

Persian translation of this paper entitled:
تبیین کاربست الگوهای فراکتال و بیومورفیک هندسی
طبیعت در طراحی منظر پایدار؛ موردپژوهی: شمال تهران
Has been published in this issue of Journal.



Explaining the Use of Fractal and Geometric Biomorph Patterns of Nature in the Design of a Sustainable Landscape in the North of Tehran
Received: 2022/05/12 Accepted: 2022/010/13

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Abstract

Establishing this connection between the city and nature can be in the form of bringing nature into the city and introducing natural symbols in the urban ecosystem. It is obvious that it is necessary to find solutions to restore the favorable condition of the environment. In this regard, establishing a compatible relationship with nature again can be very useful, and this is only possible by rebuilding the relationship between the city and nature. On the other hand, the knowledge of fractals and biomorph architecture can contain the necessary potential to organize the environmentally friendly design process, which was the goal of the present study. The descriptive analytical research method is accompanied by logical reasoning, which uses maps and satellite images using Auto CAD and ArcGIS software. At the end, strategies for sustainable environmental planning and design of these northern areas of Tehran are presented. The results of the research have shown that topography, hydrology and vegetation as the main and shaping patterns of the environment and landscape are directly related to each other and have very similar complexities and curves in terms of shape. And in a general composition they also follow a shape movement and this movement shape is wavy and congressional and has many protrusions and depressions in different scales.

Key words: *fractal, geometry of nature, sustainable design, natural landscape.*

Introduction and statement of the problem

Ideas about nature are often integrated into the theory and discourse of "biomorph architecture". For example, the ideas of the whole and the certain unit, which sometimes represent living beings, have been prominent in art and in architecture since the time of Aristotle and Plato (Stedman, 1979; Van Eck, 1994; Orsini, 1972; Grabo, 1995, p. 6). On the other hand, the rapid and excessive growth of cities due to the high rate of birth and migration to cities and the same ratio of increase in the consumption of natural resources and reserves and the spread of pollution has not only disturbed the economic

and social balance within the cities, but also It has caused the ecological imbalance of the areas surrounding the cities, and it is making the natural areas more and more difficult for its inhabitants. This is exactly against the principles of sustainable development for management and environment (Adesina, 2007). For example, Frank Lloyd Wright has described a process by which a function seeks an appropriate form in terms of being "organic" (Collins, 1998) and refers to the result of this process with the excellence of this concept. (Gilbert, 1957). Also, in recent architectural discussions, the concepts of animal biology and biomorphic are often identified with architecture consisting of irregular and curved shapes. Biological similarities have also found their way to green architecture (Toy, 1993, Vines, 2000), because like living beings and organisms, these buildings and structures are economical and self-sufficient in their energy consumption. . Also, the land use change between urban and rural or natural areas and the gradual expansion of cities has caused the loss of good agricultural land, landscapes and natural environments. The transformation created by urban and industrial societies is much faster than the speed of the natural reconstruction force, and the reconstruction process takes place very slowly due to its ecological nature. Today, humans have become the main and major disruptors of the complex order of biological systems between living and non-living elements, and the continuation of this process is considered a serious threat to the continuity of life on the planet. Therefore, in order to achieve the sustainable development of cities and the environment in the long term, there is a need to review the existing relationships between the components of the systems within the city, the relationships of the city with its environment and with other cities and regions of the world. The first area that you should think about in this regard is the peripheral parts of the city and the areas that, due to the growing situation of the cities, are constantly undergoing shape and structural changes and in a one-sided way and to the detriment of nature. It is progressing and changing. Therefore, knowing and analyzing such areas and thinking of design measures compatible with the characteristics of nature and the city in a mutual way can be considered as a fundamental matter in order to restore the optimal relations between the city. It is obvious that it is necessary to find solutions to restore the favorable condition of the environment. In this regard, creating a compatible relationship with nature again can be very useful, and this is only possible by rebuilding the city's relationship with nature. Establishing this connection between the city and nature can be in the form of bringing nature into the city and introducing natural symbols in the urban ecosystem. Therefore, presenting strategies for this zone and proposing a suitable and sustainable plan for it, only considering the natural features of the land and its substrate, is considered essential in order to create a suitable integrated zone.

