The Geometry of Dura-Europos town-planning

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Here we will consider the town-planning of Dura-Europos, a Hellenistic, Parthian and Roman town, built on an escarpment above the right bank of the Euphrates river. In particular, we will show that the geometry of the layout of this town is based on a right triangle having a ratio of its catheti equal to 1:2.

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Dura-Europos, also known as Dura-Europus by Latin people, was a Hellenistic, Parthian and Roman town. This center was built on an escarpment above the right bank of the Euphrates river. The Romans greatly enlarged it, so the town became their easternmost stronghold in Mesopotamia [1]. The center was captured by the Sasanian Empire after a siege in 256-57 AD; the population was deported and the town abandoned. Dura-Europos was covered by sand and mud, and disappeared from sight until it was rediscovered by an American expedition in 1885 [1,2]. For this reason, as told in [1], Dura-Europos "is extremely important" for archaeological researches. "As it was abandoned after its conquest in 256–57 AD, nothing was built over it and no later building programs obscured the architectonic features of the ancient city". Therefore, it is clear that all what we can find in this town is frozen to the date of the siege. In particular, the town planning was preserved as its was and today is clearly visible in the satellite images.

In [3], we find told that the "origins of Dura remain obscure, but Seleucus I probably established "Europos", ... ca. 300 BCE., the city grid may reflect this Hellenistic foundation." About the town planning of Dura the author of [3], Karen B. Stern, is referring to [4]. Accordingly, we could tell that Dura-Europos possesses a Greek town-planning of the Macedonian Age, preserved by the Roman conquerors.

About the Macedonian towns, we have detailed discussions in [5]. Here we report some passages from this book, that we can find in the chapter about this historical period. "Macedonian army conquered the East and his successors for several generations ruled over western Asia, when Macedonians and Greeks alike flocked into the newly-opened world and Graeco-Macedonian cities were planted in bewildering numbers throughout its length and breadth. Most of these cities sprang up full-grown; not seldom their first citizens were the discharged Macedonian soldiery of the armies of Alexander and his successors. The map of Turkey in Asia is full of them. They are easily recognized by their names, which were often taken from those of Alexander and his generals and successors, their wives, daughters, and relatives. Thus, one of Alexander's youngest generals, afterwards Seleucus I, sometimes styled Nicator, founded several towns called Seleucia, at least three called Apamea, and others ... ." Then, Dura-Europos is another town that we have to add to the long list of centers founded by the Nicator. This town is not discussed in [5].

Haverfield continues telling that "Many discoveries show that these towns were laid out with a regular 'chess-board' street-plan." And this is true for Dura-Europos too. "That method of town-planning - continues Haverfield - now [that is, during the Macedonian Age] made definite entry into the European world. No architect or statesman is recorded to have invented or systematically

encouraged it. Alexander himself and his architect, one Dinocrates of Rhodes or perhaps of Macedonia, seem to have employed it at Alexandria in Egypt, and this may have set the fashion." Alexander's successors planned the foundation of their centers on this fashion. "But no ancient writer credits either the founder or the architect of Alexandria or the founder of Nicaea with any particular theory on the subject. If the chess-board fashion becomes now, with seeming suddenness, the common rule, that is probably the outcome of the developments sketched in the last chapter [of Ref.5]. Approximations to chess-board planning had been here and there employed in the century before Alexander. When his conquests and their complicated sequel led, amongst other results, to the foundation of many new towns, it was natural that the most definite form of planning should be chosen for general use."

A fundamental observation is then provided by Haverfield, linking the Macedonian town-planning to the regular layout of the Roman town-planning. "We might, however, wonder whether its adoption was helped by the military character of the generals who founded, and the discharged soldiers who formed the first inhabitants of so many among these towns. Military men are seldom averse to rigidity. It is worth noting, in this connexion, that when chess-board planning came into common use in the Roman Empire, many of the towns to which it was applied were 'coloniae' manned by time-expired soldiers".

