at a scale of 1:1,000,000.

In more recent times, the TIR has tackled the transition from a printed to a digital format and the last part of this paper deals with the complex mechanism of transposing the data from printed maps to the most modern GIS and WebGIS systems. This issue reveals numerous critical topics, including accurate positioning and the problem of varying scale ratios.

Keywords: International Map of the World, *Tabula Imperii Romani*, digital cartography, WebGIS systems.

1. The origins of mapping the Earth

Humans have always tried to depict the whole world in which they live. For a very long time, different peoples have been certain that the known geographical area was identifiable with the whole Earth, leading to several attempts to draw a map of the world. The crux lies in the word "draw" as, at least since the 6th century BC[4], ancients were perfectly aware that the Earth was a sphere and this is why mapping the globe has represented a problem ever since.

When speaking of Anaximander, Diogenes Laërtius, the well-known biographer of the Greek philosophers, doesn't consider the problem; he simply separates the issue. Anaximander was "the first to draw an outline of the earth and the sea, but he also constructed the sphere"[5]. The adversative here is important, since it reveals an awareness of the difference between a drawing on a flat surface[6] and a three-dimensional model, an actual representation of the globe.

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4. Diogenes Laertius, Vitae philosophorum, c. 1, Ἀναξίμανδρος: he mentions the Earth's sphericity in an aside, suggesting it is common knowledge.

5. Ibid.: καὶ γῆς καὶ θαλάσσης περίμετρον πρῶτος ἔγραψεν, ἀλλὰ καὶ σφαῖραν κατεσκεύασε.

6. Agathemerus, I, 1, records Anaximander as the first man to draw the Earth on a panel (πίναξ). For an overview of Greek cartography, with a selected bibliography, comprising fundamental works such as Bagrow 1964 and Dilke 1985, see Migliorati 2002. An almost complete bibliography can be found in Cinque 2002. A major tool on overall survey of cartography studies is the journal *Geographia antiqua*, directed by Francesco Prontera. As to the Greek perception

The Pompeian mosaic floor[7], showing the globe as the centre of a lecture by Plato to his disciples (Fig. 1), certainly cannot be considered a document of scientific cartography but does bear witness to the permanence of the correct concept of the Earth's sphericity – at the time firmly linked to the plot of the geographical grid - as well as to the familiarity of its three-dimensional representation.

With regard to Diogenes' text, it is also worth noting the term used to indicate the sphericity of the Earth: σφαιροειδής. It is plausible that, in the 6th century BC, geographical knowledge had not progressed any further than equating the Earth with a globe. Nevertheless, it is also possible that Diogenes, in the 3rd century AD, used the term in the proper, modern sense of a rotational ellipsoid (without, of course, going so far as to specify polar flattening). On the other hand, in the Augustan age Strabo was already speaking of the Earth as a spheroid[8] and we know that the Greek geographer used several texts by earlier authors, in particular geographers, mathematicians and physicists from the Hellenistic age, in other words from those who had introduced mathematical geography[9].

One issue related to drawing the Earth is the scale factor. Ancient maps almost never include their scale, although their use of constant proportional ratios indicates that some kind of scaling factor was used. However, especially with regards to geographical maps, there is very little documentation concerning ancient cartography, so we have to rely largely on ancient sources. While reading Aristophanes' "Clouds", I was struck by some analogies regarding both the current and past problems faced by researchers: it suggests different scale factors were used and addresses the difficulty of presenting the outcomes to lay people. A few lines in Clouds[10] show the issues faced by a non-expert in giving the right value to distances on a map of the whole Earth: for instance, Strepsiades doesn't understand how a dot can house all urban buildings because he can't see the seat of the Athenian judges. Moreover, his confusion regarding space and location, originating from a failure to understand the scale factor, means that he is very afraid of how close Sparta is to Athens!

Being able to switch within a very short period of time from a general level (the dots) to the level of symbols (a set of elements representing the land or urban functions concealed in the dots) and then to an urban layout is indeed a recent result of our TIR/FOR project; nevertheless, we still have to achieve a new goal by switching to a detailed plan of structures.

Another issue, since Antiquity, concerns geo-referencing. Errors are very common when copying coordinates from a paper map, as we can still see today, but registering coordinates in fieldwork using the new, increasingly precise tools and methods is gradually eliminating this problem. Essentially, this same issue occurs with Ptolemy, whose direct astronomical surveys only cover very few sites. This is one of the reasons for the discrepancies between the Ptolemaic measurement of the coordinates of about 8,000 sites and the real situation[11].

