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UNDERSTANDING COMPLEX URBAN SYSTEMS WITH FRACTALS: GERMİR

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Abstract

Self-developed settlements in many ways are the greatest exemplars of complex systems. They build from the bottom up, they grow organically, and they look as through they are created by nature in terms of the way their networks deliver energy to their parts. In this process that can be defined as self-development, the relationships in the lower scale are realized strongly and they construct the unity of urban system through better progress. In order to comprehend the spatial features, level of complexity and the structure of this dynamic formation through time, it is possible to utilize fractal geometry which is a complex and computational approach. Departing from this, it will not be wrong to say that self-developing urban formations, where no designer is included during creation and design, are a result of dynamic and generative computational processes. Putting forward the level of complexity by using fractals for such a settlement is also important for comprehending spatial relationship features and dynamic structure of the formation. By this way, it is thought that fractals will enable a new approach in interpreting any urban formation and intervention processes by determining the level of complexity for any system.
In this respect, fractal dimension computations performed specifically to Germir settlement revealed that urban spaces in different plans have high and similar fractal levels supporting the fact that self-developing settlements are complex systems. Consequently, it can be said that Germir settlement has been formed up on a unique fractal code on its own.
Anahtar Kelimeler: Self-developed settlements, Complexity, Fractals, Germir

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Introduction

Trying to understand complex urban systems inholding permanency of change and stability is vital for both sustainability of the existing environment and the process of creation for new urban sites. In this respect, reading the city that is instrumentally important for understanding urban formation can be seen as a kind of mental activity, a discovery experience and a process of comprehension-interpretation. By this way, while the dynamic and complex structure of cities make them places of attraction awaiting their discovery, this makes them complex and difficult to comprehend at the same level.

While trying to comprehend the city as a complex system, it is strategically important to reach the implicit knowledge behind the visible part and to focus on complex relations transforming and revealing sublime parts of the whole. It is only possible with a multidimensional and holistic point of view blurred by interdisciplinary boundaries to approach urban systems with all visible and invisible aspects. Therefore, beyond visible and countable features of the city, it is fundamental to read and make comments including different realizations during reaching the knowledge beyond and understanding the relationships on patterns of features of the city.

Traditional approaches tend to simplify existing complex structures while discussing systems as static and close systems. Even though it seems very beneficial in the beginning, the idea that some features peculiar to the entirety of the system are lost while trying to understand and investigate significant features of the system by subdividing it into pieces through simplification, that some relationships are ignored, and that the system itself is much more than its parts has become more of an issue. As a result, the meaning ascribed to complexity and our approach are changing; approaches aiming to comprehend the whole with all dynamics forming itself take the place of those simplifying approaches in which city readings are performed by subdividing the whole into its parts.

At this point, as recent fast developing digital tools and computational approaches gave way to investigate, discover and define the formation of idea and knowledge through different systems, it directs our acquisition of knowledge of reality around us with its thinking and learning methods. Rather than utilizing fixed equations in defining systems through computational approaches, with the designation of the process, while creating or defining different processes and formations, the system can be processed through dynamic and multidimensional interactive relationships beyond static/stable mathematical equations. Thus, it opens a new approach in search for investigating, comprehending and interpreting the uncovered meaning of existing environment by offering an important field of research for architecture and urban design in structuring and comprehending dynamic and complex systems.

In this respect, one the computational complexity models; fractal geometry is used to understand the behavioral structure of complex systems and to reveal their level of complexity. Considering the urban point of view, self-developed settlements are such structures with infinite level of complexity, open-ended, dynamic, cooperative and alive. Formations in this structure show non-linear developments. Mathematical and geometrical aspects of these formations without a linear developmental process naturally bear fractal structures. Salingaros (2011b), supporting the same idea, states that living cities have fractal features same as other living systems.

Urban formation that was self-developed under control of the settlers, even though the settlers are not aware of that, is formed up in a fractal process in time. This ideal can be strengthened with the statements of Salingaros et al. (2000) that human brain itself has a strong fractal structure and, therefore, their produce will instinctively have a fractal formation.

The process of self-development affects the urban texture less in general and cause a little change in fractal dimension levels while decisions made by an external mechanism usually destroys the unity of structure. Fractal, urban formation free of scale, has structural components in all dimensions from micro level of construction materials to the whole structure. The idea of circumstances occurring between and in each scale may help understanding how complex urban structures live and grow. At this point, it seems vital to make use of fractal geometry to understand the spatial features and the dynamic structure of complex urban formations in time.

Within the scope of this study, it is questioned whether Germir settlement contains fractal features in terms of its complex and self-developed physical formation. Thus, it is aimed to consider settlements by determining the level of complexity through questioning the presence of a geometrical network, fractals, as an inductive structure. By doing this, it is considered important that the study may show the direction for further settlements as a process with external interferences.

A. City, Complexity and Computation

In our day, studies based on computations conducted to understand complex and highly organized urban structures have become pivotal. Determining the dynamic urban system simply as static and non-elastic formation instead of a flexible and continuously evolving system has yielded studies done to understand the current structure by modeling the urban formation through using computational approaches and numerical technologies. According to these studies, it is understood that the concept of urban structure has evolved towards approaching the city as a highly complex system in terms of the dynamic meaning of movement and continuous diversity and the static structure (Jacobs Alexander, 2001-2005; Batty, 2005; Hillier, 1999; Marshall, 2009; Portugali, 2000; Salingaros, 2005; Salingaros, 2011a).

In summary, all approaches stated in studies done for urban space readings have emerged from the theory of complexity and its integrant part; the multidisciplinary structure of computational thinking. These approaches enable us to observe urban formations through a new point of view and to create new knowledge of them. Studies based on these approaches investigate the successes and failures in urban texture by using techniques of theory of complexity and computational models.

