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Astronomy and Feng Shui in Ming Urban Planning: A Satellite and Paleo-Magnetic Based Analysis

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Abstract: Chinese urban planning has a millenary history. According to the ancient classic texts, it was based on principles related to the cosmic order as well as on traditional ideas related to the feng shui doctrines. The problem of understanding the extent to which such ideas were put into practice is still open, partially due to the overwhelming number of cities founded or re-founded in the more than 2100 years of Chinese imperial history. In the present work, a new, comprehensive analysis of this issue is presented, with a focus on the Ming period. We construct a database which includes 238 towns—virtually all the cities founded or re-founded by the Ming dynasty—using tools based on satellite imagery to investigate orientations and relationships with natural features, and historical paleomagnetic models to investigate magnetic orientation. The results show the existence of three main "families" of towns, of which one strictly adheres to "cosmic" principles, while the other two are mainly connected to the environment. Magnetic orientation turns out, instead, to be related to the imperial capitals only.

Keywords: ancient Chinese cities; Archeoastronomy; Ming urban planning; feng shui

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1. Introduction

Throughout Chinese history, the urban layouts have consistently functioned as tangible expressions of the imperial power. This phenomenon is deeply intertwined with the Chinese imperial tradition: the reign of an emperor was compared to the models of governments established by previous emperors and even by pre-imperial dynasties. As such, the shape and architecture of the city became one of the tools to exploit the emperor's rights as the supreme guardian of tradition. In essence, the imperial city transcended mere physicality; it evolved into an institution—an articulated concept steeped in symbolism, which possessed a meticulously crafted design and was imbued with ideology [1–5].

It is the aim of the present paper to investigate, in a systematic way, the characteristics and themes of ancient Chinese urban planning during the Ming dynasty. To this aim, it is worth recalling in some detail the foundation of Chinese imperial power and its relationship with the layout of imperial cities. We can start from the words of the historian of the first century BCE, Sima Qian, who in the "Shi Ji" (the Records of the Grand Historian) writes: "Looking up, [the ruler] contemplates the signs in the heavens and, looking down, observes their counterparts on earth". This statement shows the profound connection between the celestial and terrestrial realms in the emperor's perspective: he was the mediator between the two, and therefore the owner of the mandate of heaven. The ruler was more than an absolute authority: as the Son of Heaven, his virtue and adherence to proper gover-

nance were believed to ensure the stability of the state and guarantee a harmonious and tranquil world [6,7].

This rigorous cosmic order was connected to cardinality, that is, the quadripartition of space according to the four cardinal points, with the sky's north pole as the unmoving hub of the universe [8–10]. The imperial palace, the "purple forbidden city", served as the terrestrial counterpart to the circumpolar zone, so that the emperor occupied what the Chinese considered the center of the world. The entire world revolved around him, mirroring the celestial motion around the northern pole of the sky.

These ideas are reflected in Chinese town planning texts, and, in particular, in the Kao Gong Ji. The Kao Gong Ji or Record of Trades is a classic work on science and technology, compiled sometime between the fifth and third centuries BCE, and later included in the Zhou li (the Rites of the Zhou Dynasty), probably with additions of the Han period [11]. The Kao Gong Ji served as a foundational text in various fields including as a comprehensive guide for ideal cities. The foundation of a new town is indeed thoroughly described: the land must be leveled, boundaries have to be fixed, and the cardinal points must be determined by measuring the sun's shadows during the day and the stars' movements at night. Cardinal orientation is explicitly mentioned as an act aimed at establishing a deep connection between heaven and earth.

The solar method of orientation described in the text is that commonly called the Indian circle. This technique involves the placement of a vertical rod, a gnomon, right at the center of a circular area, which either is endowed with a naturally flat horizon or is equipped with an artificially leveled horizon, like a circular wall. The shadows of the pole during the morning and the evening are marked when they intersect the circle. By connecting these two marks, the east–west direction is determined. To obtain the north–south direction, a perpendicular line to this axis is drawn, ensuring the exact alignment of the city with the cardinal directions and, metaphorically, with the harmonious unity of heaven and earth.

Regarding instead the way the ancient Chinese had of fixing the cardinal points through the star's movement, it should be recalled that, during the Han dynasty, there was no "pole star" available. Due to the phenomenon called precession, indeed, the north celestial pole was in a dark zone approximately 10 degrees away from Polaris. However, there are clear hints that the Chinese astronomers were able to identify the north celestial pole in a precise way using a star's rotation. Indeed, basing on a thorough examination of existing texts, Pankenier has argued for the existence of a method of orientation based on the Great Square of the constellation Pegasus, an asterism known in China as *Ding* or "celestial palace". The method was based on observing the simultaneous transit due south of the upper and the lower stars, defining a "wall" of the square, and leveling the direction to the ground (Figure 1). The use of this method compensated for the absence of a star near the celestial pole due to precession and allowed for accurate measurements [7].

The text further continues describing the city as a square with three gates per side, crossed by three main east–west and three main north–south streets. Some main buildings and temples are specifically located within this urban plan. The topography of the town reflects a cultural perspective and entails an intricate system of hierarchy: with respect to the imperial palace, the ancestors' temple (also known as Ancestral Temple) must be to the left, the earth god's temple (the Altar of Soil and Grain) to the right, the palace itself at the forefront, and the bustling market at the rear. This arrangement (actually visible, for instance, in Beijing) confirms once again the complex symbolic importance of town planning with respect to the "cosmic" order on Earth.

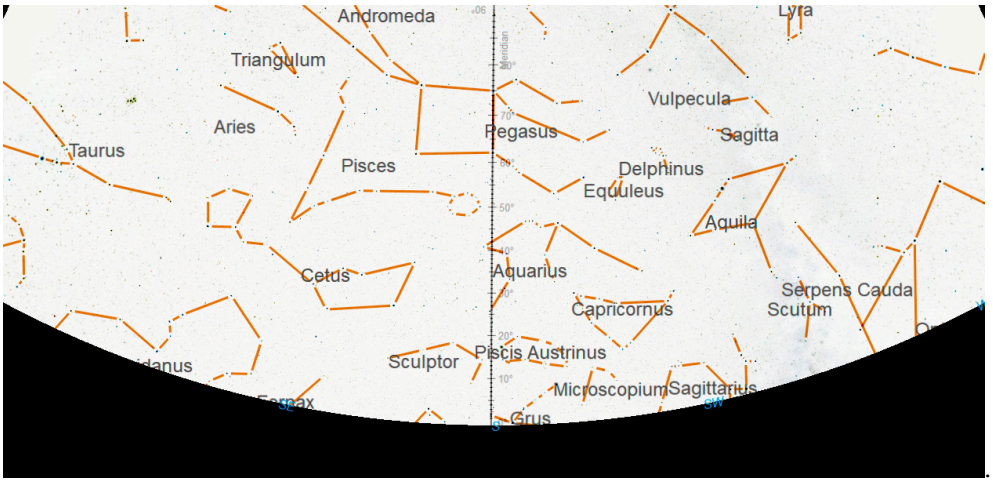

Figure 1. The southern sky as seen from Beijing, with the "western wall" of the square of Pegasus defining the direction due south. (Image: authors' elaboration with Starry Night Pro).