As I have already mentioned, since no world map drawn by ancient geographers has been preserved, a few modern scholars have proposed various reconstructions based on their interpretation of the texts, always using plane representations. We do, however, have an ancient map documenting the *oikoumene*: the well-known *Tabula Peutingeriana*[12]. We can't give the same label to other medieval maps but, in any case, lacking anything else and although this has a specific aim and deformations due to its own particular purpose, the *Tabula Peutingeriana* can be considered as an IMW of Antiquity.

of bounded space, an interesting approach is shown by Romm 1992.

7. The mosaic is dated between the end of the 2nd and beginning of the 1st century BC. The mosaic is kept at the National Museum of Naples.

8. Strabo, I, I, 20; II, V, 5. On historical sources for the term before Strabo, see Russo 2013, 358, no. 166, 167.

9. Regarding mathematical geography as a natural development of the empirical geography, see Russo 2013a, 357-364; Russo 2013b, 111-129.

10. Aristophanes, Νεφέλαι, 205-215.

11. See Russo 2013b, 134-139 and 223-225, commenting on Ptolemy's different methods regarding latitude and longitude.

12. Among a large number of works on the *Tabula Peutingeriana*, I can mention Miller 1962, Weber 1976, Bosio 1983, Prontera 2002, Albu 2014, Rathmann 2018. An accurate, detailed analysis of segments of Italy has been carried out in numerous publications by L. Bosio and G. Rosada: see Bosio, Rosada 2021.

FIGURE 1. Pompeian mosaic floor: Plato and his disciples discussing a globe wrapped in the geographical grid.

The *Tabula* was obviously meant to be used as a specific road map, a purpose that has led to its cartographical deformation: a scaled ratio of approx. 20:1 in the length/width relationship for a roll of nearly 7 m per 34 cm; a layout that entails numerous alterations in the correct orientation of the land. It should be noted that, when measuring distances along the length, those of the *Tabula* correspond quite closely to the actual distances, unlike measurements along the width. The stretching effect is not so great as the compression and deformations depend on the shape and placement of the geographical areas (Fig. 2). Despite these errors, the map goes beyond the confines of the Roman Empire and reaches the Far East, where we can read *Hic Alexander responsum accepit. Usque quo Alexander*, referring to the known *oikoumene* borders (seg. XII, 4-5) [13].

Besides the symbolisation typical of the *Tabula* (from the monotonous outline of the mountain chains to the more detailed hydrography, even recording of minor rivers, and the variety of drawings for sites using a standardisation of levels that was useful to travellers in order to be able to see, at first glance, the location of the nearest "pit stop"), there are numerous ethnic-political and geographical textual annotations whose aim is not to provide travellers with precise indications. For instance: *Campi deserti et inhabitabiles propter aquae inopiam* (seg. XI, 2), *Saline immense quae cum luna crescunt et decrescunt* (seg. VII, 4) are specific comments on the environment, whereas the names of peoples and regions pertain to the

13. The document clearly shows an awareness that there was no correspondence between the extent of the Roman Empire and the world known by Romans. Material data now attest to Roman trade reaching the Far East. On the other hand, the western limits of the world known by the Romans are still under discussion today: see Russo 2013b regarding the hypothesis that America is a land discovered since Antiquity.

FIGURE 2a. Comparison between *Tabula Peutingeriana* and a geographical map: NE Italy.

historical feature; but to whom is addressed the following information: *Fossa facta per servos Scutarum* (seg. IX,1)? I could continue with more examples but let us reflect on the fact that most of the additional information is in those areas least covered by the road network, those of which the fewest details were known. This might be due to reasons of space since the background of the map has fewer sites as it moves eastwards, appearing empty in comparison with the western areas? Given the density of information in the regions west of Antioch, the authors would have presumably attempted to avoid overloading the map. With regard to the variety of indications recorded, the *Tabula* can be likened to a tool that helps users to create a mental map of a part of the world they would probably never see. It intuitively communicates information on the

FIGURE 2b. Comparison between *Tabula Peutingeriana* and a geographical map: NE Italy.

world they live in using cartographic language. We cannot but agree with Christian Jacobs when he says "This is the paradox of geographical mimesis: recognising what you have never seen"[14].

In other respects we are looking at a geopolitical map[15]: the *Tabula* is the heir of maps that had been the prerogative of power, the outcome of explorations prior to plans for conquest (of territorial or commercial domination), which had made cartography an obvious instrument of power[16]. The itinerary model makes the world map 'publishable'.

