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Morphological Evolution of Baghdad: Analyzing Urban Growth Patterns and Transformation Processes

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ABSTRACT

Urban landscape analysis is crucial for understanding the dynamics of urban transformation, especially in historic city centers. This study delves into the morphological evolution of Baghdad, focusing on its transformation from a historic nucleus to a vast metropolitan area. The primary objective is to identify mechanisms of transformation that bring about changes in the structure of the town center. Utilizing a combination of geographical-morphological methods, historical maps, and modern satellite imagery, the research identifies six distinct urban growth patterns—concentric, irregular strip, scattered, multi-nuclei, sectoral, and instant growth. The research methodology includes a detailed collection of historical maps from Western geographical travelers of the 18th and 19th centuries and modern satellite images to compare historical and contemporary urban forms. Data digitization processes were employed to prepare these maps for analysis, followed by boundary determination to track Baghdad's expansion over time. The study integrates these digital maps to conduct temporal analyses, characterizing the main morphological phases from the historical nucleus to modern urban growth. The study is able to set forth how a complex interplay of physical, social, economic, and political forces has defined the urban form of Baghdad. Findings will make it possible to understand these growth processes for modern urban planning and design. The management of sustainable growth in a way that tackles sprawl, connectivity, and human scale in design requires a fusion of historical contexts with modern practices. This study offers the necessary information and direction for sustainable urban development in Baghdad as well as any other historic town elsewhere.

Keywords: Growth, Pattern, Transformation, Urban form, Organic growth, Urban planning.

1. INTRODUCTION

Developing an urban landscape is an essential initiative to understand the processes of urban transformation and change. This study takes an in-depth look at the various issues of urban landscape analysis specifically on how there evolved a morphological transformation

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in the historic city centres. There is a reliance on the use of several methods towards achieving this aim. Still, generally, however, the objective will be an analysis of the transformation of the urban aspects and the dynamics of the form during this change and growth processes **(Kostof, 1991; Southworth and Owens, 1993)**. The main objective, therefore, is to identify mechanisms of the transformation process that bring about change in the structure of the town centre.

Urban landscape analysis is one of the essential studies that can be of help in understanding the forces of urban change. This study takes into understanding the process of urban transformation in an old city centre up to a vast metropolitan area. It analyses the way urban structures change and adapt to different periods in history. From a deep analysis of the potentials and results of the different urban actions **(Conzen, 1960; 1975)**, the study will try to give a prognosis of the change processes determining the evolution of the form of the town, see **Fig. 1**. The study made on the morphological change process in the hybrid urban structure of the Middle Eastern towns was based on the combined typo-morphological and geographical approach that Muratori and Conzen had introduced **(Whitehand, 1977; Moudon, 1997)**. Such a double-sided study is crucial in the analysis of the interactions of different urban patterns and their work in relation to the trends and scales of development and, therefore, very crucial for providing a predictive role towards the value of future town development.

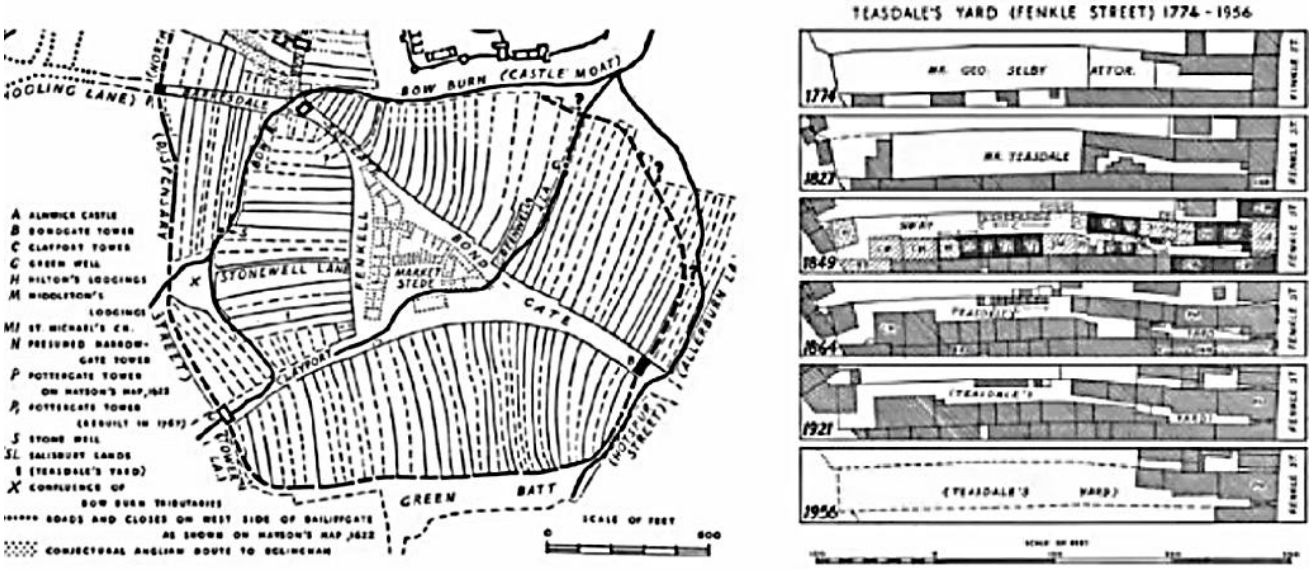

Figure 1. The Old Town of Alnwick (on the left) and the morphological processes of Teasdale's Yard (on the right) **(Conze, 1960)**.