All in all, the ideal city described in the text is a square with cardinal orientation, divided into 9 quadrants: it can be called a Magic Square, with the terminology coined by Schinz (Figure 2).

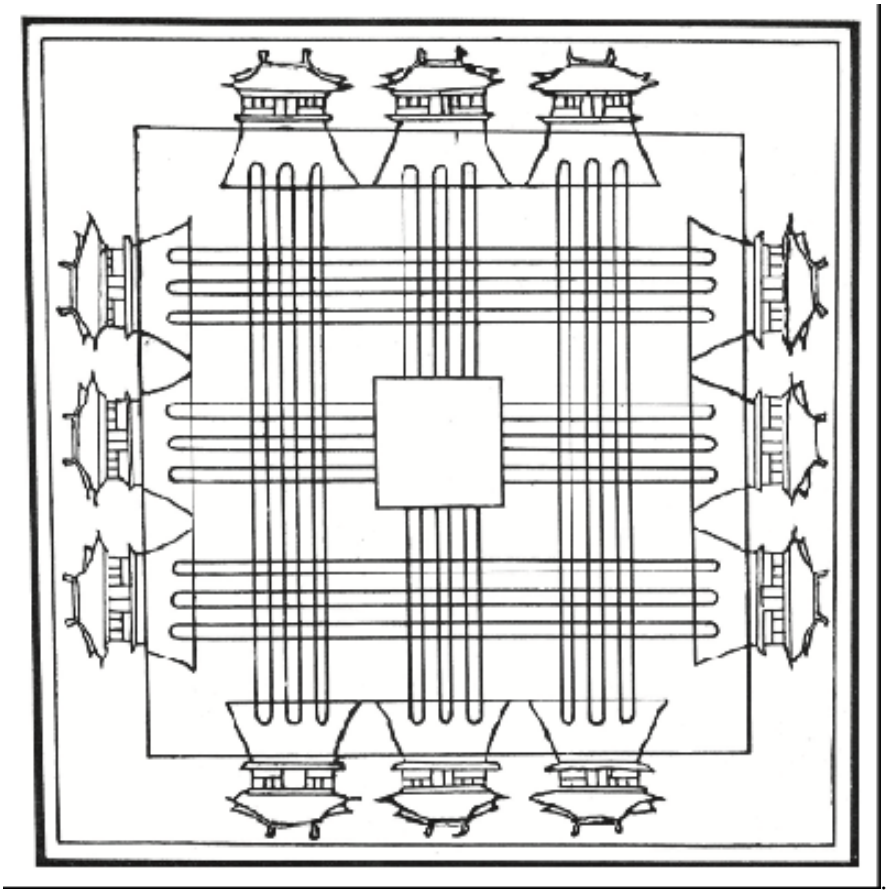

Figure 2. The Chinese town planning according to the Kao Gong Ji (public domain).

In other parts of the same text, explicit mention is made of the importance of a "terrestrial energy", the *Qi*. This is one of the first written references to a geomantic doctrine whose primary aim was to identify auspicious locations for building tombs and cities. The concept revolves around the belief that a site must exhibit harmonious interrelations of the natural elements, including mountains, wind, and water, to ensure a propitious human

existence. The practice of divination for the purpose of determining a positive balance of natural forces before selecting a site was called feng shui. It goes, of course, without saying that the Qi (and so the feng shui) has no scientific basis whatsoever. However, studying the application of feng shui ideas in ancient Chinese architecture—and specifically, in Ming times—is of crucial importance, since there are outstanding examples showing that it was used as the inspiring principle of places as important as the world-famous necropolis of the 13 Ming emperors at Shisaling [12]. The first codification of feng shui doctrines is in the classic written by the Taoist Guo Pu (276–324 CE), the Book of Burial. It was, however, not until Emperor Taizong (626–649 CE) of the Tang Dynasty that a commission of experts was chosen to determine which geomantic books could be considered reliable. Feng shui finally became part of the doctrine of the state in the Song dynasty, when it was elaborated both morally and rationally by neo-Confucian writers such as Zhu Xi (1130–1200). In the later Ming and Qing dynasties, feng shui masters were invited to take part in the planning of houses, tombs, and cities [13–15], and feng shui came to hold a significant role in the decision-making process of emperors. It provided a well-accepted rationale for their choices, and adherence to its principles was believed to ensure the longevity and stability of their rule through the flow of Qi along the tombs (actually the bones) of their ancestors.

The main duty of feng shui masters was thus to identify features considered favorable from the point of view of encapsulating and enhancing the Qi, including the morphological characteristics of the soil, the availability of water, and the specific geographical positioning within the considered area. In particular, an ideal site typically had to include a mountain at the back, a river in the front, another mountain at the far end, and hills on both the right and left sides. These features were symbolically associated with cardinal points and with totem animals: the Black Turtle of the North, the Red Phoenix of the South, the Green Dragon of the East, and the White Tiger of the West. This rather simple and schematic configuration progressively acquired further specifications and refinements, depending not only on the presence of natural elements and their positioning but also on their shape (for instance, the different "dragon shapes" a hill might have), on the presence and kind of vegetation, and so on.

Around the 8th century, feng shui divided into two different schools: form feng shui and compass feng shui. The form school maintained and further elaborated the above-described principles, constructing an increasingly articulated concept of landscape requirements. What sat compass school apart was the Chinese invention of the lodestone compass needle. Actually, through a geomantic instrument based on a lodestone spoon, the magnetic behavior of some material was very likely to be known already in the Han period [16]. Of course, they were not aware of the modern concept of earth's magnetic field, but simply discovered by chance an instrument that autonomously tended to indicate roughly north (or south depending on the magnetization of the stone). With the invention of the (much more accurate) compass needle, it was concluded that a practical method of measuring the direction of the flow of Qi had been found. The tool employed by compass feng shui masters (still today) for this purpose is the Luopan, by all means similar to modern magnetic compasses, but pointing south and endowing concentric rings with various symbols and scales. This arrangement allows for the interpretation of information in any desired direction once the south direction is determined.