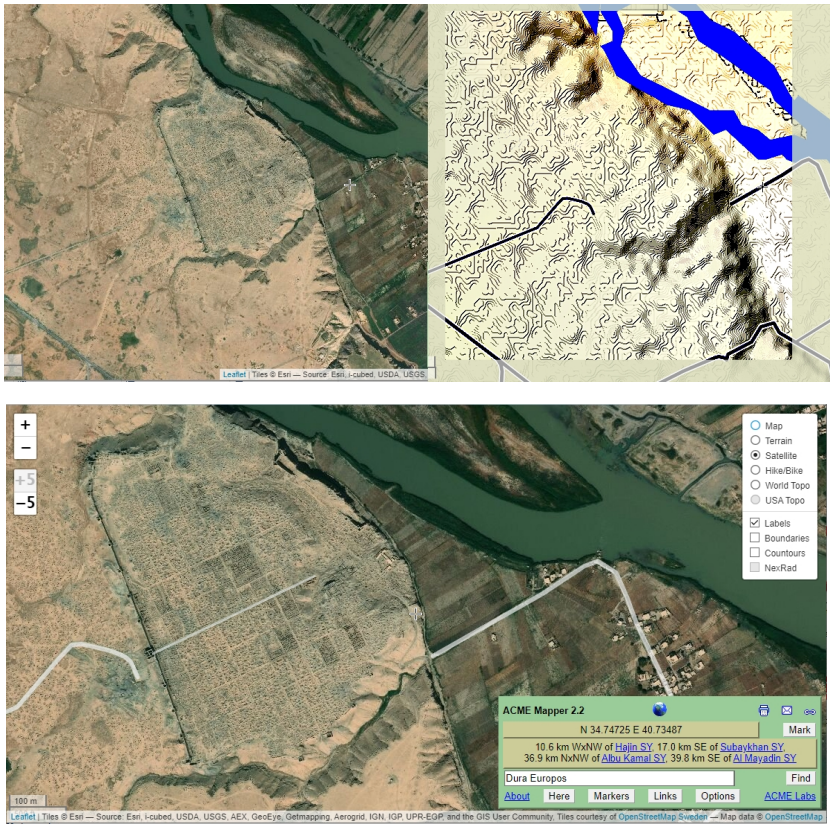

Figure 1: Dura-Europos. The image is made by satellite and terrain maps from ACME Mapper (https://mapper.acme.com). Many thanks to this site for providing such a precious help for the study and research about the planning of ancient towns. In the lower part of the image, we can see the main street, the decumanus, running from the main gate of Dura Europos.

Following Haverfield, we investigated the Macedonian town-planning in [6,7]. In particular, in these works we searched for astronomical orientations in the planning of towns and temples. So we could consider an astronomical orientation for Dura-Europos too. However, before considering it, let us see the location and the layout of the town in satellite images (Figure 1).
It is clear that the location of the site is strongly constraining the orientation of the town-planning. However, let us consider a possible astronomical orientation, as made in [6]. If we use the web site https://www.suncalc.org/, we can easily see that the decumanus is oriented according to the sunrise about 21 May or 21 July (the horizon is assumed as an astronomical horizon). Here the role of the natural horizon is not considered, because it is beyond the aim of the investigation. We could also consider the moonrise. The direction of the decumanus of Dura could be close to the northernmost possible moonrise according to a minor lunar standstill (for a discussion on lunar standstill, see please [8]). However, it does not seem that a specific astronomical orientation had been considered in the layout of the town.
In fact, it is the geometry of the town-planning which is very attractive. As we have discussed in some previous works [9-13], the geometry was used to rotate properly the grid of the town-planning to have the best possible agreement to the local environment. We have seen in [9-13] some examples showing that the orientation of the Roman towns was based on the geometry of right triangles, according to the rules of the "varatio" [14-19]. That is, in Roman towns the directions of the decumanus and the kardo, roads which are crossing at right angle, are determined by the catheti of a right triangle. The hypotenuse of the triangle is along the east-west direction.
In the case of Dura-Europos we have the right triangle shown in the Figure 2. The angle between the yellow and the red lines, that we can determine by means of the satellite images, is between 25° and 26°. The ratio of catheti is between 0.465 and 0.488. Therefore the ratio is close to 1:2, observed in [10,11].