One of the approaches underlying most of these studies is general grouping theory which uses planning and computational content of urban design methods in order to interpret diversity of urban morphologies. According to this, urban morphologies contain roughly four groups; each unites and transits with others.

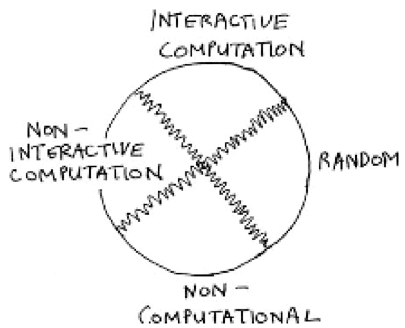

Figure 1: Categorization of urban morphologies in terms of underlying computational complexity (Salingaros, 2011a)

These four categories of urban morphology are named by Salingaros according to the underlying computational complexity. They are put in order in accordance with the decreasing amount of computational content. Another way to consider about these four categories is that the order corresponds to the decreasing computational complexity (Figure 1).

- interactive computation
- non-interactive computations
- random
- non-computational

The first category (interactive computation) represents the urban texture emerging from generative and dynamic computations that reveal the form which adapts itself to limitations come out of diversity of local conditions and human needs. Traditional methods of urban design prior to industrialization in 20th century shows that it belongs to this category of computation. The second urban category contains non-interactive computations. The difference between the first and the second is that the latter uses deterministic algorithms which ignores feedbacks in form during modeling computations, therefore, it is self-sufficient. The third urban category, random computation, may contain computations aimed at producing the randomness observed in complex formations, however, this type of computation is not related to urbanization; rather, it is responsible for the design of a random graphical urban formation. The main purpose of this category is not to reveal the basic features of the process of urban adaptation; it is only for a graphical design. These reasons and computations are pragmatically unrelated to the basic purpose of a city (Salingaros, 2011a).

With the possibilities of current digital technologies, it can be said that the category of Salingaros about random computation includes many of urban design proposals that were realized independent of the land. In fact, the greatest danger in computation and urban studies, as mentioned before, is the effort to show effective forms by ignoring the relational network of the city through using the computational power obtained from digital technologies. However, computation and digital technologies promise much more than this for urban formations.

The last category in Salingaros' classification is non-computational; its morphology is extremely simple. This is the equivalent of a static and determined algorithm. It is similar to a function that reveals the same result for any input. This non-computational process called International Style Urbanism produces military camps, depots and some industrial facilities (Salingaros, 2011a).

For Salingaros, different types of urban textures represent the processes where levels of complex computations are diversified owing to its nature. In this context, urban categorization through interactive computations is the city inholding, owing to its nature, highest level of complexity.

Departing from this, it will not be wrong to say that self-developing urban formations, where no creator is included during creation and design, are a result of dynamic and regenerative computational processes. Therefore, they are in the urban morphology category that contains interactive computations as proposed by Salingaros. In this sense, the subject of our study, Germir, is very important in terms of being a kind of tool to determine the situation mentioned above. Putting forward the level of complexity by using computational models for such a settlement is also important for comprehending spatial relationship features and dynamic structure of the formation. By this way, it is thought that fractals will enable a new approach in interpreting any urban formation and intervention processes by determining the level of complexity for any system.

B. Self-developed Settlements as Complex Systems and Fractals

Self-developed settlements in many ways are the greatest exemplars of complex systems. They are built from the bottom up, they grow organically, and they look as if they are created by nature in terms of the way their networks deliver energy to their parts. Despite drawing the sharp edges, insisting on significant function and the forethought partial nature which is argued by contemporary built environments, there is a production of environment by artisans and users in space and time continuity in the circulation of 'knowledge' and 'making'. In this continuity, the production of environment which is dependent on the place and the culture through unique internal dynamics, in time, brings the spontaneous production of the environment.

In spite of the fact that these formations which are not pre-designed as a whole incomputable ones by being shaped through experiences are developed on individual interventions, it is striking to witness their having holistic and complex nature. In these settlements which has a quality that the limits are designed by the life itself, it may be observed a "unity" which tells multiple faces of life living together, enabling interactions and revolving with a great dynamism where contradictions like open/close, in/out or full/empty are not imposed.

In this context, urban design tends to be highly instinctive in traditional societies. Human understanding and intelligence is utilized during formation and positioning of buildings in an urban are (Alexander 2001-2005, Salingaros

2011a). Therefore, it can be thought that the formation of traditional settlements is a special result of a process of complex computations that utilizes human intelligence and perception with consciously or subconsciously made decisions as a respond to its environment.

Traditional settlements are open, dynamic and live ones with an infinite level of complexity. Additionally, facts in this structure display non-linear developments. In order to comprehend the behavioral structure and to expose their level of complexity, chaos and complexity theories have been used recently. One of the mediums used for understanding the setup and for commenting on complex structures is Fractals.

Fractals and chaos are non-linear approaches utilized to comprehend balance and complexity in nature as well as in other systems. To comprehend the features of environmental relationship and dynamic structure of the urban texture in time, it is practical to put chaos theory and fractals in use. The chaos theory helps one evaluate the effect of onset conditions on the evolution of texture, and the continuity of texture in time. Fractal geometry, on the other hand, assists us in evaluation of the texture in terms of environmental organization.

