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The Western Han Dynasty Pyramids and their Orientation in TessaDEM Elevation Maps

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Abstract: The burial complexes of the Western Han dynasty have two main elements, which are the huge pyramidal mounds of the emperor and his empress. Besides these pyramidal pair mounds, also known as Chinese Pyramids, each burial complex included a mausoleum city and a satellite burial area. In 2012, we discussed a possible orientation of the two main pyramids according to the sunrise and sunset on solstices and equinoxes. Here we must consider again this solar orientation in the framework of another relevant aspect of the Chinese Pyramids Xianyang's area, that is the geographical location according to elevation maps. TessaDEM kindly provides the elevation maps, via the topographic-map.com web site. Interestingly, the maps are showing that the position and orientation of the pyramids is consistent with local elevation profiles.

Keywords: Satellite Imagery, Elevation Maps, Tessadem Maps, Surveying, Chinese Pyramids, Western Han Burial Complexes

Introduction

Near Xianyang, China, huge truncated pyramidal mounds exist. These mounds, which belong to the ancient Chinese imperial burial sites of the Western Han dynasty, are also known as "Chinese Pyramids". In the satellite images, we can clearly see the burial complexes, where the main elements are the mounds of the emperor and his empress. In 2012, we discussed a possible orientation of these two pyramids according to the sunrise/sunset on solstices and equinoxes. Now, we consider again the orientation, in the framework of what has been explained by Xinian Fu et al., 2002, in their book about Chinese Architecture. Moreover, we must consider another aspect of the Chinese Pyramids of Xianyang's area, that is, their geographical location according to elevation maps. TessaDEM kindly provides the elevation maps, via topographic-map.com web site. Interestingly, the maps are showing that the position and orientation of the pyramids is consistent with local elevation profiles.

Xianyang is the third largest city in Shaanxi province. This city is the most famous ancient capital of China. It seems that the name of Xianyang relates to the geographical location of the city. According to Wikitravel.org, "*Xian* has a meaning of "both" and *yang* has a meaning of "bright (sun)"." Xianyang is located in the south of mountain ranges and in the north of Wei River. "Generally, the south of the mountain and the north of the river, there are always more sunlight. Thus, Xianyang is named with the meaning of "double bright sides of mountain and river" (wikitravel.org, archive). And also: "Xianyang was among the capital city's environs during the Western Zhou dynasty, and was made the capital of the state of Qin in 350 BC during the Warring States period before becoming the capital of China during the short-lived Qin dynasty" [Wikipedia]. Since the city is south of mountains and north of a river, "both sunlight-rich (yang) orientations", it gained the name of "Xianyang", meaning "fully yang" [Wikipedia]. Yang is one of the two complementary forces, with Yin, of the Yinyang concept of life (Britannica).

Clearly, the Xianyang name is indicating a specific geographical location. Let us see it in the TessaDEM elevation maps by topographic-map, (Figure 1).

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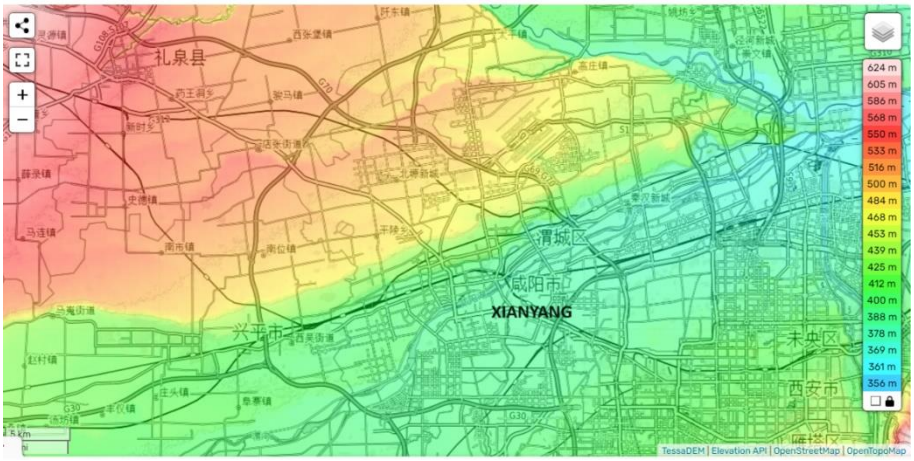

Fig.1: Elevation map of Xianyang area, courtesy en-gb.topographic-map.com.