Ultimately, we have a map that records a lot of levels of information, which could be confusing although it must be admitted that the road network emerges clearly, even in the most data-intensive areas. In the same way, we are loading the IMW sheets with a large number of records in order to create the *Tabula Imperii Romani*, but the transition from paper to digital cartography means that the layers of information can be handled more easily, albeit requiring greater precision in positioning data, all the more so considering the present possibility to switch from general to detailed.

Luisa Migliorati

2. FROM THE PRINTED TO THE DIGITAL VERSION OF THE *TABULA IMPERII ROMANI*. SOME REMARKS ON THE BASIC CARTOGRAPHIC SYSTEM

The *Tabula Imperii Romani*, launched in 1928 by O.G.S. Crawford, was conceptualised using the *International Map of the World* (*IMW*) as its cartographic background. Its large scale (1:1,000,000) was chosen because it allows "a stratified inventory of archaeological finds from the areas affected by the greatest Roman expansion" (Sommella, 2006, 4). In the early 1970s, the use of the *IMW* was questioned by Robert A. Gardner who suggested, instead, the *World Aeronautical Chart* series, also at a scale of 1:1,000,000. The use of this new chart would have reduced costs significantly, as well as facilitating the introduction of a new style in the project (Gardner, 1973, 111). In fact, as pointed out by Gardner himself, problems of cartographic representation had frequently been brought up during the meetings of the scientific committee (Gardner, 1973, 108).

Notwithstanding a few changes in the graphic style of the sheets, the base cartography remained unaltered until the beginning of this century, when a new idea of digital cartography for the *Tabula Imperii Romani – Forma Orbis Romani* project was developed, employing vectorial cartography to overcome the obstacles resulting from the large reference scale. The project was originally developed using the program NetGis, an application in Java language allowing vectorial files in DXF format (Drawing Exchange Format - the export format of Autocad and Microstation), which can be consulted via any web server and

14. Jacobs 1990, 66.

15. See Montoya Arango 2007 for the spatial language of power between Antiquity and the modern age.

16. For Roman antiquity, see the passage by Suetonius (vita Domitiani, X, 3) on Domitian's death sentence for Mettius Pompusianus because he had circulated a world map.

browser[17]. Despite an initial attempt to make it available online, the K-32 sheet, produced under the joint direction of professors Paolo Sommella and Robert Étienne (curator of the French section) is still in paper format.[18] Only the records of the mapped sites were available online.

As the project has almost completed its transition to the digital format[19], several problems can finally be resolved. In addition to individual sheets at a scale of 1:1,000,000 (the cartographic background on which the archaeological evidence was mapped), each volume included a black and white map on which the boundaries of the *Tabula* were overlayed on a grid with a scale of 1:1,000,000 and which could sometimes include more than one sheet, as in the case of northern Europe (Fig. 3)[20].

This map, however, has no geo-topographical reference and is no longer capable of fulfilling cartographic requirements. The digital interactive system developed in recent years informs users immediately of the geographical limits of their search. The use of a new base map was suggested during a meeting of the International Commission of the *TIR-FOR* project on the new, digital consultation system of the *Tabula Imperii Romani* (Fig. 4)[21]. The transition from a printed version to a digital one changed the original layout that had been the inspiration of the *Tabula*: a "silent map" was no longer sufficient for the purposes of the project. The use of digital cartography has definitively resolved the problem of a neutral interface on which other layers can be overlapped.

17. http://www.formitaliae.it.

18. The innovation of the K-32 sheet lies in the fact that a new system to visualise the data on paper has been implemented and that a detailed map at a scale of 1:250,000 has been attached to each publication, which allows users to appreciate archaeological data in full detail (Sommella, 2006).

19. The digital project has not completely replaced the final printed version. Over the last few years, for the *TIR* project sheet J-34 has been published in printed format, produced under the direction of V. Antoniadis (2016), P. Karvonis (2016), G. Zachos (Zachos, 2016), while, for the FOR, the *Ager pomptinus I* (Ebanista, 2017).

20. The sheets including various countries caused a number of diplomatic problems which were only resolved in 1993, when the International Commission promoted cooperation between the countries involved in the project (Migliorati, 2014, 1956).

21. Institut d'Estudis Catalans, Barcelona, 12-13 May 2016.

The use of a physical map showing geographic features in the background, which replaced the earlier black and white one and on which it is possible to overlay other cartography (such as the borders of modern countries included in the territory of the Roman Empire), made significant improvements to the project. It is now possible, for instance, to define the geographic scope of a search in relation to both ancient and modern landscapes. The most challenging issue we are facing is specifically the geo-topographical framework, which is necessary both within the context of visualisation using a denominator of a scale to the million, and within the context of visualisation using the *Leaflet* system, the opensource JavaScript library currently used in the *TIR-FOR* project, which obviously guarantees a much more detailed view. The interactive cartographic background seems to be helping to resolve the problems regarding the rendering of archaeological features. Users can now carry out thematic geographical searches by simply showing or hiding one or more layers.