The term, fractal, was first suggested by a Polish French mathematician Beneoit B. Mandelbrot in 1975. Mandelbrot, stating that shape of any object in nature cannot be defined through Euclid geometry, suggested that these definitions are possible by using fractal geometry. While Euclid geometry is limited in defining simple and basic geometric forms, fractal geometry is competent in defining nature and natural patterns (Figure 2, 3). Shapes which define these patterns of nature in fractal geometry produce a repetitive algorithm.

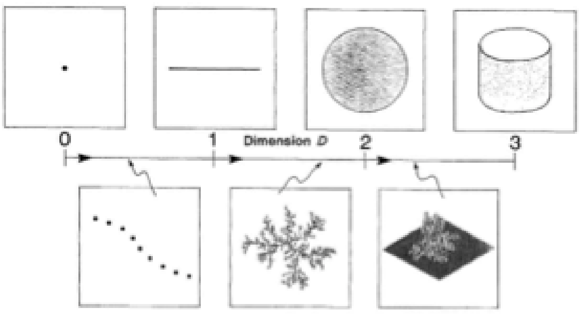

Figure 2: Comparison of Euclid Geometry and Fractal Geometry (Batty and Longley, 1994)

Beside the fact that fractal dimension can be computed by using different methods, the most popular one is the box counting computation in which the logarithmic rates of empty and full cells on a two-dimensional grid system are used. On the other side, in production of designs, displacement of midpoint is used.

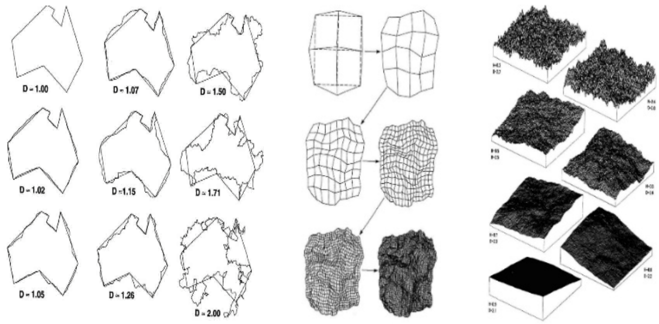

Figure 3: (a) fractal dimension evaluation of a coastline, (b) transformation of a surface with the use of fractal geometry, (c) transformation of a topographical sample by increasing the fractal dimension value (Batty and Longley, 1994).

Objects with fractal geometry have two fundamental features related to the urban texture: The first is of forms of these objects. Elements forming the urban texture have fractal dimensions and their level complexity is higher compared to that of prismatic objects with net geometry. The latter is of their formation process. Fractal objects develop from the lower scale towards the upper one with the repetition of the same pattern. Similar geometry or development model repeats itself in different scales. “Self-similarity” refers to the repetition of the same pattern in different scales. This feature, self-similarity, must be considered as continuity in terms of level of complexity and environmental organization beside the presence of similar forms in different scales. Fractal dimension is feature visible all through the city from a building to the whole city, and as environmental organization differentiates the rate of fractal dimension changes. Deriving similar fractal dimension values in different scales must be considered as the presence of texture unity and continuity of environmental organization. (Frankhauser, 1998, Kaya and Bölen, 2006).

Fractal criteria can be used to determine the success of urban geometry. The concept of collaborating events inter-scales and occurring at any scale may enable a better understanding of how a city lives and grows.

Which cities are fractals?

Living cities have fractal features in depth just like all other living systems. The pressure about designing environments proper for the population and for automobiles pushed urban planners of the 20th century to pursue non-fractal geometric models. The fractal features of traditional city are destructed resulting

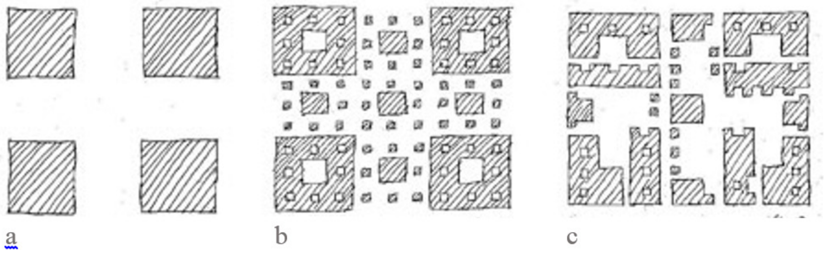

Figure 4: (a) A non-fractal modernist city plan, (b) Surrealistically designed fractal city plan, (c) Determination of city style by the flowing geometry of the city itself. (Salingaros, 2011b)

in disastrous incidents (Salingaros, 2011b). The formation of traditional city follows pedestrian commuting lines. The city under the dominance of walking humans, even if those constructing the city are ignorant of the situation, will be formed in a fractal way with increasing additions. Human mind has a carved fractal shape, therefore, its creations will sure have fractal structure (Mikiten, Salingaros and Yu, 2000, Salingaros, 2009). In fact, humans must be psychologically pre-conditioned to create non-fractal items. Unfortunately, this is exactly what our education system and mass media have done to us for the last decade (Salingaros, 2011b).

If the structural and connective hierarchy is not present in each of its smaller scales, this city is not a fractal one. A real mathematical fractal has similar structures down to its indivisible small parts. For a physical fractal, the smallest scales are so small that they are invisible for a normal eye and this means a range of values from the biggest to the smallest. There are two ways to derive a fractal down to the smallest scales. The first is *adding* the infrastructures, and the latter is *subtracting* the infrastructures.

The first way, adding infrastructures in any scale creates multi-layered textural items with curves which are never plain or smooth. It creates a fractal "asperity" on every corner. Presence of curled urban borders in urban planning, as it is with sops and café chairs surrounding squares, makes human relations easier (Salingaros, 2011b). Current urban places are almost always surrounded by a fractal border. Destroying the fractal structure by levelling edges destroys the catalytic geometry that enables the inter-human relations, and slaughters the urban environment (Salingaros, 2005).