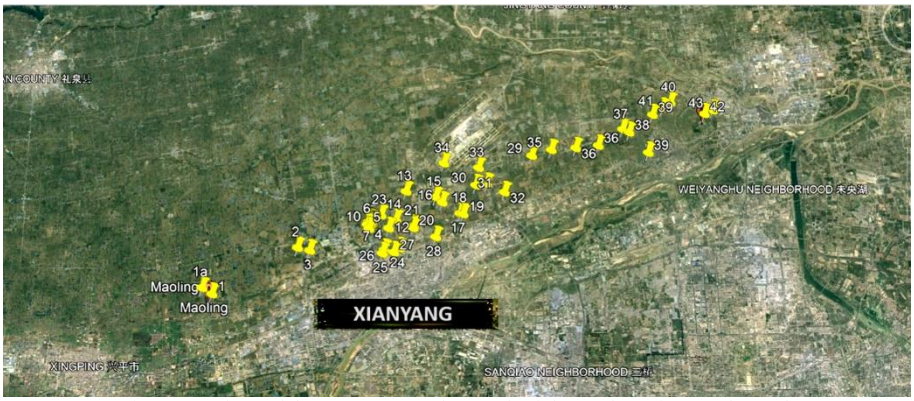

Fig.2: Locations of the Western Han dynasty burial complexes in Google Earth

The map in the Figure 1 is based on TessaDEM, https://tessadem.com. According to the web page, "TessaDEM is a near-global 30-meter Digital Elevation Model (DEM). The aim of TessaDEM is to provide an elevation database representing the Earth terrain by combining 30-meter spatial resolution and tree height bias removal. To achieve this, elevation data were merged and adjusted from multiple sources according to tree height, urbanization and water presence using AW3D30, MERIT DEM, Forest Height, World Settlement Footprint and Global Surface Water. Elevation data can be viewed on topographic-map.com which uses TessaDEM as the data source." TessaDEM is licensed under the Open Database License (ODbL) v1.0. We are grateful to topographic-map.com and TessaDEM, for the opportunity to study the area of Xianyang with their remarkable tool.

About Xianyang, let us add that it was under the Duke Xiao of Qin's reign, that the city had been designed as capital. In 350 BC it was organized the relocation of the Qin's administration from the old capital Yueyang to the new city. Xianyang became the capital for over 140 years. In 221 BC, Qin Shi Huang conquered the other warring states. He established the first centralized empire in Chinese history. Therefore, Xianyang became the pivot of politics, economy and culture of Qin Empire. For his afterworld, Qin Shi Huang built a huge mausoleum, accompanied by his Terracotta Army. "This and other large undertakings diverted enormous levels of manpower and resources away from agriculture. Coupled with the state's repressive measures on the population, these factors eventually led to the fall of the Qin dynasty and with it the original city of Xianyang" [Wikipedia].

As previously told, Xianyang is located on the northern bank of the Wei River, "on the opposite side of which" Liu Bang built the Han dynasty new capital of Chang'an, once he became emperor [Wikipedia]. Liu Bang was the Emperor Gaozu of Han (256 – 195 BC), reigning from 202 to 195 BC [Wikipedia].

Fig. 3: Position of Chang'an according to Wikipedia. The map is a courtesy en-gb.topographic-map.com.

As the Figure 1 clearly shows, the terrain north of Xianyang is elevated with respect to the city, that is, it was certainly preserved from floods in ancient time. Then, this was a proper place for the mausoleums of the emperors, a place protected from flooding. In fact, it is in this large area north of Xianyang, see the Figure 2, that we can find the Chinese Pyramids. Wikipedia provides us a list of the related mausoleums complexes.

The orientation of pyramids

Near Xi'an, in the Lintong district, we can find the huge Mausoleum of the First Qin Emperor, Qin Shi Huang, accompanied by his large Terracotta Army. The Mausoleum is a truncated pyramid. Pyramids continued being built for several centuries, during the following dynasties that ruled China. The shape of the Chinese pyramids is different from those of the ancient Egypt because they have a flat top.

We have already discussed the orientation of the Chinese pyramids in 2012. About the orientation, we mentioned Charvátová et al., 2011, that considered the Chinese tombs oriented by magnetic compasses, and Vance Russell Tiede, who considered an astronomical orientation of them. The paper by Charvátová et al. is telling that the pyramids near the cities of Xi'an and Luoyang, together with their suburban fields and roads, are clearly showing a spatial orientation, sometimes along a South North cardinal direction, sometimes with deviations of several degrees to the East or West. The researchers are telling that architects and surveyors used a magnetic compass. For this reason, they oriented the survey according to the North magnetic pole and not according to the geographic pole. Of course, an orientation according to the local terrain must be considered too. Astronomical orientations were proposed by Vance Russell Tiede, who is telling that two ancient Chinese texts of the Western Han Dynasty, ca. 100 BC, record that the Imperial Astronomer was used to make solar observations to determine the solstices and equinoxes, and for determining the cardinal directions with a circle and gnomon. Moreover, Tiede tells that, during his investigation of the Chinese pyramids, he determined several astronomical orientation patterns.

In our work of 2012, we proposed how sunrise and sunset are linking the Chinese pair pyramids of the emperor and his empress, starting from the mausoleum of Emperor Xiaojing of Tang near Goushi (Henan) and its satellite pyramid of Empress Ai (see Figure 2 in arXiv). The Tang Dynasty ruled during the VII-VIII centuries CE. Are the earlier pair mounds of Western Han emperors and empresses displaying some solar orientations too? The answer is positive. We can apply software to evidence sunrise/sunset on satellite maps of these complexes. The results have been shown in Figures 3 and 4 of our arXiv paper. In the Fig.3, the directions of the sun on winter and summer solstices are given, as we could see from the pyramids of the Changling and Maoling groups. Note that in the Changling groups (III century BCE), the two mounds have the same size. In that of Maoling of the II century, the empress' mound is smaller. In the Fig.4 of arXiv, we see again the sun on winter and summer solstices over the pyramids of the Duling and Weiling groups, both built during the first century BCE. In the Duling group the two mounds have the same size. In that of Weiling group, the empress' mound is smaller. It seems therefore that there was not a specific rule governing the relative sizes of the emperor/empress mounds.