All in all, it has to be expected that all these traditions played a relevant role in Chinese city planning, and we can expect two scenarios. An ideal urban "cosmic" layout with a square-shaped plan in which the axes are accurately orthogonal and oriented along the cardinal directions, surrounded by walls with a specific number of gates and complexes in clearly delineated positions, and a "geomantic" city located in favorable positions, characterized by peculiar geographical features (one or more among a mountain to the

north, hilly terrain to the east and west, a southward-flowing watercourse); the orientation of the north–south axis in this case may or may not refer to a magnetic measure made at the time of planning (Figure 3). These scenarios are not, of course, by necessity mutually exclusive, especially when the planner had room to decide the specific location of the city center (for example, he could place it in such a way as to point to a mountain coinciding with the northern direction shown by the Luopan or by an astronomical measure.

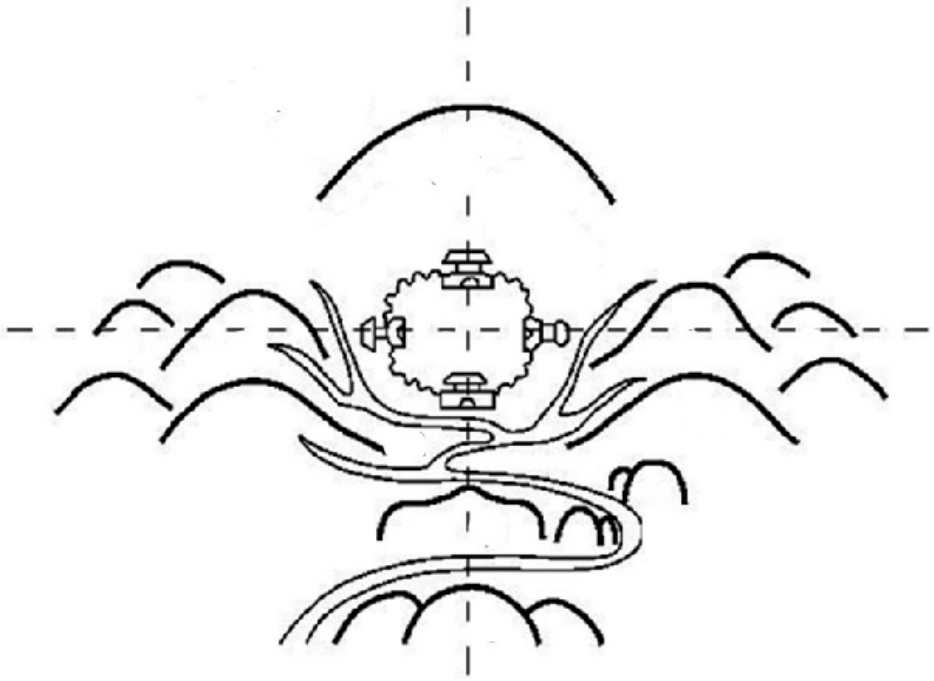

Figure 3. The ideal placement of a town according to form feng shui (public domain).

Important studies aimed at identifying these characteristics of Chinese town planning do exist already [3,4,6]. However, during the Chinese empire, several hundreds of towns were founded, and this has prevented a systematic, comprehensive approach so far. It is our aim here to provide such an approach which was made possible by two facts: the optimal satellite imagery coverage of Chinese towns, and the development of historical paleomagnetic models. We shall concentrate on the towns founded during the Ming dynasty. As is well known indeed, it was with this dynasty—whose monarchs succeeded in overruling the Yuan dynasty established by the Mongols—that a wide program of the valorization and application of ancient traditions was carried out (1368–1644 CE). Actually, the Ming period is also a special period of human history from the point of view of architecture, since masterpieces like the Forbidden City and the Temple of Heaven in Beijing and the royal necropolis of Shisanling were built. The founding (or re-founding) of towns was phrenetic during the Ming rule: the emperors created three capitals in the arc of some 30 years, and—according to our database discussed below, which virtually includes all of them—founded 235 other towns.

2. Materials and Methods

2.1. Historical Cartography

Cartography in China has a millenary history, as the first maps date back to the Han dynasty [17]. Chinese cartographers exhibited meticulous attention to scale, emphasizing in accurate depictions the dimensions of the cities and the placement of buildings (one of the foundational texts delving into the principles of cartography is that attributed to Pei Xiu, 3rd century CE). As a consequence of such a long tradition, historical cartography

has been an important instrument for the present study, because it allowed us to identify with certainty the original nucleus and design of many towns which underwent a huge expansion in the last century. In particular we relied on two recent projects, which, starting with the digitization of numerous historical documents, aim at a public use for the research of Chinese historical cartography: "Local Gazetteers Research Tools"—LoGaRT, developed as part of the research activities by the Local Gazetteers Working Group at the Max Planck Institute for the History of Science (MPIWG); and CHMap, a Platform of Historical Maps of China, led by the MPIWG and the Department of History, Shanghai Jiao Tong University (SJTU). The Local Gazetteers Research Tools software is designed for searching, analyzing, and collecting data from digitized Chinese local gazetteers. The underlying philosophy of LoGaRT is to treat all available digitized gazetteers as a conceptual database for historical inquiries. The CHMap cartographic database provides digitized and geo-referenced land survey maps of China. Maps that have been digitized and georeferenced by the Academia Sinica in Taiwan have also been utilized.

In practice, the analysis was performed by overlaying (in opaque mode) the maps taken from these archives onto the corresponding GEP image in order to check their orientation and to identify which of the modern streets correspond to the ancient urban plans. We used these maps for a total of 145 towns.

2.2. Satellite Imagery

Satellite imagery is a powerful tool to study the important aspects of ancient landscapes, including topography, planning, and the astronomical orientation of monuments and cities. While direct fieldwork is always recommended for data sampling, in the case of a large number of monuments, the use of remote sensing techniques facilitates the collection of comprehensive data. In recent years, leveraging geographical tools and multitemporal very high-resolution satellite imagery in Google Earth Pro (hereafter referred to as GEP) has also demonstrated its capability to provide information relevant to the physical, environmental, and geographical characteristics of cultural heritage, including the discovery of new archeological sites in remote areas and the monitoring of historical sites [18,19]. As a digital model of the terrain, GEP also allows the analysis of landscape morphology, including the identification of reliefs and the corresponding horizon profile. An outstanding feature of the program lies in the exceptional geo-referencing accuracy of its satellite images. These images are meticulously aligned with real-world geographic coordinates and precisely oriented to true north, enabling accurate measurements of the orientation of objects within them, such as the urban layout. Furthermore, the historical record of satellite images provided by the program serves as a support for the historical reconstruction of the layout where recent developments or demolitions have been carried out.