Another way of building a fractal is creating spaces as if screwing holes into an item in different scales. While cavernous urban interfaces allow the pedestrian flow through an urban border, it prevents the automobile flow through the same border. Examples of this can be colonnades, porticos, arcades, small shop entrances, king-posts all along the sidewalk, and such (Salingaros, 2005; 2011b). Spaces between buildings are fractals structures in their scale.

Another key feature of fractals is that they are self-similar and consistent. This refers to the fact that different scales are related to each other in a kind of scaling symmetry. In the simplest geometric samples, the design is repeated gradually in smaller scales, and this enables different scales being connected to each other as a whole. In more complex implementations, the process and structures in different scales in the city basically collaborate. Consistent large-scale structures are made up of small-scale components. This is something that makes different scaled interacting structures a whole both in terms of geometry and in terms of processes emerged in these scales.

A fractal city (free of scaling) has structural components of all sizes ranging from the city itself to the micro components used in building it. In this regard, the purpose of this study is to determine if Germir settlement is a fractal formation by trying to understand the settlement through fractals with its level of complexity.

C. The Fractal Settlement: Germir

In this study, it is projected to experience the relationship between vitalness, complexity and fractal features of self-developed settlements on the example of Germir, a town located in a valley 6 km eastward from the city center of Kayseri (Figure 5, 6). Permanent settlements in Germir have occurred during Hittite, Cappadocia, Roman-Byzantium, Seljukian and Ottoman eras. Germir, according to Cadastral Record Books dated 1500, where Turks, Greeks and Armenians have long lived together, was under administration of Koramaz district with a population of in which 95% of the population was non-Muslim.

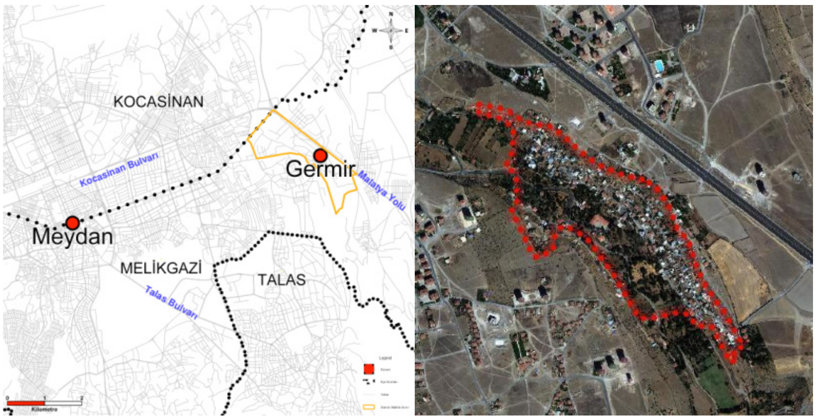

Figure 5: Location and aerial photos of Germir (www.kayseri.bel.tr/web2/uploads/eDergiler/germir/)

In the 1584 Cadastral Records, it is stated that there was a little number of Muslims and a lot of non-Muslims living in the village. Considering the census of 1875, there were 203 Turkish domiciles, 405 Armenian domiciles and 606 Greek domiciles, 1214 domiciles in total with a population of 6070 people living in the village. There are 2 Greek and 1 Armenian churches, 2 mosques, a public bath, a jewelry shop, 15 linseed oil shops, 20 shops, 65 stores and a slaughterhouse (www.kayseri.bel.tr/web2/uploads/eDergiler/germir/).

Figure 6: Some photos of settlement in Germir (www.kayseri.bel.tr/web2/uploads/eDergiler/germir/)

The multi-layered structure, living up-to-date by conserving it authentic texture and its readability are vital factors of studying on Germir. Contrary to the fact that the structure was not primarily designed as a whole, it is exciting that it is shaped according to experiences and circumstances individually, and it preserves a complete, complex and lively nature. In this regard, the struggle to comprehend the complex structure of the physical formation that is thought to be affected by vital processes may be considered a remarkable step to understand the settlement. It is obvious that Euclid geometry is not sufficient to model and comprehend such complex structures. That is, Euclid geometry is for 0, mono, two and three dimensional geometric structures. On the other hand, fractal is a concept bearing the process of quantizing complementary features of shape, texture, number, color, prevalence, randomness and order which we use to define the peculiarities of a system or a case. In short, it measures complexity.

In this sense, in order to reveal the strong connection between the fractal features and complex nature of a settlement, layout plans, street silhouettes, single structure and detailed fractal computations are done with the help of IMAGE J software. Thus, we have questioned the presence of a high fractal value and fractal consistency in varying scales and plans all along the settlement. Fractal value computations are performed through 2D plans of Germir. Therefore, fractal dimension will result in fractional value changing between 1 and 2. When the value is close to 1, the fractal level is low while it has high fractal level when it is close to 2. Fractal dimensions of urban textures are mostly between 1,4-1,8 for major studies on world cities (Batty and Longley, 1994; Frankhauser, 1998b). Concordantly, the complex urban settlement of Germir is questioned to have fractal features in various levels and to have high fractal features as an urban formation.