The study thus highlighted the importance of inserting new urban spaces, namely streets and squares, in already compact urban structures, as occurred in many towns and cities due to urban extensions and modern planning practices. The relationship between urban elements is comprehensively analyzed, and the regularities and irregularities that occur at different analytical levels are explained, see **(Alobaydi and Rashid, 2024; Alobaydi, 2017)**. The spatial development of the city is analyzed at the macro-level; the influences of planning strategies on the urban form are outlined **(Alobaydi et al., 2020; Mohammed and Alobaydi, 2020a; 2020b; Albabely and Alobaydi, 2024)**. The morphology of the old city core is analyzed at the meso-level; the relation between urban spaces and surrounding

building types post-modernization is analyzed at the micro-level, see **(Conzen, 1960; Farnah et al., 2022; Alsaffar and Alobaydi, 2023; Al Hashimi and Alobaydi, 2023)**.
The following sections elaborate on the major dimensions of studying urban landscape through morphological analysis—both geographical-morphological methods and transformation processes as well as issues touching on the processes of urban growth. They each aim to provide a broad perspective regarding the phenomena that need to be encountered by a contemporary understanding of urban changes whose exhaustive account will ensue.

2. ROLE OF MORPHOLOGICAL ANALYSIS

Urban morphology can be referred to as the study of urban form, functions, and structure, and it involves development processes that make cities of today what they are in time **(Adams, 2012; Sanders, 2008)**. The purpose of morphological analysis is to study the settlement as a physical entity and as a transformed built environment shaped by social forces **(Gebauer, 1981; Moudon, 1997; Whitehand, 2007)**. This research attempts to deliver the importance of understanding the inherited urban context and the processes of transformation that built up the urban form that has been delivered at present. Urban morphology methodologies make it possible to detect historical marks present in the modern urban fabric that help to understand the physical and social development of urban structures in greater depth **(Vance, 1990)**. The dynamics of urban morphologies that change continuously in a spontaneous manner, through planning actions and social, economic, and political pressures and influences, are essential for creating a basis for historical urban analysis and proposing effective urban conservation strategies. Historical processes have been explained to act as a solid basis for understanding how urban forms are developed over time. Building from this, the following will present the geographical-morphological methods and the processes of transformation to detail how the mechanisms of urban change work. The last section is an analysis of the urban growth processes, and how historical phases and accumulation shape the character and evolution of cities.

2.1 Geographical-Morphological Methods and Transformation Processes

The geographical-morphological method is at the core of the determination of the evolution of urban forms (transformations and growth processes) and is undertaken through the use of historical-geographical maps and cultural interpretations of urban form. In the 19th century, German geographers laid the scientific basis for classifying towns and cities by plan types and increased the importance of cartography in revealing traces of the historical city **(Gauthiez, 2004)**. The method involves the mapping of urban forms and the mapping of the physical urban forms, a technique which is a core element in urban morphology **(Conzen, 1975; Whitehand, 1977; 2007).** The mechanism of the transformation process in the historic core occupies the central part of this work. The study of the history of the built-up area and the road networks leads to the identification of different types of buildings and their development throughout various historical phases. Knowledge about these transformations is crucial for the understanding of the causes which created the existence of each urban element and the overall arrangement of the urban complex **(Adams, 2012; Sanders, 2008)**. The interventions and the experiments constantly executed in the built environment are examined to deal with spatial and social segregation, thus emphasizing the importance of

managing and controlling transformation processes in the framework of quality urban conservation.
The geographical-morphological methods were explained earlier as showing how urban transformation occurs; today we discuss a narrower topic of urban growth processes. However, a deeper insight will be given in the next section regarding the phases of history that have led to what we have today as well as the idea that it is not only history but also continuity which have given cities their shape such as size and character.

2.2 Growth Processes

Urban growth is deeply transformational in the form, size, and character of a city within the process of urban pattern evolution **(Kostof, 1991; Alobaydi, 2017; Alobay and Rashid, 2015, 2017)**. It is necessarily dynamic, with periods of relatively rapid expansion interspersed with those of slower development. In the historical interpretations, the means of growth were assumed to be cumulative, with the progression characterized by a series of increments superimposed over time **(Conzen, 1960; 1975; Portugali, 1999)**. This cumulative characteristic has resulted in various growth patterns, mechanisms of different physical attributes and spatial characteristics. Organic urban forms usually encompass ancient towns and cities, while modern patterns owe themselves to design and planning practices over more recent centuries. However, societal, economic, and environmental influences continuously adapt and re-adapt these trends **(Conzen, 1960, Whitehand, 1977; Moudon, 1997)**. In this study, we have essentially focused on analyzing and mapping the growth pattern according to the processes of formation and transformation in six historical phases of Baghdad. Having known all the growth processes very well, it is now appropriate to look at the specific methods which we have pursued during our research. Below you will find how we systematically approach the collection, digitization and analysis of data concerning the evolution of Baghdad as an urban area.