Along with GEP, our survey benefited from using HeyWhatsthat. This program provides in detail the horizon visible from chosen viewpoints, and generates a 360-degree panorama, complete with labels identifying visible mountains and other features. Users can also adjust settings such as observer height to simulate different viewing conditions.

2.3. Astronomical Analysis

To reconstruct the sky at the moment of foundation of the towns, we used the open-source digital planetarium Stellarium, which has proven to be a useful and affordable tool in Archeoastronomy studies. The program allows for the setting of the geographical location and the observation date. For the calculation of declinations, we used the Declination Calculator GETDEC kindly provided by Clive Ruggles.

2.4. Paleomagnetic Models

The magnetic field of the Earth, and thus the magnetic declination, vary continuously in time and space, so that the direction indicated by a magnetic compass (magnetic north) does not generally correspond to true north. This has the immediate consequence that, if we want to establish if an ancient direction was determined using a magnetic compass, measuring it today with a magnetic compass is not useful. However, recent advancements in the development of reliable models of Paleomagnetism, a branch of geophysics studying the Earth's ancient magnetic field preserved in rocks, minerals, and archeological artifacts, make this analysis possible by furnishing palaeomagnetic models which estimate the value of magnetic declination at a given place and time in the past. A well-known example of such models is the Magnetic Field Calculators of the National Oceanic and Atmosphere Administration (NOAA) based on the World Magnetic Model (WMM), which however only goes back to 1900 CE. For the aim of the present paper, a model going as far back as the 14th century was needed, and such a model is CALS10k.2, kindly provided by the German Research Centre for Geosciences in Potsdam. It is a global geomagnetic field model for the past 10 millennia, covering the span from 8000 BCE to 1990 AD [20,21].

2.5. The Database

The database we developed for this study is fully available as Supplementary Material to the present paper. It is designed as a comprehensive tool of free use for comparing and analyzing the characteristics of Ming cities. Existing databases have been of help in its completion, in particular Xu's database [22] and the work of a research team led by Qiaofeng Xue on the geolocation of cities in late imperial China. This team's efforts took into account the construction and reconstruction of city walls, resulting in the creation of the China City Wall Areas Dataset (CCWAD) for the late imperial period [23].

The database developed for this paper comprises 238 cities, virtually all towns which were founded or underwent urban re-planning during the Ming dynasty. The information provided for each city are geographical coordinates, foundation/reconstruction year, main axis azimuth (the azimuth of the axis closest to true north), second axis azimuth, elevation of horizons in correspondence of both axes, astronomical declination of both axes, and notable surrounding morphological conditions (these include details about the presence and positioning of natural features such as hills and watercourses). Finally, historical cartographic references are mentioned if available, together with the estimated magnetic declination at the time of planning (Figure 4).

2.6. Statistical Tools

To analyze data and extract patterns from our dataset, we used very simple, standard statistical tools. In particular, we used a method of smoothing of a discrete dataset, the so-called kernel density estimation (also called "curvigram"). Essentially, the method approximates the probability density function f(x) with the sum of the values assumed by an opportunely chosen, smoothing kernel function K(x) on the discrete data available, as follows:

$$f(x) = \frac{1}{nh}\sum_{i=1}^{n} K\left(\frac{x - x_i}{h}\right) \quad (1)$$

Here, h is a positive scaling parameter. Various choices are possible for the kernel, which however must be positive and normalized to one. We used a gaussian kernel:

$$K(x) = \frac{1}{\sqrt{2\pi}} e^{-\frac{x^2}{2}} \quad (2)$$

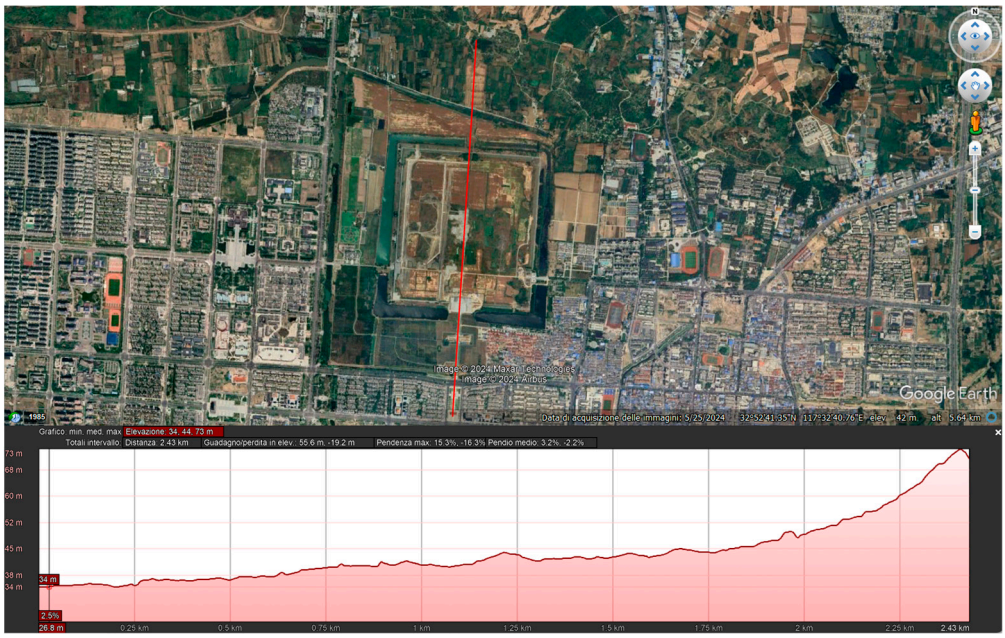

Figure 4. Example of the measures carried out for the construction of the database. The inner precinct of the unfinished Ming capital in Fengyang bears an azimuth of 4° east of north and points to the Phoenix "hill to the north", as indicated by the red line. The deviation of 4° degrees east is in accordance with the calculated magnetic declination at the time of construction.

3. Results

Our analysis started with the study of the Ming imperial capitals, which of course are expected to be singled out for their symbolic role of places where the mandate of heaven was physically residing [24–29] (Figure 5).