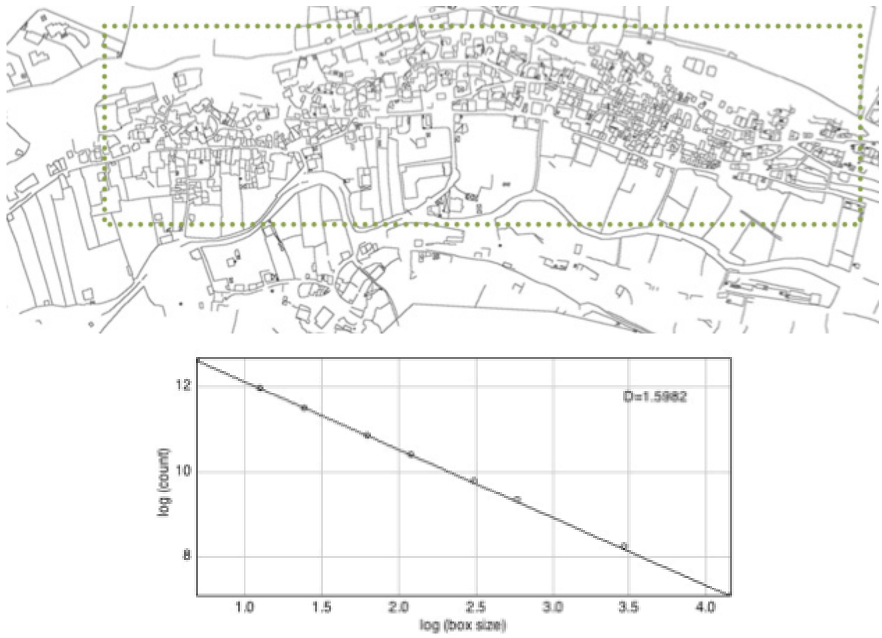

Figure 7: Germir layout plan and its fractal dimension values obtained from Image J software

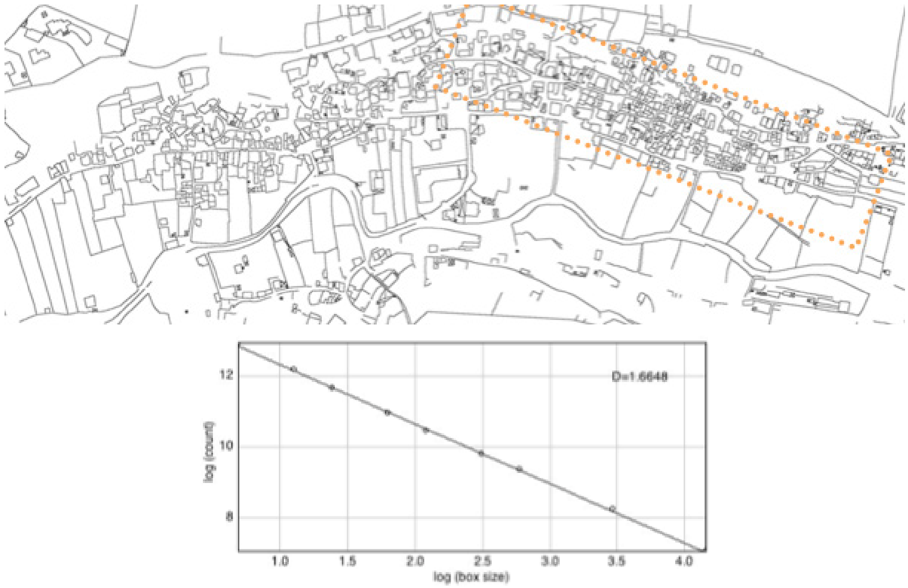

Figure 8: Upper Neighborhood of Germir and its fractal dimension values obtained from Image J software

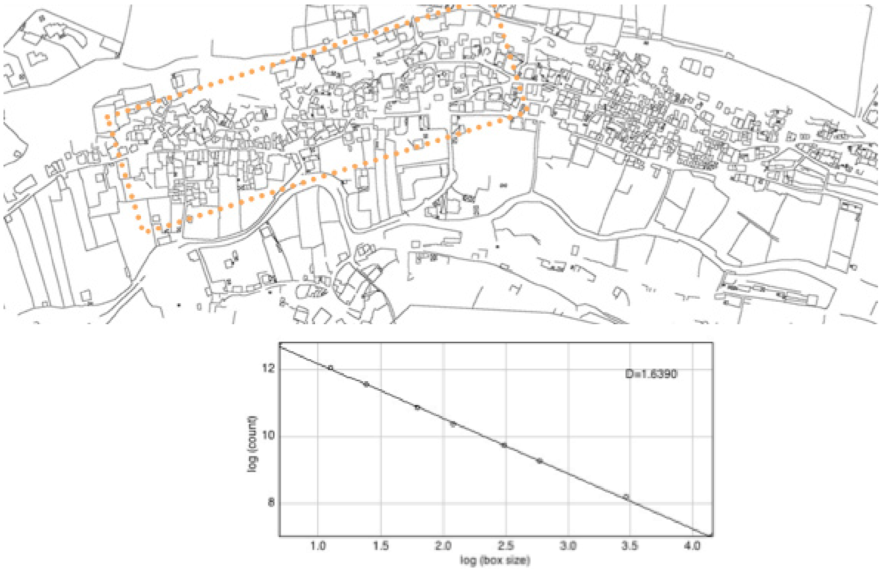

Figure 9: Lower Neighborhood of Germir and its fractal dimension values obtained from Image J software

Primarily, the fractal dimension computations are done on three different regions determined in the settlement plan of Germir. The first fractal dimension computation is done on the whole (Figure 7), and the other two are done on the right and left sides of the geometric center of the settlement plan of upper and lower Germir (Currently called Aşağı and Yukarı Germir) (Figure 8,9). As a consequence of fractal dimension computations, it is observed that the values 1,6, 1,67 and 1,64 respectively of the general plan, upper and lower districts of Germir have high fractal values (Figure 7,8,9). In addition, these fractal values of Germir and its two neighborhoods have very little differential, that is, the whole and its parts contribute the sustainability of physical features.