As told in 2012, regarding the Figures 3 and 4 in arXiv paper, we imagined some possible places to observe the sun near or over the pyramids, from where it was possible to see the direction of the rays of light linking the two pyramids. Possibly, this fact was considered in the planning of the two mounds, in such a manner that the sun's light could join the consorts in their afterworld. Of course, since the pyramids are quite large, several other locations to observe the sky exist, changing the overall effect.

Imperial Tombs

Let us consider what we can find in the book entitled "Chinese Architecture. The Culture & Civilization of China", by Xinian Fu et al., 2002, translated by Nancy Shatzman Steinhardt, for the Yale University

Press.

The "Western Han tombs form a coherent imperial unit that shields the capital to its north and northwest. … Each imperial tomb consisted of four parts: the mounds, one for the emperor and a smaller one for the empress, located within a precinct known as the funerary precinct (lingyuan) that may have been walled; aboveground ritual halls; the funerary city (lingyi), believed to have been walled, where workers lived during tomb construction and where tomb caretakers continued to reside after imperial interment; and auxiliary tombs that could include burial plots awarded to officials for service to the emperor or servant/slave tombs" (Xinian Fu et al., 2002).

Therefore, as in the case of the Egyptian pyramids, the Chinese huge pyramidal mounds were not the only elements of the burial complexes. They required a large logistics environment for their building and maintenance, as stressed by the presence of a workers' city.

Fig.4: Satellite image courtesy ACME Mapper 2.2 of the Western Han Changling site. According to Wikipedia, the tomb for the emperor is in the west and empress tomb is to the east. Satellite tombs are located east of the Chang Mausoleum. "There are about 60 earth mounds in the satellite tomb area that exists today, making Changling the most numerous of subordinate tombs of the Western Han dynasty imperial tombs" (Wikipedia, mentioning Ji Yang, 2006, and ChinaCulture.org, 2008).

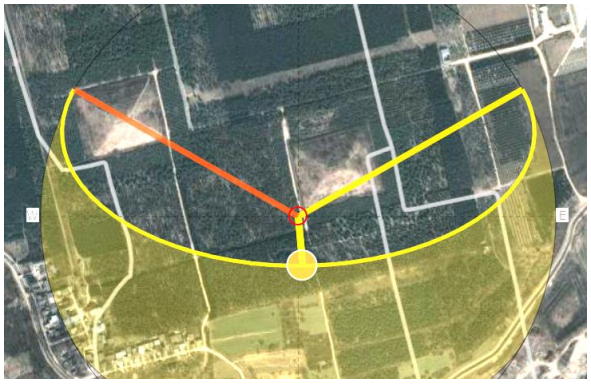

Fig.5: The Changling complex and the sunrise and sunset on summer solstice. Courtesy suncalc.org. See also the figures in arXiv, 2012.

"Changling, tomb complex of the Han founding emperor, who died in 195 BCE, and his empress, who died in 180 BCE, was the hub of all subsequent Western Han imperial burials. … The funerary city north of the burial precinct was walled only on the north, south, and west sides, a situation described in records of the capital and confirmed by excavation. Auxiliary tombs were to the east. They included large tombs that belonged to loyal ministers of the first Han emperor as well as simple burials, presumably for servants" (Xinian Fu et al., 2002).

Anling is the burial complex of the second Han emperor Huidi and his wife. This complex is "due west of his parents' graves" (Xinian Fu et al., 2002). Xinian Fu and coauthors explain that "The names of the first two Han imperial tombs may be taken from the characters chang and an, which form the name of the capital, resulting in Changling and Anling; ling means royal tumulus". It is also explained that "the placement positioned subsequent emperors right and left of Liu Bang in the manner of successive sons who, in a traditional Chinese-style house, reside according to birth order in rooms right and left of the central room in which homage is paid to the ancestors" (Xinian Fu et al., 2002). Therefore, in the book by Xinian Fu and coauthors, we can find a very important reference to the relative location of the burial complexes. "The placement also suggests the implementation of the zhaomu system". This system had its origin during the reigns of the sixth and seventh Zhou kings that is at the beginning of the tenth century BCE. As "intended specifically for funerary temples, the zhaomu system prescribed that the founder of a dynastic line be positioned in the center, … for the second ruler, to the founder's left" (Xinian Fu et al., 2002). The third ruler is placed to the founder's right. The "fourth and sixth rulers would be to the left, and the fifth and seventh be to the right" (Xinian Fu et al., 2002). Therefore, we find that Anling was placed to the first ruler's left, when we are facing north. The tomb of the third ruler was placed "to the right, although as explained below, far to the south" (Xinian Fu et al., 2002). Xinian Fu and coauthors explain the reason of the location, motivated by dynastic competition with the relatives of Liu Bang's widow, Empress Lü. The third Han emperor "was buried thirty-seven years later in a

tomb called Baling, named after the Ba River along whose bank it was situated. This first of two southeastern Han royal tombs may have been the result of a desire to be distant from the woman who had usurped power for the previous eight years and to counterbalance evil forces that might emanate were it closer to Empress Lü's grave" (Xinian Fu et al., 2002). Baling was the first imperial tomb carved into natural rock.