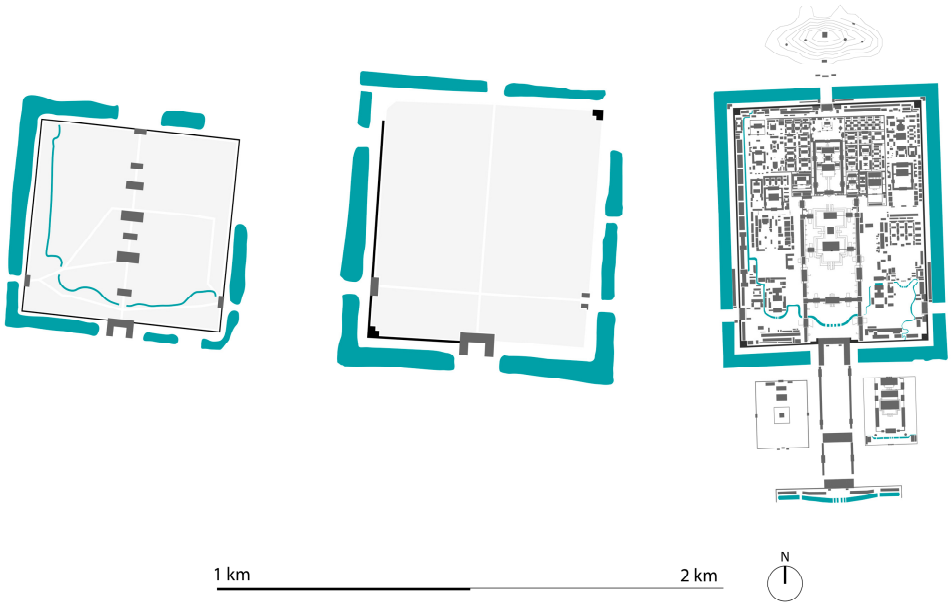

Figure 5. The inner cores of the three Ming capitals, showing the deviation of the axes from the meridian: from left to right, the Imperial Palace in Nanjing, the inner precinct in Fengyang, and the Forbidden City in Beijing (image: authors).

After the establishment of the dynasty, the first Ming emperor Hongwu elected his capital in Nanjing (1368) and initiated a vast program of the re-planning of the city. Immediately thereafter, however, he also started the project of a brand new capital, Fengyang,

located near his homeland. Works there proceeded for seven years, but were interrupted in 1375 before completion so that Nanjing remained the capital up to the advent of the third Ming emperor, Yongle, formerly Prince of Beiping, the future Beijing. Yongle decided in 1403 to elect the city of his principate as his capital and initiated a complete reconstruction which ended in 1420. In all three cases, we can speak of "new" towns, since the already existing Nanjing and Beijing were radically re-planned; common architectural patterns can be seen in their plans, and it turns out that in all three cases the general principles of feng shui in *both* its versions (form and compass) were applied.

In particular, in Nanjing, the Zhongshan hills (Purple Mountain) were elected as the "mountain to the north" for the emperor's tomb, the magnificent Xiaoling mausoleum, and their eastern flank played the role of the dragon hills. The role of the tiger hill to the west was played by a low natural stone relief which was fortified already during the Wu Kingdom, while the river to the south is Qinhuai River, meandering to the south of the imperial palace. The latter was built along an axis oriented 5° east of north, skewed more than 10° with respect to the original orientation of the town, but in accordance with the magnetic field declination in Nanjing at the time of construction. In Fengyang, the possibility of constructing a new city on a previously unbuilt site facilitated the role of the Ming architects, who adopted the "Magic Square" plan, but again, followed the principles of both feng shui schools. Indeed, the axis points to the Phoenix hill to the north, while an artificial stream flows from east to west passing south of the city beyond the outer city walls. Again, we find a clear skew from the cardinal orientation, in this case 4° east of north, fully compatible with the magnetic declination at the time of planning. Finally, the spectacular project of Ming Beijing also followed the same criteria. The town lies on a flat plain, but the Forbidden City was endowed by an artificial hill to the north and an artificial canal (the Golden Water River) to the south. The main axis is, also in this case, skewed with respect to the meridian (2.5° to the west of north), in agreement with the magnetic declination at the time of planning.

Moving now to the results obtained in the analysis of the full database, which—as mentioned—includes virtually all the cities founded or re-founded during the Ming dynasty, the scenario becomes much more complicated, but clear trends can be individuated. Indeed, three families of towns can be singled out:

1. Family 1, or "classic" cities, whose plan adheres to the Classics both in plan—which is orthogonal and based on a cross—and in orientation to the cardinal points (error below 5°). A total of 58 cities or 24.5% of the total belong to this family (Figure 6).
2. Family 2, composed by orthogonal cities that are not, however, cardinally oriented. A total of 93 cities or 39% of the total belong to this family (Figure 7).
3. Family 3, including all those cities that, although an ancient main axis can be traced, do not, however, present a clear orthogonal grid, also considering historical cartography (so that the unrecognizability is not a modern effect); 87 cities were collected in this group, which is 36.5% of the total (Figures 8, 9).

For families 1 and 2, we also studied the orientation of the second axis in order to check if the orthogonality of the urban layout was strictly adhered to. Results show a strong ($R = 0.96$) correlation of the two axes at 90°, although there are a few examples in which the lack of orthogonality is sensible (up to 6°).