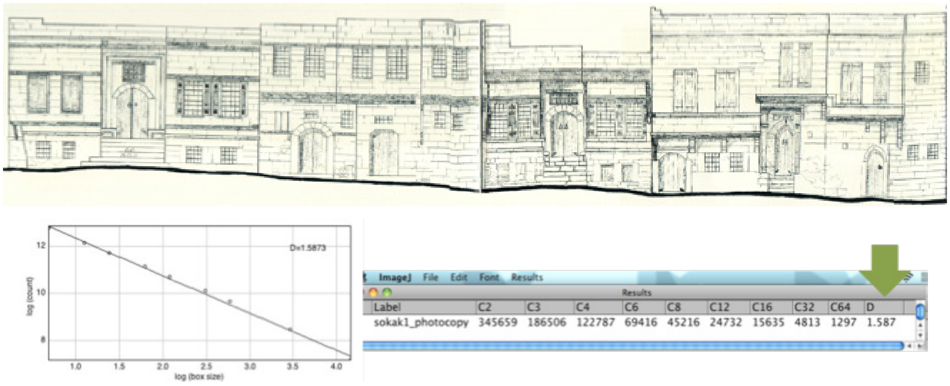

Figure 10: 'The street silhouette of Germir 1'[1] and its fractal dimension values obtained from Image J software

[1] The drawing from the archive of Erciyes University Faculty of Architecture.

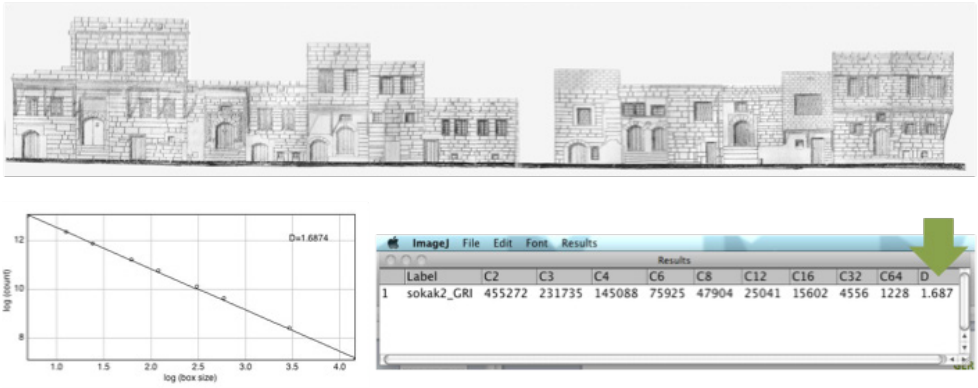

Figure 11: 'The street silhouette of Germir 2'[2] and its fractal dimension values obtained from Image J software

Following the computation of fractal dimension on the layout plan, the fractal dimension computations for street silhouettes is done. The results of these computations showed that they are similar to that of layout plans, 1,59 and 1,69 (Figure 10,11).

Figure 12: 'Front entrance of a house in Germir'[3] and its fractal dimension values obtained from Image J software

[2] The drawing from the archive of Erciyes University Faculty of Architecture.
[3] The drawing from the archive of Erciyes University Faculty of Architecture.

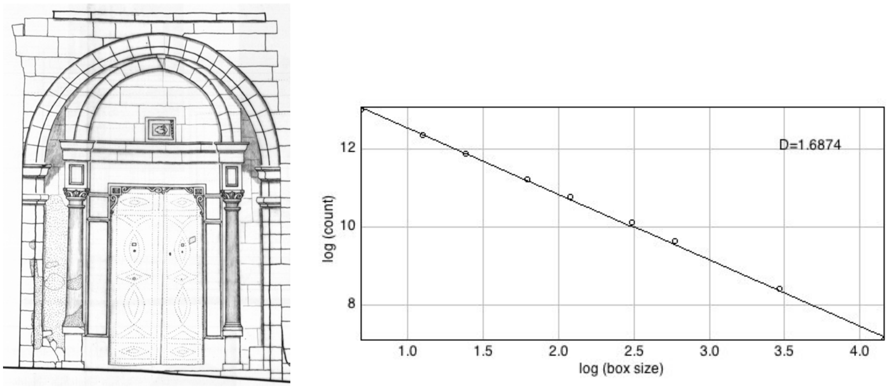

Figure 13: 'Front door of a house in Germir'[4] and its fractal dimension values obtained from Image J software

In addition to fractal dimension value computations of layout plans and street silhouettes, which offers information about the whole settlement, fractal dimension values of a single building with its front entrance or a part of it such as the front door are computed. Respectively the values of 1,6 (Figure 12) and 1.69 (Figure 13), and values obtained from the previous computations are almost the same.

Conclusion and Evaluation

As stated previously, self-developed settlements are open, dynamic and living formations with an infinite level of complexity. Parts of this structure display a nonlinear development. In general, chaos and complexity theories have recently been used to define the complexity levels and to comprehend the behavioral structure of all these formations, especially of complex urban systems. In this respect, a tool that is used for description and comprehension of physical structure of complex urban systems is fractal geometry.

Fractal dimension is a progressive feature all along the building towards the whole city, and as the environmental organization changes, fractal dimension values change. Obtaining similar fractal dimension values in different scales is accepted as the presence of progression in environmental organization and of unity of texture.