Fig.6: The Yangling Mausoleum of Emperor Jing (ruled 157–141 BCE), sixth emperor of the Western Han dynasty, at the center of the satellite image, and of his Empress Wang. In this case too, we can find the pyramids linked by the sun. In the image it is shown the case of the sunrise on summer solstice. Courtesy suncalc.org.

Yangling is the burial complex of the fourth Han emperor, who reigned from 188 to 141 BCE. This tomb "has received tremendous attention since the 1990s when hundreds of naked figurines (possibly originally clothed with perishable materials) were excavated in pits adjacent to the tumulus". Yangling is characterized by individual funerary precincts with square layouts for the emperor and empress. "The mounds may have been planned to imitate the ruling pair sitting on a throne" (Xinian Fu et al., 2002). It is interesting that the layout is representing the ruling pair on throne; however, we can find also a solstice solar link between the pair, as shown in the Figure 6.
Xinian Fu and coauthors are also telling the following: "A circular, stone compass divided into quadrants by bisecting lines was placed on an imaginary line that would have run between the two mounds". "In the construction of the Yangling Mausoleum, [the Compass Stone] was used to measuring the horizontal line and the height. It is the earliest measuring stone found so far and one of the most important ritual buildings in the Yangling Mausoleum … In 1999 archaeologists excavated the surrounding area of the Compass Stone and found that the inside area has two layers. In the center, there is a square platform about 54 meters wide with 3 doors on each side and a total of 12 doors. Hollow bricks unearthed in the gateways have patterns of the Four Gods, namely Azure Dragon, White Tiger, Vermilion Bird, and Black Tortoise" (Yanlin Zhang, 2021). These four mythological creatures are the guardians of the four cardinal directions. These four entities are also known as the "Four Guardians": the Azure Dragon of the East, the Vermilion Bird of the South, the White Tiger of the West, and the Black Tortoise of the North. Of them, we discussed in 2022.
In the work proposed by Jiao Nanfeng, 2008, the researcher writes "that the designing of Yangling Mausoleum was influenced by the planning of Chang'an City, the capital of the Western Han Dynasty". In other words, according to Jiao Nanfeng, "the whole Yangling Mausoleum precinct was symbolizing and representing the Chang'an City, and the mausoleum courts of Emperor Jing and Empress Wang, the "Stone of Compass" and the outer enclosing wall were the symbols or reappearances of Weiyang and Changle Palaces, the ritual architectures and the city wall in the afterworld". Of the Chinese town orientation we discussed in 2013.

Fig.7: The Maoling Mausoleum of Emperor Wu (ruled 156–87 BCE). Here too, we can find the pyramids linked by the sunrise on summer solstice. Courtesy suncalc.org. See also the figures in arXiv, 2012.

In the Figure 7, we can see the Maoling, mausoleum of Emperor Wu [Wudi] of Han (157–87 BCE. The construction of the tomb began in 139 BC, the second year in the reign of Emperor Wu, and took 53 years until completion upon the emperor's death. The town of Maoling was created during the construction of the tomb (Wikipedia). "Han Wudi reigned more than fifty-four years, more than twice as long as any other emperor of Western Han, and thus had a long time to spend on the construction of his tomb; perhaps he anticipated filling all the space to the east between his tomb and Anling with aboveground architecture or with auxiliary burials. Maoling's fame is further enhanced by one auxiliary tomb, approximately 2 kilometers to the east, awarded by Wudi to his young military officer Huo Qubing" (Xinian Fu et al., 2002).

In the book by Xinian Fu and coauthors, we can find, among the many relevant observations, the following one on the mounds. The First Emperor Qin Shi Huangdi is buried "under a mound that was built up beyond its original height". However, the tumuli of Liu Bang and Wudi "were natural mounds". Of course, the Chinese architects rendered the natural mounds in truncated pyramids.

About the planning of all the area, Xinian Fu and coauthors observed, "The most important evidence of the realization of a Qin vision in Western Han Chang'an was uncovered in 1993. In that year a research team found that a straight line could be drawn northward from Ziwu Valley, south of the capital, through the south-central gate of Chang'an, continue along the longest street in the capital, … between the tombs of the founding emperor of the Han dynasty and his wife, and onward to a bowl-shaped depression believed to be the location of Tianqi Shrine." The line continued reaching a Han military commandery on the Yangzi River in the South and "a commandery today in Inner Mongolia at the northern bend of the Yellow River" (Xinian Fu et al., 2002).

About the capital, "Centered between the northern and southern and eastern and western boundaries of the empire, the Han capital was symbolically the center of the ruler's domain and the pivot of the four quarters of the universe. This no doubt was the vision of the First Emperor, even if the early Han rulers conceived of it as their own" (Xinian Fu et al., 2002).

Elevation Maps

At the beginning of the present discussion, we have seen that the name Xianyang means a fully sun orientation. So, let us put aside the orientation with magnetic compasses, and forget any astronomical orientation with stars. Let us consider the Western Han mausoleums in their landscape, looking at elevation maps. First, let us remember the location of pyramids in Google Earth (Fig.2). Comparing with the Figure 1, it is evident that we have a connection between the pyramid positions and orientations and the elevation profiles of the area, which is elevated with respect of the plain. The places where we can find the burial sites cannot be flooded.