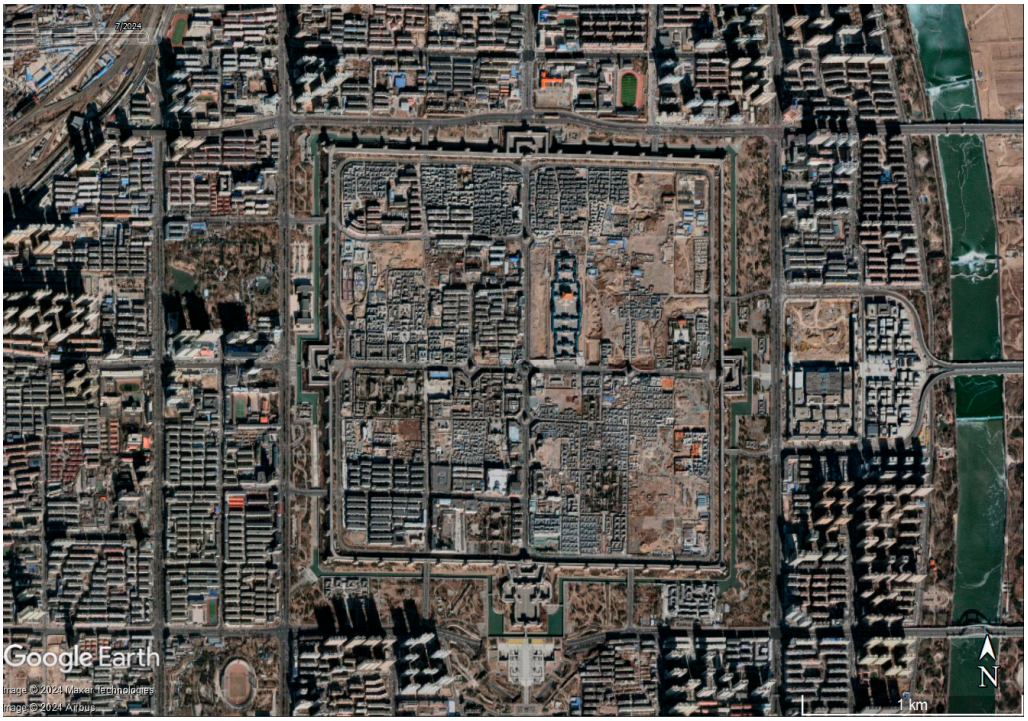

Figure 6. An example of a city belonging to family one: Datong. Cardinal orientation and quadripartition are evident (Image courtesy of Google Earth).

Figure 7. An example of a city belonging to family two: Shangqiu (Image courtesy of Google Earth).

Figure 8. Example of a city belonging to family three: Changting. Only one main ancient axis is present, pointing east of north toward the hills, and roughly parallel to the river (Image courtesy of Google Earth).

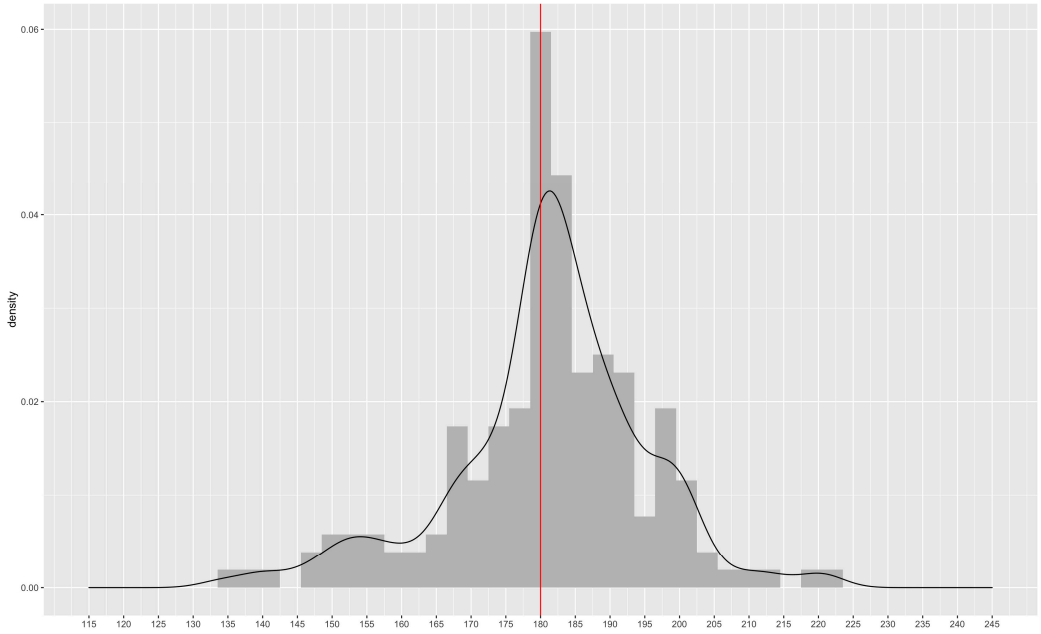

Figure 9. Orientation histogram and kernel distribution of the Ming towns' main axes. The red vertical line denotes the meridian.

The above grouping in families with respect to the city plan can now be compared with the data on landscape features, with the following main trends:

(1) Family 1 of the towns strictly corresponds to a rigorous idea of symbolic city planning: it is indeed very rare to identify landscape features which might have influenced cardinal orientation, while, on the contrary, there exist cases in which natural features of the landscape would have dictated a different disposition. (Figure 10)

(2) Among the 93 towns belonging to the second family, a strong relationship with a watercourse has been identified in as much as 49% of the cases; of these, 20 towns are

located in a context characterized by both a main watercourse and several mountainous elements. Here, topography played a key role in siting the city plan. A possible connection with the rising sun has also been investigated, whose presence, of course, would be an indication that it was the second axis to be planned first. Actually, the distribution does not show any accumulation of data (in particular, to the solstices rising points). (Figure 11)

(3) Finally, out of the 87 towns collected in the third family, again in as much as 50%, 44 towns, the main axis appears to be oriented in accordance with a predominant topographical element, identifiable in most cases with a watercourse. (Figure 12)

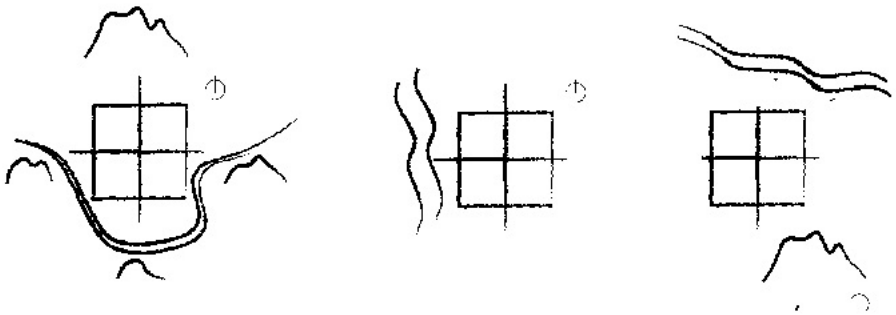

Figure 10. Schematic types of family 1 (cardinally oriented) towns, represented by squares: From left to right, in accordance with feng shui with mountain to the north and river to the south, adapted to a natural feature as a river, and purely symbolic planning irrespective of natural and feng shui principles.