Research methodology and background

The nature of the current research is applied and its method is "descriptive-analytical" and has drawing software. First, the theoretical framework of the research is derived from the documents, documents and scientific records that are related to the research topic, and after examining these topics, the related general result, research process and design principles are deduced from it. Based on this, it is possible to better understand the study area. Then, using the findings of the research in this section, in the next step, measuring and analyzing the fractal patterns and natural geometry in the bed and the relationship between them using maps and satellite images, maps and using AutoCAD software and ArcGIS software, the result was analyzed and investigated with theoretical principles, and finally the result of this research was presented as strategies for planning and designing a sustainable environment of these areas.





Research literature

Biomorphic

Referring to the history and flow of debates about the relationship between form and function in biological structures, it can be noted that in the middle of 1850, "Darwin" took the situation seriously and using the theory of "Von Humboldt", he claimed that "nature" has chosen the forms that have created the best compatibility and appropriateness with the environment of their establishment; But he never mentioned how nature created these forms in their place for the first time. Probably, he never had training or interest in "morphology" and as far as the effects of his works in morphological studies are concerned; it can be said that these works made people look at organisms as "historical beings". In his first draft of the book "Origin of Species" written in 1842, he declared that: "We must look at every complex and rich mechanism as a summary of a long history of useful measures and methods. Just like a work of art. Now, it is not clear to me whether he considered architectural history to be comparable to the phenomenon of "natural selection" or not (Mahmoudi-Najad, 2019, p. 23). There is no doubt that as far as biological theory is related to the category of form with the environment, it can be said that the dependence of the category of Darwinism with architecture has deteriorated and decreased. The developments and improvements that have taken place in the air conditioning equipment have caused the architectural forms to adjust their relationship with the climatic conditions. Glass walls have been used in warmer regions as much as they have been used in Canada; while the traditional Japanese frame building system has been used more outside Japan than inside Japan. It can be said that only in the areas where the utilization of "native materials" is extremely important, it can be seen that the characteristics of the environment have been effective in the forms (Collins, 2015, pp. 187 -188). The French rationalists were actually more attracted to this idea of subordination of form to structure (which seemed perfectly reasonable without considering any analogy); Thus, there will be no doubt that it was Sullivan who for the first time based the foundation of the architectural creed on biological assumptions (Collins, 1375, p. 189).

Chaos

Until recently, thinkers imagined the world as a set of systems that are moving in a specific and predictable way according to the algebraic laws of nature. Now they emphasize the creative role of disorder and chaos and consider the world as a set of systems that operate in their own ways. This new science is called complexity theory or nonlinear dynamics. Therefore, it is considered a mathematical concept that can be considered as a kind of randomness with certainty. Chaos theory is based on the premise that there is some kind of order in every disorder. In the sense that order should not be sought only on one scale and a phenomenon that is completely random and unpredictable on a small scale may be completely predictable on a larger scale.

Fractals and the geometry of nature

From trees to galaxies, nature shows itself as a flow of "self-like" forms. Fractal shapes are strangely connected with our daily life. With a little attention around, many of these forms can be seen. These entities are known as the main actors of geometry resulting from chaos theory. This geometry has unique features that can explain many events in the world around, but the main feature that exists in this geometry has caused special uses of this system.



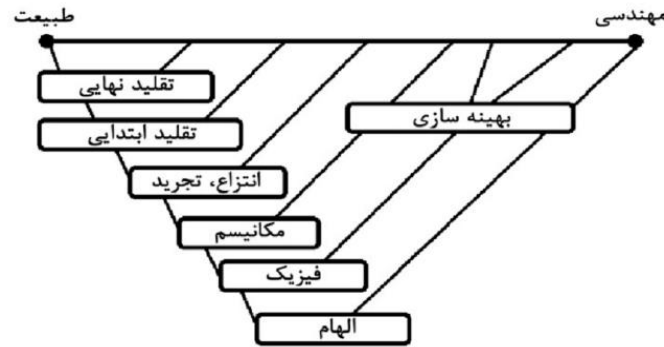


Diagram 1. Stages of inspiration and imitation in biomimetic and biomorphic architecture;
Source: Qaroni and others, 1392, p. 129.