The system has been significantly improved since 2016. It is now possible to overlay several items on the default background, listed under the Geographic Information Layers tool[22]: peoples, rivers, geographical features (at the moment still in the form of a geometrical shape, only available for Spain but not *queryable*) and roads (only visible in the Hispanic provinces and for *Dacia*). Further tools could help to improve the system even further. It would be particularly useful, for instance, to add a layer with the boundaries of modern countries, which could be overlayed on the Google Satellite visualisation system[23], thereby allowing users to keep a physical background for their own research. These data, of course, will be combined with the area covered by the *TIR* sheets, and with the boundaries of the Roman Empire.

Direct access to the *DARE* (*Digital Atlas of the Roman Empire*, Centre for Digital Humanities, University of Gothenburg, Prof. Johan Ahlfeldt), which users can overlay on the *TIR*, fills the gap

22. https://tir-for.iec.cat/tirfor/showMapPage.

23. Nowadays, in fact, the modern cartographic elements are only replaceable with the default physical cartography. In the interactive menu it's possible to choose between other cartographic layers among ESRI Roads, Google roads, Google Satellite and Gray.

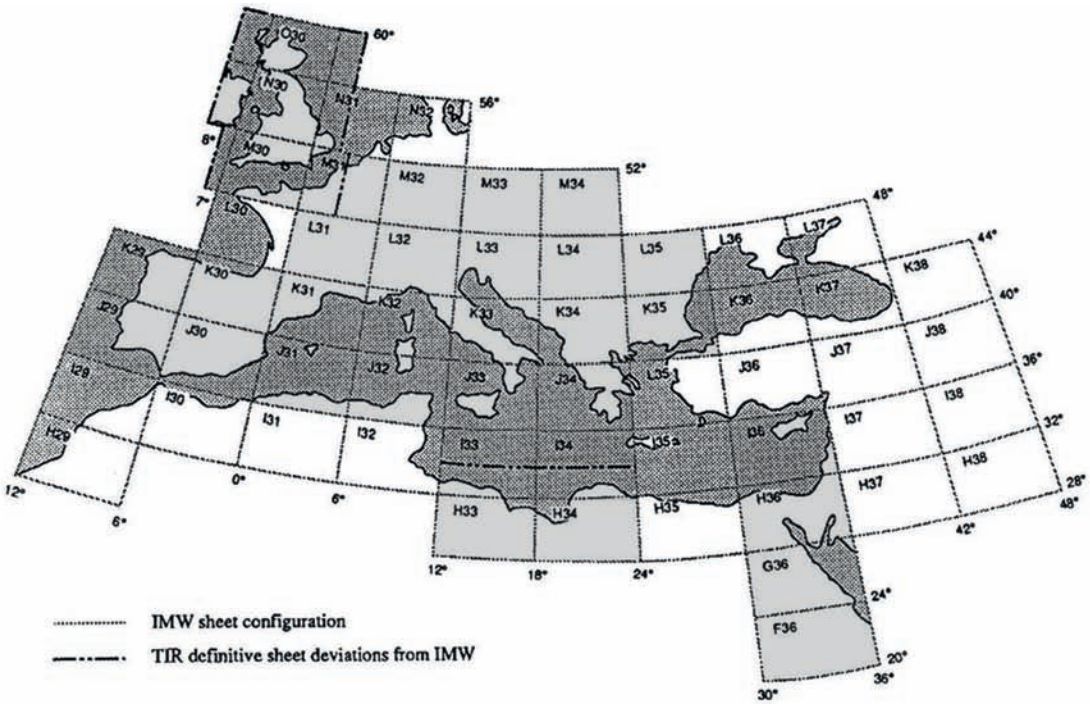

FIGURE 3. TIR and IMW sheets configuration (from Talbert, 2018). In grey: the TIR sheets published from the 1930s to 2016.