Let us start from the first mausoleum located in the Xianyang area, that of the Changling group, that is the burial complex of first Western Han emperor. Then we will see the burial complex of the second emperor (Anling group). The third emperor is buried in Baling, which is far from these sites for the abovementioned reason. Then we will show the site of the fourth emperor (Yangling complex). Then we continue with the Maoling complex and other complexes according to Wikipedia list.

Changling group

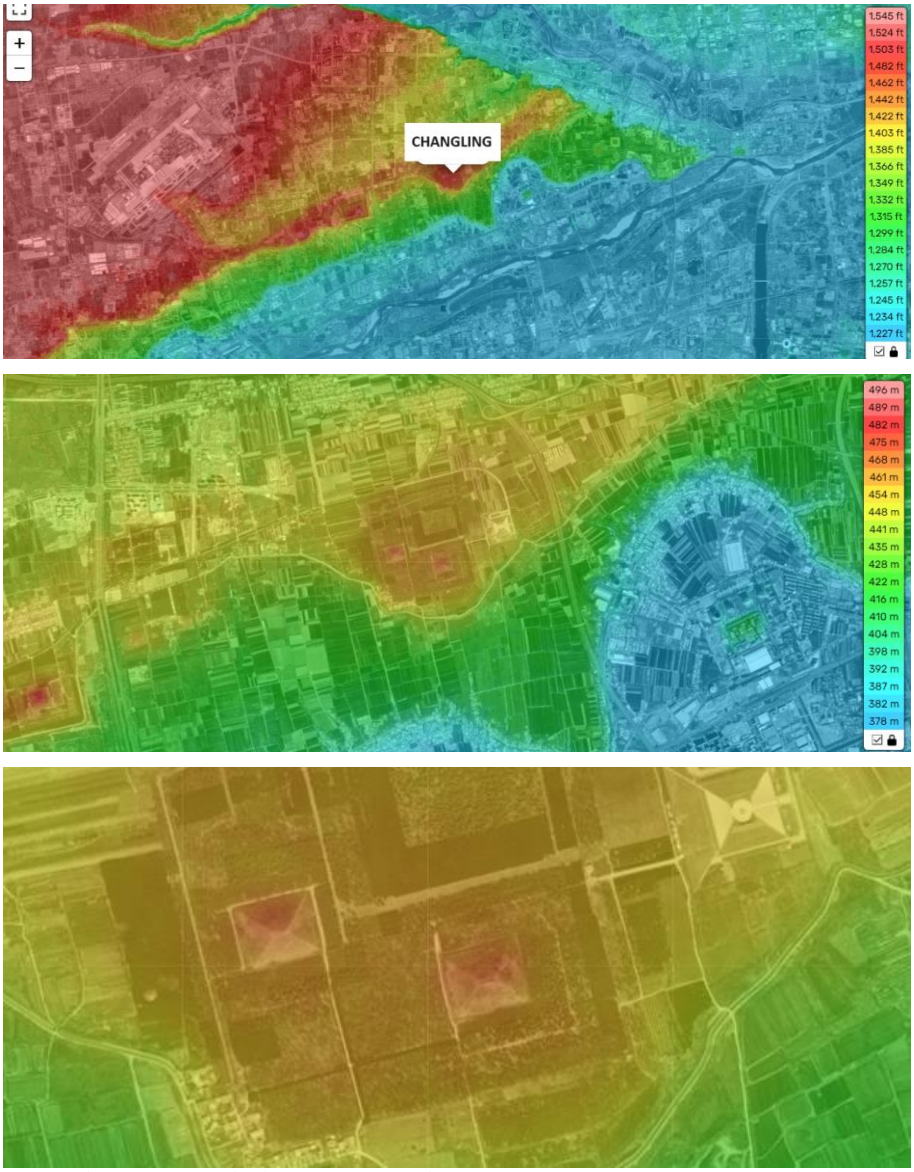

Fig. 8: Changling mausoleum group: Tomb of Emperor Gaozu of Han 34.4347°N 108.8766°E (west), Tomb of Empress Lü 34.4338°N 108.8813°E (east). Maps courtesy en-gb.topographic-map.com.