Fractal rhythms

In addition to using fractal geometry as an analytical tool, Boville (1996) also uses it as a creative tool. This makes him in a completely unique position. Although many researchers discuss the relationship between fractals and architecture, almost none of them specifically provide guidelines for creating architecture according to fractal principles. To solve this problem, Beauville mainly uses fractal rhythms as a generator of architectural organizations. A simple way to produce such rhythms is by changing the middle position. Until 1957, mathematicians believed that the patterns of nature are complex and irregular and have an indeterminable structure until "Mandelbrot" stated in 1957: "Clouds are not spheres and mountains are not cone-shaped. . The coastline is not circular and thunder does not move in a straight line. In 1957, Mandelbort was nicknamed as the father of fractals by using the word fractals, which means a stone broken and crushed in an irregular shape (Lux, 2016). Fractals have an initial form and structure that is formed in the direction of their cellular integration, that is, the initial form of the city can be predicted from the form of the first city core, which is somewhat agreed upon by urban planning thinkers. "Edward Lawrence" is a professor of meteorology at MI University. In America, T proposed the "chaos theory" in the 1970s. In 1972, he published an article titled "Does the movement of a butterfly wing in Brazil cause huge tornadoes in Texas?" published this article became known as "Butterfly Effect". According to this theory, small events lead to big events. According to Lawrence, due to the presence of turbulence, climate changes cannot be predicted and these predictions are always approximate (Qabadian, 1382, p. 165).

Combined urban-natural areas

The different functions of the city edge and suburbs include: health, utility and social functions, as well as ecological functions and capacities. In addition, there is considerable economic importance in these areas (cited in Lange et al., 2007). Integrated urban-natural areas are a part of the countryside that is under the greatest pressure due to its potential for development, access and entertainment, for new house construction, transportation infrastructure, and in some cases, mining operations and dumping and waste depots. . This area is often suitable for developments that occur close to the main transportation network or close to population centers that create demands. Some researchers believe that these areas are very fragile in terms of the appearance of the land and landscape, and as a result, it is necessary to preserve the natural and fragile character of the environment and landscape and limit the expansion of the city (Sullivan et al, 2004).

Expression of research findings

The city of Tehran is located in the natural bed between 35 to 36 north latitude and 50 to 53 east longitude. This bed is limited from the south to the northwest margin of the



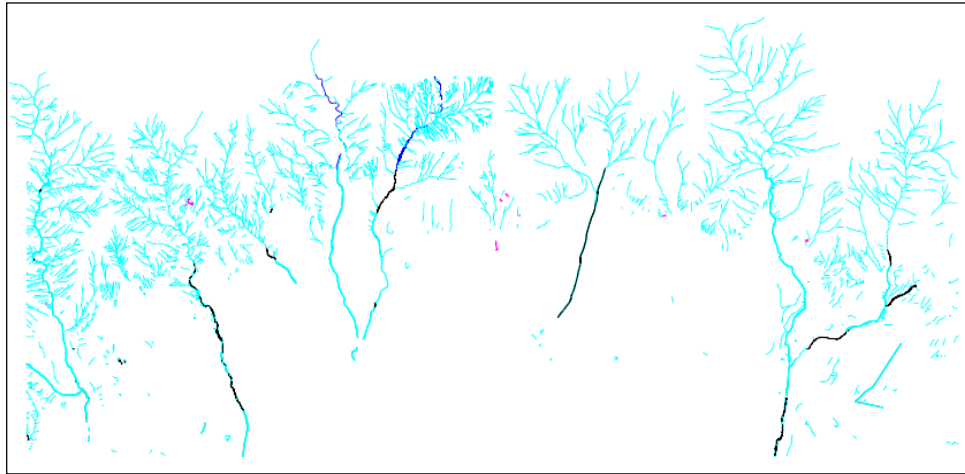
central desert, from the north to the southern slopes of the Central Alborz, from the east to the Jajroud valleys and from the west to the Karaj valleys, and the 22 districts of Tehran are located within this range. Have taken Map No. 1 shows the location of Tehran and its surroundings.



Map 1. Location of Tehran city and its surroundings. Source: Tehran Studies and Planning Center, 1401

Topographic pattern and shape of the earth Some landforms have fractals only in one or two scales and not in more dimensions, which is more true for sedimentary structures, while in a valley or bed eroded by water, more layers of details can be seen. In each of them, the branching pattern is repeated. Considering that the bed of the studied area is an erosion bed and by observing the shape and topographic features of the area, it can be seen that the shape of the land in this area is really fractal, and the features of fractal patterns are clearly evident in it. As it can be seen, the topographic level lines of the range have a fractal shape and structure, and in each scale, a similarity of shape can be observed in these lines. This pattern itself is the origin of many other fractal patterns and created the appearance of the earth along with the protrusions and depressions, which is also a fractal shape. According to these shapes, the pattern of waterways, the pattern of ridges and other fractal patterns are created. The pattern of topographical alignment lines in the study area. The figure below also shows the appearance pattern of the northern mountains of the region, which itself is affected by the topography. By enlarging a part of this natural pattern, it can be seen that the movement of the lines takes place in the same way as seen in the image further away and this process will continue.