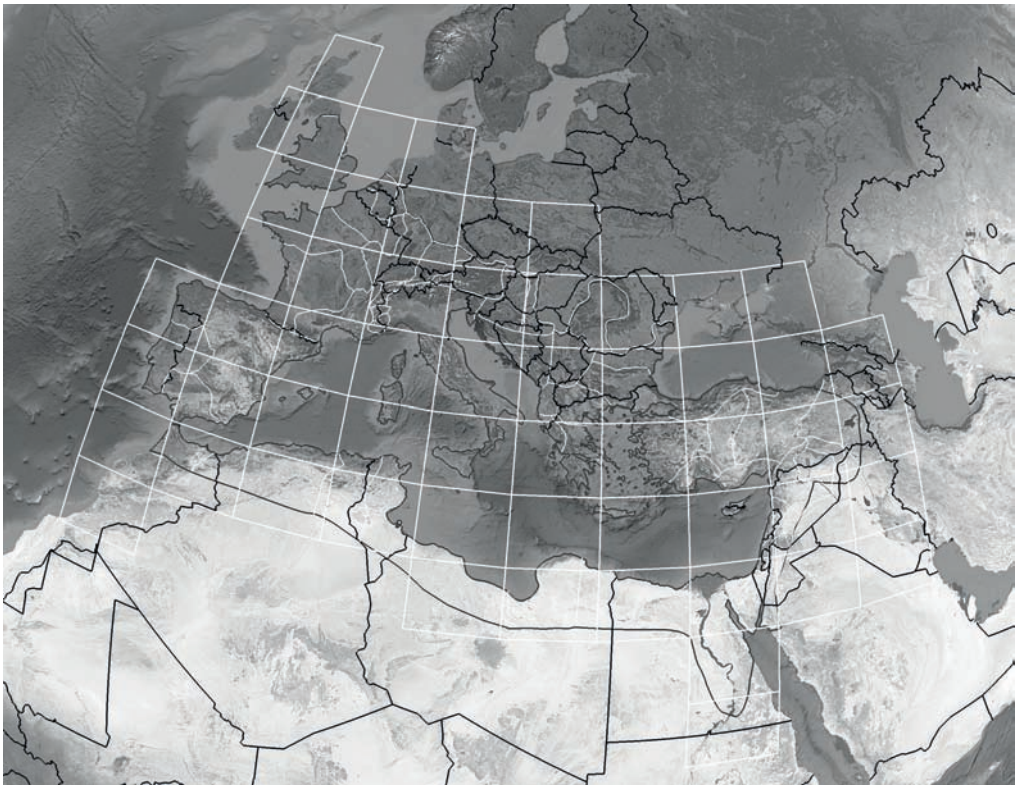

FIGURE 4. Proposal of a new base map produced on GIS and Google Earth with the limits of the IMW series, the boundaries of the Roman provinces, the limits of the Roman Empire at its maximum expansion and the boundaries of modern states. Rendering: Ilaria Trivelloni.

between the provincial division of the territory and the road network. The project can be completely superimposed on the *Tabula*, not integrated with it: when shown, the *DARE* covers all the other layers except for the archaeological sites featured on the *TIR-FOR*.

Even though there is still much that can be improved (e.g. we should aim to allow broader, simultaneous queries of all the layers), significant progress has been achieved so far. This new digital map, although still under development, will prove helpful in creating an increasingly specialised cartography, which could facilitate research. Given that the transition to digital cartography is almost definitive, the innovativeness of research should also be achieved via the increasing specialisation of the cartography included in the database. A turning point could definitely be the introduction of cartographic layers showing, for instance, the geomorphology of specific areas. This process would also enable valuable collaboration with other opensource systems. As the 1:1,000,000 scale is no longer a constraint, it's now possible to introduce tools which would allow the archaeological features mapped in the *TIR-FOR* to be seen in detail, yet without losing contact with their broader geographical setting.

The creation of an interactive map and the consequent creation of "talking cartography" are amongst the most important results in the transition of the *Tabula Imperii Romani* to a digital platform, in that they helped to overcome the many visualisation issues entailed in printed cartography at a scale of 1:1,000,000.

Ilaria Trivelloni

3. Data transposition problems from the printed to the digital maps: some considerations

This paper stems from some considerations generated within the work of the TIR Italian team that dealt, from 2015[24], with the transposing of the map published in the *Tabula Imperii Romani. Sheet K-32 Firenze* (Sommella, 2006a) to the TIR web platform (https://tir-for.iec.cat/).

From a practical point of view, the plan was to transpose the sites reported on the printed maps, specifically published as a general map (1:1,000,000 scale) and detailed maps (1:250,000 scale), both in the UTM geographic network and sexagesimal degrees[25]. The operating mechanism has proven to be quite complex from the beginning, as the problem of the precise geo-location of the data has immediately arisen.