Anling group

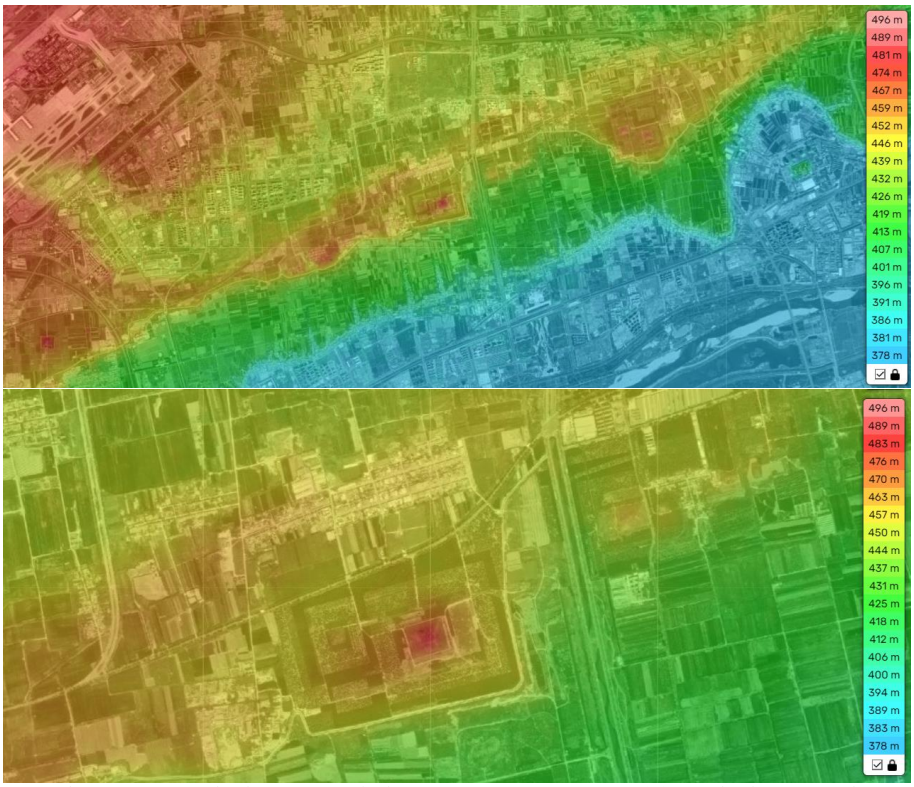

Fig. 9: Anling mausoleum group: Tomb of Emperor Hui of Han 34.4229°N 108.8413°E (A), Tomb of Empress Zhang Yan 34.4232°N 108.8370°E (B), Tomb of Marquis Zhang Ao (father of Empress Zhang Yan) 34.4277°N 108.8512°E (C), Tomb of Princess Lu of Yuan (mother of Empress Zhang Yan). Maps courtesy ACME mapper and en-gb.topographic-map.com.

Yangling group

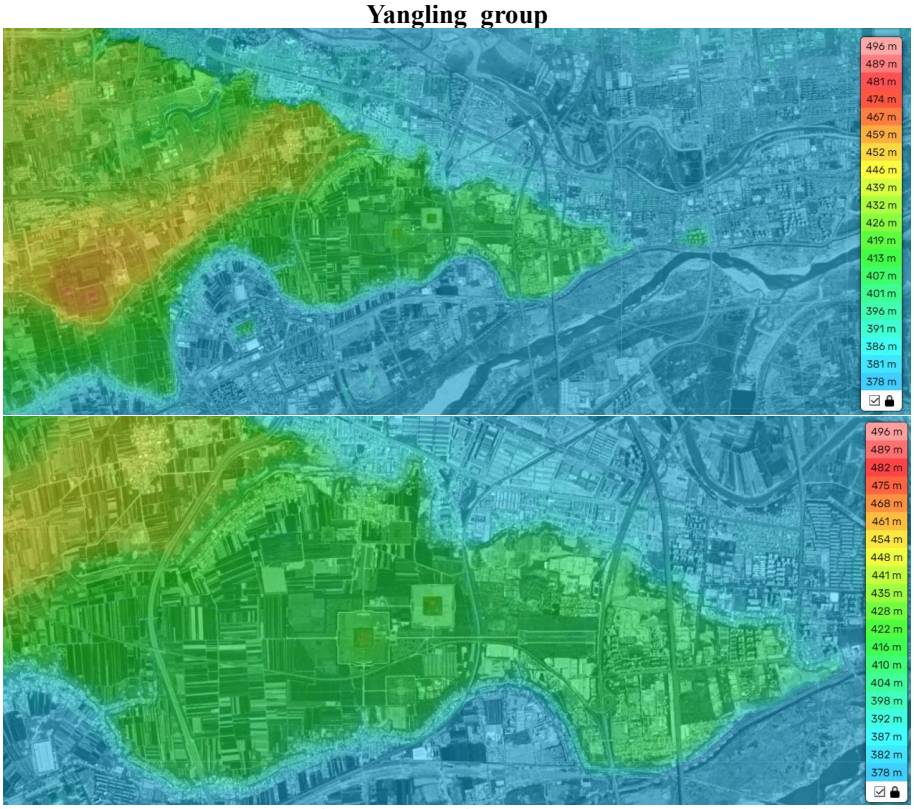

Fig. 10: Yangling mausoleum group has the Tomb of Emperor Jing of Han, 34.4438°N 108.9408°E, Tomb of Empress Wang, 34.4463°N 108.9475°E. Maps courtesy en-gb.topographic-map.com.