The model of the network of natural waterways the pattern of rivers and waterways in the region is a complex branching pattern. Complex branching pattern is the most common pattern among rivers. These branches are like tree branch branches, which are called tree branches. The structure of this template is very expandable. From the mixing of smaller elements and the formation of smaller elements, a hierarchy can be seen from small streams to big rivers. This hierarchy can also be seen in the pattern of catchment basins and the accumulation of basins to create larger drainage systems. The branching tree pattern is one of the most common quadruple base patterns introduced by Peter Stevens.



Map 2. Fractal pattern of waterways, source: authors

Conclusion and summary

Fractal geometry is the geometry of nature itself, and fractal patterns are nature itself, so using this geometry is the best solution for designing in natural areas. In the same way, in the old cities and the cities that were formed based on a logical process, fractal geometry can be expressed as the existing geometry in them. On the other hand, the residents of the city have a great desire to live with nature, which leads to the creation of a very long and curved edge in the peripheral areas of cities that have suitable natural edges in order to increase the connection of citizens with nature. To be The area of integration of city and nature (outskirts of the city) is considered as a very important factor in the biological and aesthetic quality of the city from the physical, biological, form and ecological point of view. On the other hand, it can be said that one of the most important and ponderable issues related to the stability of natural and artificial structures in urban systems is following natural patterns. It was said that this created pattern is a fractal pattern and the geometry that expresses it is fractal geometry, and in these cases, the tendency to increase the length of the edge, which is the tendency to better quality from the biological point of view, is parallel to the increase in the length of the edge and the decrease in the ratio. The area of the area in relation to the environment is on the one hand and the creation of fractal shapes in the transitional area (such as small built spots in nature that are along the urban network) and as a result the fractal dimension increases. As a result of this, fractal geometry as the geometry of nature and suitable geometry for the design of the city and especially the urban edges can help in a good way to design in the areas where the city is combined with nature. The suggested strategies and solutions for design are: Creating continuity in the existing green spots, turning open spaces into connecting factors of these spots by identifying open spaces in the region, creating connecting green spaces according to their physical conditions, drawing from the patterns of natural plant spots. And also the expansion of green spaces into built-up areas from any point where there is the possibility of penetration in order to increase the contact level of the city with the surrounding green spaces and increase the fractal dimension in the region. ♣ Preserving the natural shape of the slopes in the area that have not yet been subjected to earthworks and using their shape as a model for the reconstruction of the destroyed areas and trying to create the least interference and occupation in these slopes (in If there is an urgent need to create roads or buildings in such areas, a detailed study of the natural features should be carried out in a manner consistent with the basis of this operation. ♣ Preservation of the existing natural environments in the area and their proper use in order to be a role model





for all operations of organizing the region on the one hand and to strengthen the role of their green space in order to create a protective sanctuary against the intrusion and excessive expansion of the city. ♣ Organizing the marginal structures created in the area and controlling the volume of construction and the amount of building density in the area by using the surrounding by quasi-natural green space and defining the forms compatible with nature for these structures, keeping in mind Research findings. ♣ As it can be seen from the results of the analysis of bed patterns, topography, hydrology and vegetation factors as the main patterns that shape the environment and landscape are directly related to each other and have very similar complexities and curves in terms of shape. They are together and in a general composition they follow a form movement and this movement form is wavy and congressional and has many protrusions and depressions in different scales. ♣ Restoration, revitalization and development of valleys as a factor of infiltration of nature and natural environment into the urban space, and on the other hand, increasing the level of connection between the city and nature by protecting the valleys and natural tongues and waterways by creating a wide sanctuary. and preventing the equalization of the substrate and related open spaces by urban uses and ♣ Limiting the residential development in the lands next to the valleys and channels and the boundaries of the faults in order to create a structure that ensures proper communication upstream and downstream (for example, by building a linear park along the rivers-valleys and also preserving and revitalizing the green space of the valleys and the natural bed of the rivers in the region.

Declaration of no conflict of interest

The authors declare that there was no conflict of interest for them in conducting this research. (Conflict of interest refers to a situation where the material or non-material personal interests of the author or authors are in conflict with the research results and this affects the research process or the honest announcement of the results).

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