Nowadays, the digitisation of numeric data in cartography is immediate and expeditious, without using printed maps, the coordinates be obtained manually by geometric trilateration or from GPS systems, with a low margin of error or at least a quantified error rate, respecting the maximum scale of the final display (both digital and printed). Also the 1:1,000,000 scale of Sheet K-32 was produced to be "read" exactly at this specific scale and therefore the dot-shaped elements indicating the archaeological evidence are of a suitable size for easy reading (not too small), but also for the correct localisation of sites.

The problem arises when transposing the dots on the TIR web platform. The maximum graphic display scale can reach approximately 1:10,000, as is the case for the most common online maps, such as Google Maps or Google Earth, or libraries used to build web mapping applications, such as Leaflet (Lazzarin, 2007). Note that 1:10,000 is a graphic scale generally used for activities in the field and archaeological surveys, even larger than the one used in the FOR project[26].

So, once a dot has been transposed on the GIS it will correspond to the centroid (calculated as precisely as possible) of the dot or of the symbol represented on the printed map. In the 1:1,000,000 K-32 map the evidences are marked by dots with a diameter of approximately 1 mm, hence the practical difficulty of considering its centroid. In order to make this operation as precise as possible, the map was scanned and the coordinates read using digital image processing software, so as to draw more precise perpendicular and parallel axes

24. The work was first carried out only by the writer, and from 2016 also by Ilaria Trivelloni and from 2020 also by Dario Canino and Alessandro Vecchione.

25. Series 1301 - Sheet N. K 32.

26. Usually 1:25,000 for the Italian series of the *Forma Italiae* (http://www.formitaliae.it/).

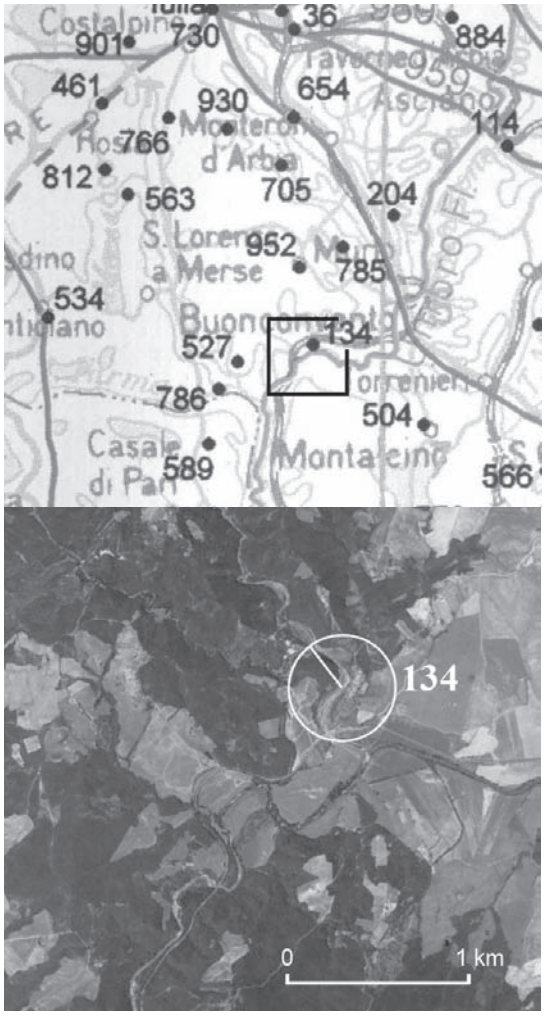

FIGURE 5. Comparison between the map printed on Sheet K-32 (at the top) and the visualisation in Google Earth (at the bottom). The area indicated in the square on the map corresponds to the satellite image window at the bottom, the circle is the extension occupied by point no. 134. Base: on the top Sommella, 2006a tab. I, on the bottom Google Earth. Rendering: Laura Ebanista.

than with manual instrumentation. In spite of this, considering the scale ratio, the dimension covered by the surface of a 1 mm dot is equivalent to 785,000 m^2, therefore 0.785 km^2 (Fig. 5). This situation does not improve with 1:250,000 scale maps where the evidences are marked not by dots but by symbolic graphic elements that occupy more space (Sommella, 2006b, 22-24). The symbols have an average size of 4 × 4 mm, therefore the occupied area corresponds to about 1 km^2. The use of dots and non-graphic elements would obviously be preferred in this circumstance but also in general: a graphic element is usually of irregular shape (it's therefore more complex to calculate the centroid) and occupies an area that is too large in reality (regarding this topic in archaeological cartography, see Guaitoli, 1999, 361). It should also be considered that, even if a symbol of minimum size is used, you cannot go below a certain threshold, on the one hand because it would be impossible to represent this graphically and, on the other, because the human eye can only perceive these as two separate points when they are placed at most 0.10-0.17 mm (Walker 2012, 507-509).