Maoling group

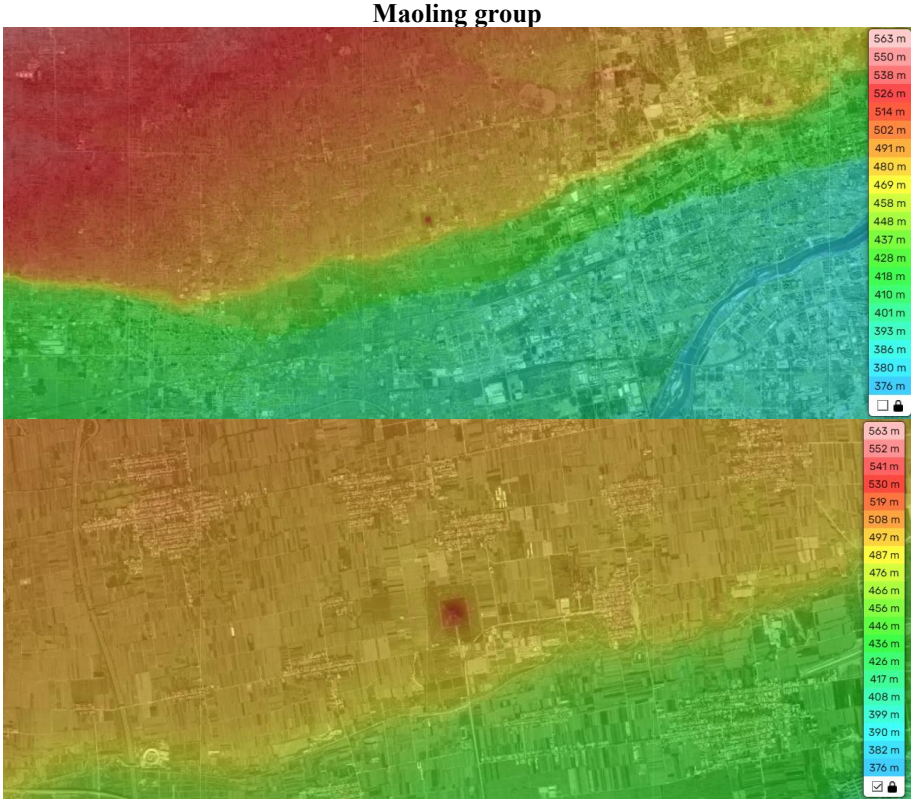

Fig.11: The location of the Maoling Group in elevation map on satellite map by topographic-map

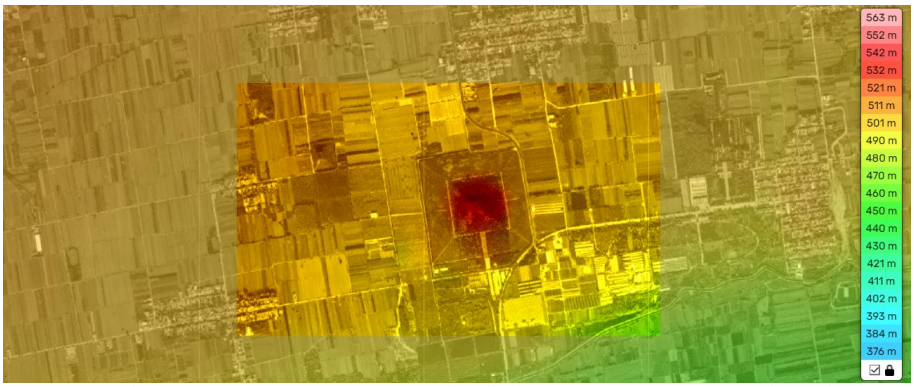

Fig.12: Tomb of Emperor Wu of Han 34.3381°N 108.5697°E (east) The size is 222 metres x 217 metres. The tomb of Empress Li 34.3403°N 108.5620°E (west). Maps courtesy en-gb.topographic-map.com.

Yanling group

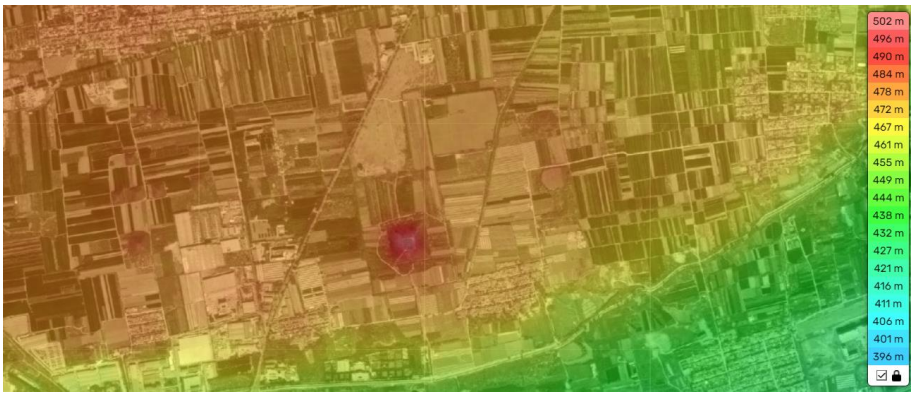

Fig. 13: Yanling Mausoleum group. Tomb of Emperor Cheng of Han 34.3749°N 108.6980°E (A), Tomb of Empress Xu 34.3746°N 108.6847°E (B), Tomb of Consort Ban 34.3798°N 108.7045°E (C). Maps courtesy ACME Mapper and en-gb.topographic-map.com.

Kangling, Weiling, Yiling groups

Fig.14: In the image, from west to east the Kangling (G), the Weiling (H) and the Yiling (I) groups of mausolea. In detain we can see the elevation of the main pyramids of them. Maps courtesy ACME Mapper and en-gb.topographic-map.com.