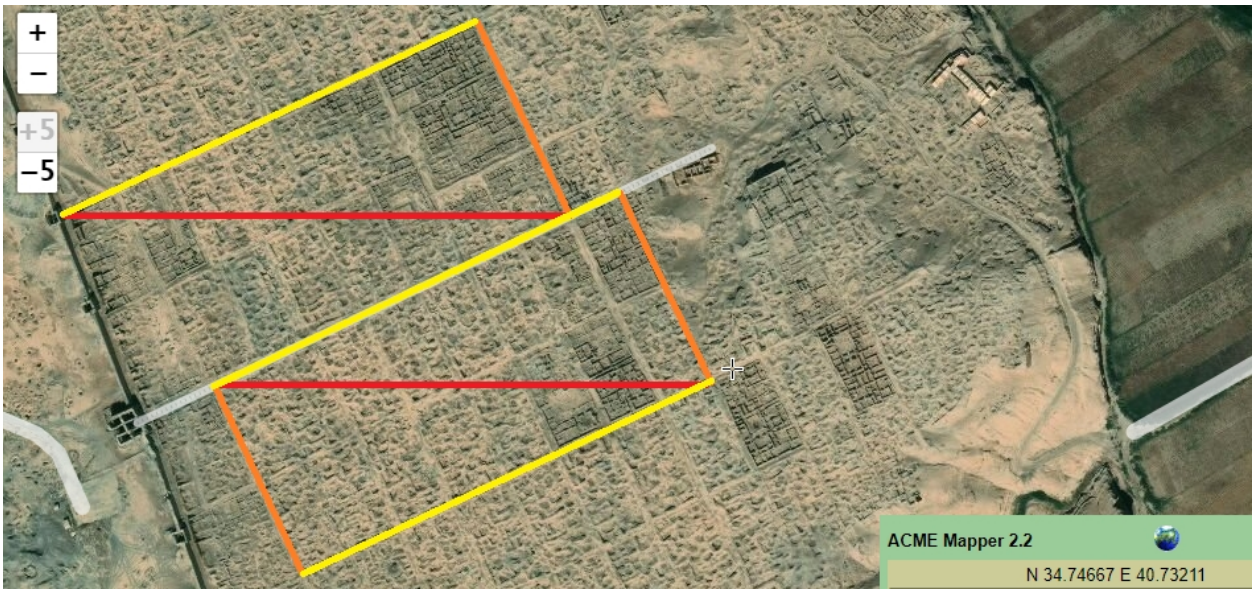

Figure 2: The right triangles in the planning of Dura-Europos. The image is made on a satellite map from ACME Mapper (https://mapper.acme.com). Many thanks to this site for providing such a precious help for the study and research about the planning of ancient towns.

In Dura-Europos, as told in [20], "the grid pattern, with block sizes of 70 x 35 meters and a street width of 7-8 meters, dated from the second century BC, when Dura was rebuilt as a Hellenistic city." Actually, the insulae (blocks) are rectangular, as those of the Roman Iulia Concordia in Italy, which has a ratio 1:2, too. The same ratio can be observed for Torino, Iulia Augusta Taurinorum, in this case with square blocks. In the plan of Dura-Europos, if we consider half an insula as the fundamental unit of the town-planning, that is a square block of 35 x 35 meters, the catheti in the Figure 2 have their lengths which are 8 and 4 times the size of this unit, respectively.
It seems therefore that geometric rules were used to orient the town planning in the chosen landscape for Dura-Europos. Then the geometric approach, based on right triangles, was a method common both in Hellenistic and Roman surveying processes.

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