It is evident that an area of about 1 km^2 (the one covered by the dot on the map) cannot refer to specific evidence such as a *villa*, cistern or bridge, but to a series of items. On the TIR online platform (https://tir-for.iec.cat/) there are two levels of detail for the entries of archaeological evidence: "Main typology" (mandatory) and "Elements" (optional). This choice facilitates the reading of data in this respect[27]: a macro-site is produced to which many elements refer. Nevertheless, the problem of precise localisation remains, "Main typology" being an area that incorporates more specific evidence within it. On the other hand, positioning can lead to considerable error when working only with dots and not with areas.

The key point is always the source of the data and the positioning methodology on the map, using a certain graphic scale during the specific search.

This problem will be partially overcome when the positioning on the TIR-FOR web platform starts with the entry of data in the FOR records[28], which are usually positioned on a map scaled to 25,000. This scale is more compatible with the best graphic visualisation possible using a web map viewer (about 1:10,000). In this case, the transition to the TIR would consist of selecting and grouping data from the FOR records, in line with the graphic scale. For

27. On this topic, see https://tir-for.iec.cat/methodology-2/.

28. See https://tir-for.iec.cat/wp-content/uploads/TIR_FOR_record_sheet-1.pdf.

example, a *villa*, a cistern and necropolis could be merged in the same record, albeit noting that their overall size may be less than the real size of the dot that represents them.

For example, Fig. 6 shows a proposal to handle such matters, as presented in Barcelona during the meeting of the International Commission for the TIR-FOR held in 2016. It is an excerpt from the archaeological map of the *Forma Italiae Ager Pomptinus I* (Ebanista, 2017, tab. I out of text). This is an area of the southern *Latium* coast, at the mouth of the Rio Martino canal, a watercourse dug in Roman times. This small area forms part of a larger region, the *Ager Pomptinus*, a territory characterised since Antiquity by the presence of extensive swamps. Many attempts have been made to reclaim this area, from Volscian, then during the Roman age, until the Papal reclamations and up to the so-called 'Bonifica Integrale' (Full Reclamation) of the 1930s. In the archaeological map there are 18 items of evidence, among dots, areas and polylines.

The map edited in the *Forma Italiae* volume is produced on a 1:10,000 CTR (Regional Technical Map) then scaled to 25,000. The location (Fig. 6) is clear and precise in relation to the printed map, also taking advantage of the extremely flat territory and a map with few contour lines, which remains legible even when reduced in scale. Starting from this map that corresponds to the FOR digitisation, it is possible to hypothesise its transposition to the TIR display.

At the mouth of Rio Martino (no. 12F)[29] there are buildings related to a Roman *villa* (no. 11F). Based on the different data collected, there is the *Clostris*, one of the *stationes* of the *Via Severiana* (no. 13F), a coastal road known from *Tabula Peutingeriana*. 2 km further inland, along the Rio Martino canal, there is another *villa* (no. 2F), identified thanks to the large amount of pottery and architectural material, periodically unearthed during seasonal ploughing. The presence of buildings is also confirmed by an unedited 18th-century map that locates structures when they were still visible (Ebanista 2017, 28 Fig. 22). Furthermore, some funerary inscriptions (no. 5F) are known, most likely related to a necropolis in connection with *villa* no. 2. There are also sporadic fragments and areas of pottery and architectural material in the surrounding area (no. 1-3-4-7-8-9-10-14-15-16-40-41F).

Processing the findings of this area and transferring them from the FOR to the TIR web platform (or ideally on a 1:1,000,000 map) whose graphics only uses dots and not areas, only two records would be achieved, corresponding to the buildings located at the mouth of the Rio Martino, along *via Severiana*, interpreted as *Clostris statio* (no. 11F), and another related to the *villa* along the course of the canal, in a more internal position (no. 1-5F).

The result is represented by the two areas superimposed on the archaeological map in Fig. 6; areas of 1 square km have been drawn, corresponding to the dot of 1 mm in diameter, in comparison with the map of the K-32 at 1,100,000. The figure shows how, in going from the 25,000 to the 1,000,000 map, it is not possible to go into more detail. In the case of record 2, for example, the *villa* will be classed as "Main typology" and the necropolis and pottery as "Elements".