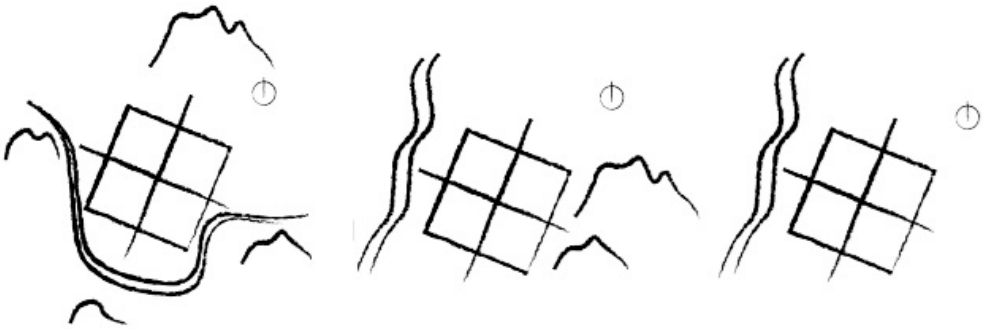

Figure 11. Schematic types of family 2 (non-cardinally oriented) squared towns: from left to right, in accordance with feng shui with a mountain in the north and the river to the south, adapted with two main natural features as a river and a mountain, in accordance with river flow.

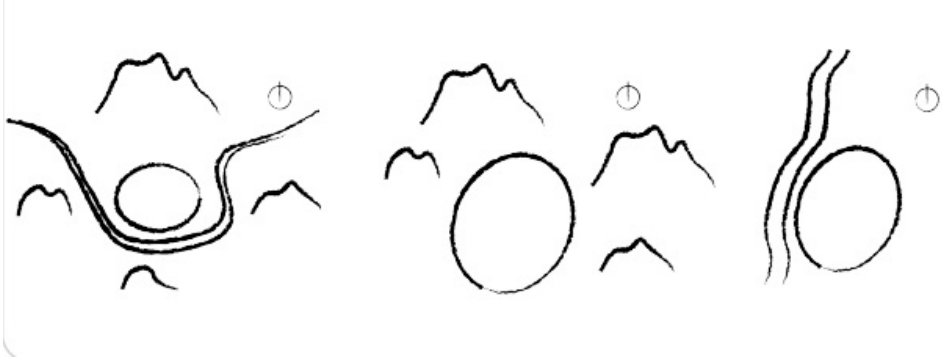

Figure 12. Schematic types of family 3 (non-squared) towns, schematized with an oval: from left to right, in accordance with feng shui, in accordance with mountains, in accordance with a water flow.

The relationship with rivers was certainly functional, although, of course, the flow of water is a fundamental element of the dictates of the discipline (as feng shui literally translates to "wind and water"). Effectively, we were able to recognize projects clearly inspired by form feng shui ideas in only a limited number of cases.

Regarding compass feng shui, our analysis brings us to exclude the use of this doctrine for the orientation of the Ming cities. Indeed, to investigate the possible use of a magnetic orientation tool in orienting the towns, we performed a simple R-test on palaeomagnetic data versus orientation data (Figure 13). The result clearly shows a complete absence of correlation, R = 0.1. Even limiting to only those layouts that were certainly and entirely of new foundation, the result remains similar, with a correlation test of R = 0.11. Taking into account that, instead, a clear correlation is visible for the three capitals (of course, we cannot speak about statistical significance in the presence of three data, but it is also obvious that the sample cannot be enlarged. . .) it appears that the use of compass feng shui was reserved for the planning of capitals only.

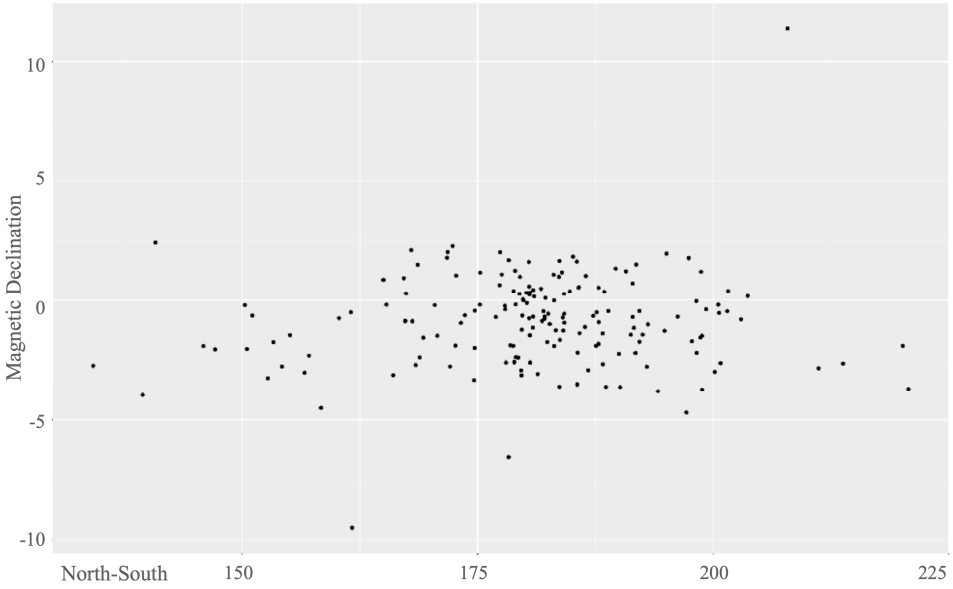

Figure 13. Orientation vs. magnetic declination at the date of planning of the Ming towns.

4. Discussion

As mentioned in the introduction, the Ming rulers were keen on ancient traditions and they were followers of feng shui form beliefs, a fact which is clearly visible also in their magnificent necropolis, the Valley of the 13 tombs at Shisanling [10]. The recent availability of high-resolution satellite imagery and of affordable paleomagnetic models allowed us to study, in a comprehensive way, the towns founded during the whole of the Ming dynasty, one of the periods of maximal splendor of the Chinese civilization. The results show that the Ming cities were indeed planned adhering to a restricted number of general rules, whose connections with fundamental texts (the Classics) and with traditional, equally important doctrines (the form and the compass feng shui) can be definitively clarified due to the (virtually) complete extension of the study sample.

The first point to be made concerns the three cities which were, in the arc of less than 50 years, chosen as capitals and planned, or re-planned, to this aim. Here, inspiration from the classics' canons did not include astronomical orientation: the principles of form feng shui were followed (or forced, as in the case of the artificial hill built to the north of the Forbidden City) however, and complemented with the main principle of compass feng shui, that is, orientation to magnetic north. Combining magnetic orientation with key landscape

features required additional efforts which were thus reserved for capitals—and therefore, to the imperial residences.

Astronomical—and thus symbolic—orientation to the cardinal points was instead adhered to in a relevant percentage of the other cases. These cases correspond to a full variety of natural and topographical features; in other words, symbolic orientation was explicitly superimposed at the moment of foundation. On the contrary, form feng shui characters in the placing of towns appear either in a quite generic way or unattended, and in most cases, they are anyhow related also to practical considerations, especially the river flows.