In this context, when the settlement texture of Germir is assessed through layout plan, street silhouettes, building sides, and building details, similar fractal dimension values are obtained in different scales. This may be commentated the progress in texture characteristics and as the coherence of this texture with the natural environment self-emergence and development, the

[4] The drawing from the archive of Erciyes University Faculty of Architecture.

main characteristic of the main settlement, defines the similarity in fractal dimension values of the whole and its parts in different layers through conserving the unity from the part to whole. All obtained levels were between 1,6 and 1,7 and this means a complex structure in terms of mass and environmental organization. Consequently, it can be said that Germir settlement has been formed up on a unique fractal code on its own (Atak Doğan, 2016).

With the approach revealed here, it can be stated that the current circumstances can be investigated by using fractal geometry and the knowledge of urban formation can be produced; all planned interventions can be performed or be formed up while being tested. Thus, fractal geometry can be used as a tool for designing the continuity of the present circumstances beyond producing the knowledge of the present. Additionally, all fractal dimension computations are done with the help of 2D illustrations; the settlement is not studied in 3D. Realizing a 3D computation of fractal dimension values on 3D models of settlement textures would enable us to compare the current and 3D results, and, by this way we can produce much more information about the texture of settlement.

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REFERENCES

Alexander, C., *The Nature of Order, Books 1-4*, Center for Environmental Structure, Berkeley, California, USA. Book 1: *The Phenomenon of Life*, 2001; Book 2: *The Process of Creating Life*, 2002; Book 3: *A Vision of a Living World*, 2005; Book 4: *The Luminous Ground*, 2004.

Atak Doğan, Ö., (2016) Karmaşık Kentsel Oluşumların Değerlendirilmesi İçin Hesaplamalı Bir Yaklaşım, (Doktora tezi). İstanbul Teknik Üniversitesi, Fen Bilimleri Enstitüsü, İstanbul.

Batty, M., Longley, P. (1994), Fractal Cities: A Geometry of Form and Function, Academic Press, San Diego, CA and London.

Batty, M. (2005), Cities and Complexity: Understanding Cities with Cellular Automata, Agent-Based Models, and Fractals, MIT Press, Cambridge, Massachusetts.

Büyükmıhçı, G. (2005), *Kayseri'de Yaşam ve Konut Kültürü, Kayseri: Erciyes University Publication.*

Frankhauser, P. (1998a), The Fractal Approach. A NewTool for the Spatial Analysis of Urban Afflomerations. Population: An English Selection, 10, 205-240.

Frankhauser, P. (1998b), Fractal geometry of urban patterns and their morphogenesis. Discrete Dynamics in Nature and Society, 2, 2, 127-145.

Kaya, H. S., Bölen, F. (2006), Kentsel Mekan Organizasyonundaki Farklılıkların Fraktal Analiz Yöntemi ile Değerlendirilmes, Journal of İstanbul Kültür University, Vol. 3, No. 4, page: 153-172.

Marshall, S. (2009), *Cities, Design and Evolution*, Routledge, London, UK.

Mikiten, T. M., Salingaros, N. A. & Yu, H. S. (2000), Pavements as Embodiments of Meaning for a Fractal Mind, Nexus *Network Journal* 2, pages 61-72. Reprinted as Chapter 7 of *A Theory of Architecture*, Umbau-Verlag, Solingen, Germany, 2006.

Portugali, J. (2000), Self-Organization and the City, Springer-Verlag, Berlin.

Salingaros, N. A. (2005), Principles of Urban Structure, Techne Press, Amsterdam, Holland.

Salingaros, N. A. (2011a), Urbanism as Computation, "Complexity Theories of Cities Have Come of Age: an Overview with Implications to Urban Planning and Design", Springer, Heidelberg, J. Portugali, H. Meyer, E. Stolk & E. Tan, Eds.

Salingaros, N. A. (2011b), Turkish Version Of Chapter 6 "Connecting The Fractal City" Principles Of Urban Structure, Doxa, Issue 10, Norgunk Publishing House, Istanbul, June 2011, Pages 78-101.

www.kayseri.bel.tr/web2/uploads/eDergiler/germir/ (10.06.2017)

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KARMAŞIK KENTSEL OLUŞUMLARI ANLAMADA FRAKTALLER: GERMİR

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Öz

Değişimin ve durağanlığın sürekliliğini içinde barındıran, karmaşık kentsel oluşumları anlamaya çalışmak, yeni kentsel mekânların oluşum süreçlerinin biçimlendirilmesi ve aynı zamanda yapılı çevrenin sürdürebilirliği açısından önemlidir. Bu bağlamda, kentsel biçimlenişleri anlamada araçsal bir öneme sahip kent okuma çalışmaları; bir tür zihinsel etkinlik, keşif deneyimi ve anlama-yorumlama süreci olarak görülebilir. Kentsel oluşumların dinamik ve karmaşık yapısı kenti keşfedilmeyi bekleyen çekici bir yapı haline getirirken, okunmasını da aynı derecede karmaşıklaştırmakta ve zorlaştırmaktadır.

Karmaşık bir oluşum olarak kenti anlamaya çalışırken, bütünü oluşturan öğelerin kendilerinden öte oluşumun ortaya çıkmasını sağlayan ve dönüştüren karmaşık ilişkiler ağına odaklanmak, görünenin ardındaki örtük bilgiye ulaşmada stratejik bir öneme sahiptir. Kentsel oluşumları görünen ve görünmeyen yönleriyle ele almak ancak disiplinler arasındaki sınırların bulanıklaştırıldığı, çok boyutlu ve bütüncül bir bakış açısıyla mümkün görünmektedir.