This issue is complex, as can be seen by this small example. Although we live in the digital era and the processing of digital cartography is increasingly widespread compared to printed formats, I am convinced that printed cartography cannot be abandoned. On one hand, because the vast majority of scientific archaeological cartography is, today, still published in printed form (for the Italian territory, the TIR Sheet K-32, the *Forma Italiae* series, as well as numerous other publications of various kinds), and on the other hand because it's undeniable that, even today, although cartography may be processed digitally, the outcome of research is always in a printed format.

Therefore, although GIS would seem to overcome every problem linked to graphic scales (it is possible to use, as a cartographic base, any kind of map at any level of scale or photographic and satellite images), the issue is still complicated. Despite GIS being a large container of data that enables comparisons and interpolations during the study and research phase, it's always necessary to consider whether data will be consulted in its printed or digital form, as well as the graphic scale

29. The numbers (12F, for example) refer to those marked on the archaeological map in Fig. 2. The corresponding texts are published in Ebanista, 2017, 47-59.

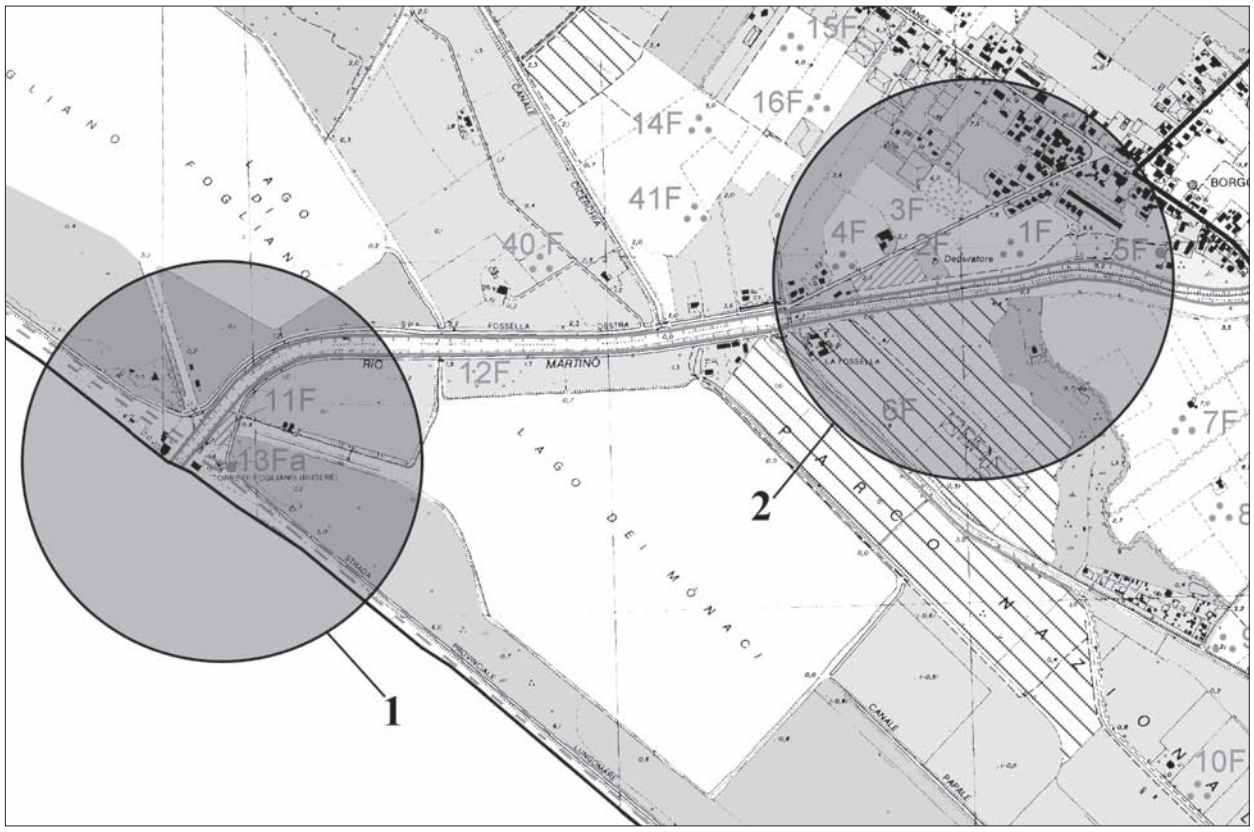

FIGURE 6. The two areas superimposed on the archaeological map represent the two hypothetical points of the TIR of 1 mm in diameter. Base: Ebanista, 2017, tab. I out of text. Rendering: Laura Ebanista.

required for the basic cartography or virtual map viewer.

Laura Ebanista

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