In a sense, the process of town foundation during the Ming empire appears to be similar to the Roman's one: adhering to symbolic principles (in the case of the Romans, those of the Etruscan's sacred books or disciplina, stating cardinal orientation and quadripartition) in many cases but also orienting "according to nature" in many others [29–31]. Interestingly, in both Ming and Roman town foundation, there is not a one-to-one correspondence between local morphological constraints and non-symbolic orientation. In other words, there exist several examples in which the morphology of the terrain would have dictated a certain disposition, but a symbolic one was adopted.

5. Conclusions

In Schinz's words, studying the Chinese towns "provides us insights into what was probably the most elaborate and complex system of thought developed in antiquity" [3]. The analysis carried out here on the Ming dynasty fully confirms this raffinate complexity: Chinese urban planning principles and concepts took into account "cosmic" beliefs as well as natural factors, and we can say that the idea that mostly catches urban Chinese philosophy is *harmony*. Clearly, the idea of harmony between humans and nature implies what we today mean by sustainability, and in the case of historical towns or city centers poses us the problem of sustainable development in the presence of cultural heritage.

Actually, urban conservation in China has evolved significantly since 1982, with the introduction of the first Law on the Protection of Cultural Relics and the establishment of the Historic and Cultural Cities list [32]. This law focused on protecting tangible cultural heritage, such as historic buildings and relevant urban areas. However, its implementation soon faced challenges, largely due to rapid urbanization and the pressure for economic development. In 2008, the Regulation on the Protection of Historical and Cultural Cities, Towns, and Villages established stricter guidelines, introducing the concepts of "primary protection areas" and "construction control zones" to preserve not only monuments but also the surrounding environmental and landscape context [33–37].

An emblematic case of the tensions between conservation and development is Datong, where starting in 2008, entire historical areas were demolished and reconstructed in a "historical" style until to 2018. Subsequently, in March 2019, the Datong municipality received a letter of criticism from the central government regarding the management of the historical city. The letter raised concerns about "problems of large-scale demolition, large-scale construction, real demolition and construction in ancient cities or historical and cultural blocks". Recently, the Notice on Strengthening of the Special Assessment Work for the Protection of National Historic and Cultural Cities (2021) was introduced, with criteria for evaluating historic cities, including provisions to de-list cities that violate conservation principles. For example, a city can be removed from the list if it undergoes large-scale demolitions that irreversibly alter its historic layout or if its cultural values are severely compromised. These measures underscore the importance of heritage protection even in the context of rapid urban transformation, promoting an approach that integrates cultural heritage preservation with sustainable urban development.

In the course of this work, we have actually registered (through GEP historical images database) several examples of the demolition and reconstruction of historic cities that occurred in recent decades; in some cases, rapid urbanization has significantly shaped the spatial layout of ancient cities without any effort for preservation or reconstruction. Some critical cases have been strongly brought to the public attention, such as Datong, but in others, the demolition proceeded slowly and almost unnoticed. The result is the loss of the historical urban dimension, or rather of the minute fabric that characterized it, replacing the existing buildings with large infrastructures and tall edifices. An example is the city of Caozhou Fu (Shandong), where several areas, within the historic layout and in the outer circle, are being demolished. Reconstruction, still in progress in several inner areas of the historic city, is characterized by very high buildings that change the perception of the size of the historic layout and of its placement in the original landscape.

Interest in the contemporary implications of traditional urban planning has however been revived in recent years in China with the introduction of the concept of a "large-scale landscape", considering a city and its "proximity" as a unitary entity. The concept is in a sense elastic and allows for various scales of interaction with the city, emphasizing the need to respect the environment and promoting the integration of the city with it. This approach aims to define a spatial pattern in relation to the site, establishing an organized structure from the outer periphery to the inner core. Recognizing the value of such "large-scale landscape" concepts would translate into development planning that, respecting the relationships the city has with its context, seeks to preserve the historical landscape while concurrently establishing an organized spatial framework (such as regulating building heights within a broader context). In the same direction is the general description of the UNESCO Historic Urban Landscape (HUL), described as "the urban area understood as the result of a historic layering of cultural and natural values and attributes, extending beyond the notion of a historic center or ensemble to include the broader urban context and its geographical setting". This encompasses an extended concept of identity for each single town, pointing to integrated conservation strategies for both urban heritage and natural landscapes, with the aim of sustainable development.

Within this evolving scenario, the research presented here may be of help in identifying the main cognitive aspects of the ancient "urbanscape" to be explored with close attention. These aspects in many cases include the sky, as the main "cosmic" ingredient of ancient Chinese town planning (actually, the role of astronomy as a universal value in cultural heritage has been recently recognized also by the UNESCO, with the inscription of new sites such as Chankillo in Peru [38]). In particular, the following points of attention emerge:

- Geomorphology of the Surrounding Landscape: This involves identifying the natural features characterizing the vicinity of the city, such as hills, mountains, and rivers, and understanding their role relative to the original city plan.
- Orientation: The primary orientation of the city, establishing deliberate choices made by ancient urban planners using astronomy.
- Horizon: The city's visible horizon, considering its possible original significance in both feng shui planning and in connection to the observation of celestial phenomena.

Attention to preserving the characteristics of the cultural landscape of ancient cities in order to achieve a sustainable modern urban development with respect to cultural heritage, should lead to establishing a control and guidance system of the urban landscape that is able to maintain the above-mentioned aspects, and we hope that the present work may contribute in this direction.

Finally, a further aspect related to the present research can be mentioned in connection with modern planning. If indeed the idea of a "terrestrial energy" is, of course, mere pseudo-science, the ideas of beauty and harmony expressed by feng shui are also easily

and objectively perceived as such today. Accordingly, the traditional doctrine of feng shui can be seen as a way to emphasize the preservation and the development of ecosystems in the modern design process. This, again, aligns with the principles of ecological landscape planning and sustainable development. Renewed interest in this so-called "shen–shui" ("mountain–water") planning, and thus, at least in a certain sense, in the esthetics of form feng shui, is evident in some recent projects. An example is the Olympic Forest Park in Beijing, where artificial hills, sloping riverbanks, valleys, lakes, wetlands, and forests, are all utilized to provide crucial ecological functions.

Supplementary Materials: The database developed for the present article can be downloaded at: https://www.mdpi.com/article/10.3390/rs17010161/s1.

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