Geleneksel yaklaşımlar mevcut karmaşık oluşumları son derece basitleştirme eğiliminde olup, sistemleri statik ve kapalı sistemler olarak ele almaktadır. Başlangıçta çok yararlı gibi görünse de zamanla sistemleri basitleştirerek belirgin özelliklerini inceleme ve parçalarına ayırarak anlamaya çalışırken sistem bütününe ait birtakım özelliklerin kaybedildiği, bazı ilişkilerin gözden kaçırıldığı ve sistemin tek tek parçaların toplamından daha fazlası olduğu görüşü gittikçe önem kazanmaktadır. Dolayısıyla karmaşıklık kavramına yüklenen anlam ve ele alış biçimimiz de değişmekte; kent okuma çalışmalarında bütünün parçalara ayrılarak

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incelendiği indirgemeci yaklaşımların yerini kendisini oluşturan tüm dinamiklerle birlikte bütüncül sistemi anlamaya yönelen yaklaşımlar almaktadır.

Bu noktada son dönemde hızla gelişen sayısal temelli araçlar ve hesaplamalı yaklaşımlar, düşünce ve bilgiyi farklı sistemlerle yapılandırma olasılıklarının araştırılması, keşfedilmesi ve tanımlanmasını doğurarak, sunduğu düşünme ve öğrenme biçimleri ile çevremizdeki gerçeklikten bilgi edinme yöntemlerine yön vermektedir. Böylelikle dinamik ve karmaşık oluşumların anlaşılmasında ve yapılandırılmasında mimarlık ve kentsel tasarım için önemli bir araştırma alanı sunarak, yapılı çevrenin örtük anlamının belirgin bilgiye dönüştürülmesi amacıyla incelenmesi, anlaşılması ve yorumlanması arayışında yeni bir açılım sağlamaktadır.

Bu bağlamda karmaşık sistemlerin davranış yapılarını anlayabilmek ve karmaşıklık derecelerini ortaya koyabilmek için hesaplamalı karmaşıklık modellerinden biri olan fraktal geometri sıklıkla kullanılmaktadır. Kentsel bağlamda düşünüldüğünde kendiliğinden oluşmuş yerleşimler karmaşıklık düzeyi sonsuz olan, açık uçlu, dinamik, uyumlu ve yaşayan oluşumlardır. Bu yapıdaki oluşumlar doğrusal olmayan gelişmeler gösterirler. Doğrusal bir gelişme süreci izlemeyen bu tür oluşumların matematiği ve geometrisi; bünyesinde doğal olarak fraktal yapıları barındırır niteliktedir. Salingaros (2011b) da bunu destekler biçimde canlı şehirlerin tüm öteki canlı sistemler gibi özünde fraktal niteliklere sahip olduğunu belirtir.

Kendiliğinden oluşmuş yerleşimlerde kullanıcılarının egemenliği altındaki kentsel oluşum, giderek artan eklenmelerle -her ne kadar onu inşa edenler bu durumun farkında olmasa da- zaman içinde fraktal bir şekilde inşa edilmiş olur. Kendiliğinden gelişim süreci, kentsel dokuyu genel olarak daha az etkileyip fraktal boyut değerlerinde daha az değişime yol açarken, harici bir mekanizmanın etkisiyle verilen kararlar genellikle fraktal yapının bütünlüğünü bozar niteliktedir. Fraktal yani ölçekten bağımsız bir kentsel oluşum, kendi boyutundan yapı malzemelerindeki mikro yapıların boyutuna varıncaya kadar tüm boyutlarda yapısal bileşenlere sahiptir. Her ölçekte gerçekleşen ve ölçekler arasında içsel olarak birlikte çalışan olaylar fikri, karmaşık kentsel oluşumun nasıl yaşayıp büyüdüğünü anlamayı kolaylaştırabilir. Bu anlamda karmaşık kentsel oluşumların zaman içindeki dinamik yapısını ve mekânsal ilişki özelliklerini anlamak için fraktal geometriden yararlanmak önemli görünmektedir.

Çalışma kapsamında, Germir yerleşiminin kendiliğinden gelişmiş karmaşık bir kentsel oluşum olarak fiziksel biçimlenişinde, fraktal öğeleri barındırıp barındırmadığı sorgulanmaktadır. Böylelikle kentsel oluşumun bünyesinde geometrik bir ağ yapının yani fraktallerin parçadan bütüne varlığı sorgulanarak yerleşimin karmaşıklık düzeyi ortaya konulmak suretiyle yerleşim üzerine düşünmek amaçlanmaktadır. Bu sorgulama ile birlikte, çalışmanın yerleşimin

sürekliliğinin devamı için yapılacak müdahalelere yön verilebilecek olması da ayrıca önemli görülmektedir.

Bu bağlamda Germir yerleşim dokusunun fiziksel özellikleri vaziyet planı, sokak siluetleri, yapı cephesi, yapı detayı üzerinden incelenerek farklı düzeylerde benzer fraktal boyutlar elde edilmiştir. Elde edilen tüm değerler 1,6'dan 1,7'ye varan bir aralıkta değişim göstermiş olup, kütle ve mekân organizasyonunun karmaşık yapıda olduğunu göstermektedir. Bu durum hem doku karakterindeki süreklilik hem de dokunun doğal çevre ile uyumu olarak değerlendirilebilir. Yerleşimin ana karakteristiği olan kendiliğinden oluşum ve gelişim, dokunun genel olarak parçadan bütüne doğru bütünlüğünü koruyarak gelişimiyle farklı düzlemlerdeki fraktal boyut değerlerinde hemen hemen ortak bir sonucun ortaya çıkmasını açıklamaktadır. Sonuç olarak Germir yerleşiminin kendiliğinden kendine özgü bir fraktal kod üzerinden şekillendiği söylenebilir.

Keywords: Kendiliğinden oluşmuş yerleşimler, Karmaşıklık, Fraktaller, Germir.

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