In detail. Kangling Mausoleum group: Tomb of Emperor Ping of Han, 34.3978°N 108.7124°E, Tomb of Empress Wang. Weiling Mausoleum group: Tomb of Emperor Yuan of Han, 34.3903°N 108.7391°E Tomb of Empress Wang, 34.3932°N 108.7338°E. Yiling mausoleum group: Tomb of Emperor Ai of Han 34.4009°N 108.7646°E, Tomb of Empress Fu 34.4026°N 108.7725°E.

Discussion

Previously, we used the elevation maps for the analysis of the Japanese Kofun tombs (the term "kofun" means "ancient tomb"). Kofun are ancient burial mounds mainly constructed between the middle of the third century to the early seventh century CE. The larger kofun have a very distinctive shape and are usually defined as keyhole-shaped mounds. By means of the maps by topographic-map.com, we had the possibility to observe the Kofun in their landscape and appreciate the orientation of the long axis of their keyhole-shapes. Also in the case of the Western Han dynasty pyramids, we have the possibility to apply the elevation maps by topographic-map.com and observe the orientation of the mounds in their landscape. The Western Han pyramids have an orientation according to the North-South axis. However, we can see in some cases a deviation toward west of some degrees. This deviation seems being linked to the local terrain elevation profile so that the pyramid layout can adapt itself in a proper manner to the local slope of the terrain. In particular, it seems that the Chinese architects and surveyors used the natural elevations of the land to shape the burial mound into truncated pyramidal forms. In fact, in the book by Xinian Fu

and coauthors, we can find that the tumulus of Han founder Liu Bang was a natural mound (see again it in the elevation maps of Figure 15).

In any case, as previously told, and clearly shown from the proposed maps, the terrain north of Xianyang is elevated with respect to the plain and the river, and certainly was preserved from floods in ancient time.

Fig.15: The burial site of the first Han emperor was in origin a natural mound. Map courtesy en-gb.topographic-map.com. The deviation from the North-South direction of the pyramid layouts is dictated by the natural mound, not by the magnetic field direction or by the rising of a circumpolar star.

References

1. ChinaCulture.org (2008). Changling Mausoleum. http://en.chinaculture.org/library/2008-02/15/content_32614.htm
2. Charvátová, I., Klokočník, J., Kolmaš, J., & Kostelecký, J. (2011). Chinese tombs oriented by a compass: evidence from paleomagnetic changes versus the age of tombs. Studia Geophysica et Geodaetica, 55, 159-174.
3. Fu, X., Guo, D., Liu, X., Pan, G., Qiao, Y., & Sun, D. (2002). Chinese architecture. Yale University Press.
4. Ji, Yang (2006). Changling of Emperor Gaozu of Han. Imperial mausoleums of China. China National Art Photograph Publishing House. pp. 28–31. ISBN 7-80069-732-0.
5. Nanfeng, J. (2008). On the Construction Concept of Western Han Imperial Mausoleums. Chinese Archaeology, 8(1), 178-184.
6. Sparavigna, A. C. (2012). The Chinese Pyramids and the Sun. arXiv preprint arXiv:1211.0915.
7. Sparavigna, A. C. (2013). Sunrise and Sunset Azimuths in the Planning of Ancient Chinese Towns. International Journal of Sciences, 2(11), 52-59. https://doi.org/10.18483/ijsci.334
8. Sparavigna, A. C. (2017). Magnetic Compasses and Chinese Architectures. PHILICA, 2017(1094), 1-11.
9. Sparavigna, A. C. (2017). Magnetic Compasses and Chinese Architectures. arXiv preprint arXiv:1709.07056. https://doi.org/10.48550/arXiv.1211.0915
10. Sparavigna, A. C. (2022). Meteoric Iron in Ancient Egyptian and Chinese Cultures, from Pyramids to Circumpolar Stars. SSRN 4113311, http://dx.doi.org/10.2139/ssrn.4113311
11. Sparavigna, A. C. (2022). Japanese Kofun in Maps given by a Spaceborne Digital Elevation Model based on Multiple Satellite Data Sets. SSRN 4043799, http://dx.doi.org/10.2139/ssrn.4043799
12. Steinhardt, N. S. (Ed.). (2002). Chinese architecture (pp. 1-5). New Haven, CT: Yale University Press.
13. Tiede, V. R. (2010, January). Astronomical Orientation of Pyramid Tombs in North China. In American Astronomical Society Meeting Abstracts# 215 (Vol. 215, pp. 331-01).
14. Tiede, V. R. (1978). Orientation of Ancient Chinese Pyramids. Archaeoastronomy Bulletin, vol. I, 3:7-8
15. Xinian Fu, Daiheng Guo, Xujie Liu, Guxi Pan, Yun Qiao, & Dazhang Sun (2002). Chinese Architecture. The Culture & Civilization of China. Translated by Nancy Shatzman Steinhardt. Yale University Press, 2002. ISBN 0300095597, 9780300095593
16. Zhang, Yanlin (2021). Yangling Mausoleum of Han Dynasty. ChinaTourStar.com https://www.chinatourstar.com/xianyang-attraction/yangling-mausoleum-of-han-dynasty.html