3. RESEARCH METHODOLOGY

The research methodology consisted of the use of different methods and techniques in morphological and geographical analysis of the case study of the city of Baghdad: from the historical nucleus of the city—characterized by the existence of a wall with a recognizable outline—to that of a capital city. The methodology is detailed according to the description below:

3.1 Data Collection

- Historical Maps Acquisition: the process denotes the collection of all available maps, which had been based on the old plans produced by the Western geographical travellers that visited Baghdad during the 18th and 19th centuries.

- Modern Imagery Gathering: this involves the recent and the most up-to-date satellite aerial images of Baghdad acquired to provide for modern data comparison needs.

3.2 Data Digitisation

- Map Digitisation: it refers to the preparation of the historical maps collected in digital form to enable them to be compatible with modern analysis tools.

- Boundary Determination: the paper within defines the boundaries of Baghdad, and the tracking of its enlargement through various time lines so that the actual stages of the city enlargement to be described.

3.3 Data Analysis

- Map Integration: using computer according to ways in which digitalized historical maps, in individual or combined form, while using modern satellite maps can be synchronized so that errors and differences between manual and satellite maps be characterized and filtered.

- Temporal Analysis: characterization of the main periods that the city had been forced to differentiate its morphology beginning with the historical nucleus and.

The accomplishment of these procedures ensured that a good understanding was reached concerning the morphological and geographical development of Baghdad, accruing a transition of its form from its historical roots to its present form. This methodological approach guaranteed that the research was conducted comprehensively and systematically, giving important contributions to the field of historical and contemporary urban dynamics of Baghdad.

4. RESULTS AND DISCUSSION

4.1 Urban Growth Patterns

Cities have identifiable typologies that reflect historical phases and societal needs. A study identifies six different growth patterns after the analysis. Three of these, that is, concentric, instant, and scattered, fall in line with the typologies seen and articulated in North America. In addition, the three other growth patterns irregular strip, sectoral, and multi-nuclei have been located through the analysis of the historical development of Baghdad. On the other hand, it is, however, interesting to note that the growth processes that have been identified by Southworth and Owens **(Southworth and Owens, 1993)** can also be found in the version of Baghdad's evolution yet within different scales of the urbanized areas, see **Fig. 2**.

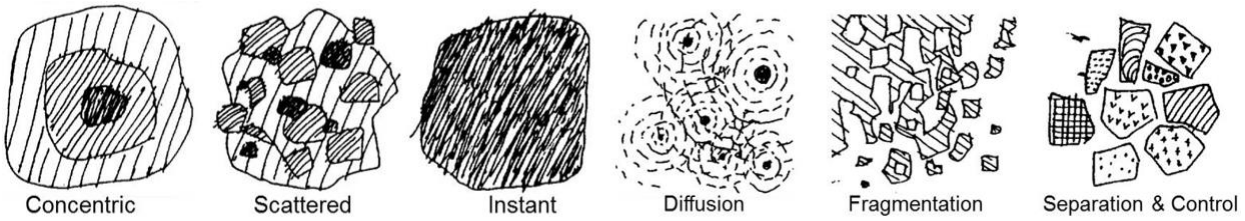

Figure 2. Patterns and processes of urban growth defined by Southworth and Owens **(Southworth and Owens, 1993)**.

4.1.1 Concentric Growth

The expansion of urban centers typically follows a concentric pattern, characterized by rings emanating from the city's core **(Kostof, 1991; Southworth and Owens, 1993; Portugali, 1999; 2012)**. Baghdad exemplifies this trend from the 1050s to the 2000s, growing along its original street networks. New urban developments extended towards the city's

periphery, encircling the old urban core and fostering the concentration of commercial and mixed-use activities, notably visible in the historic organic nucleus of al-Kadhimiya, see **Fig. 3**.

4.1.2 Irregular Strip Growth

Strip development of an irregular nature characterizes cities established along natural features or lines of commerce **(Kostof, 1991)**. Even early settlements, such as the Caliph's palace and residences, were irregular along the Tigris River banks. To its east, there developed a series of mosques and bazaars, and then army camps. Urban growth moved beyond the caravans and beyond the city's outer walls as an irregular pattern of buildings not occupying an even space by 1850 as the city grew, as shown in **Fig. 3**.

4.1.3 Scattered Growth

Urban growth in Baghdad started early in the 20th century as development radiated outward from the city's old center, thus generating dispersed building agglomerations. Small to medium-sized subdivisions were generated at the highway and railway junctions to create this kind of dispersed pattern of development. This development, as time elapsed, gave way to slum and squatter dens, and later, modern planned neighborhoods like Sadr City were built as replacements for portions of the city, see **Fig. 3**.

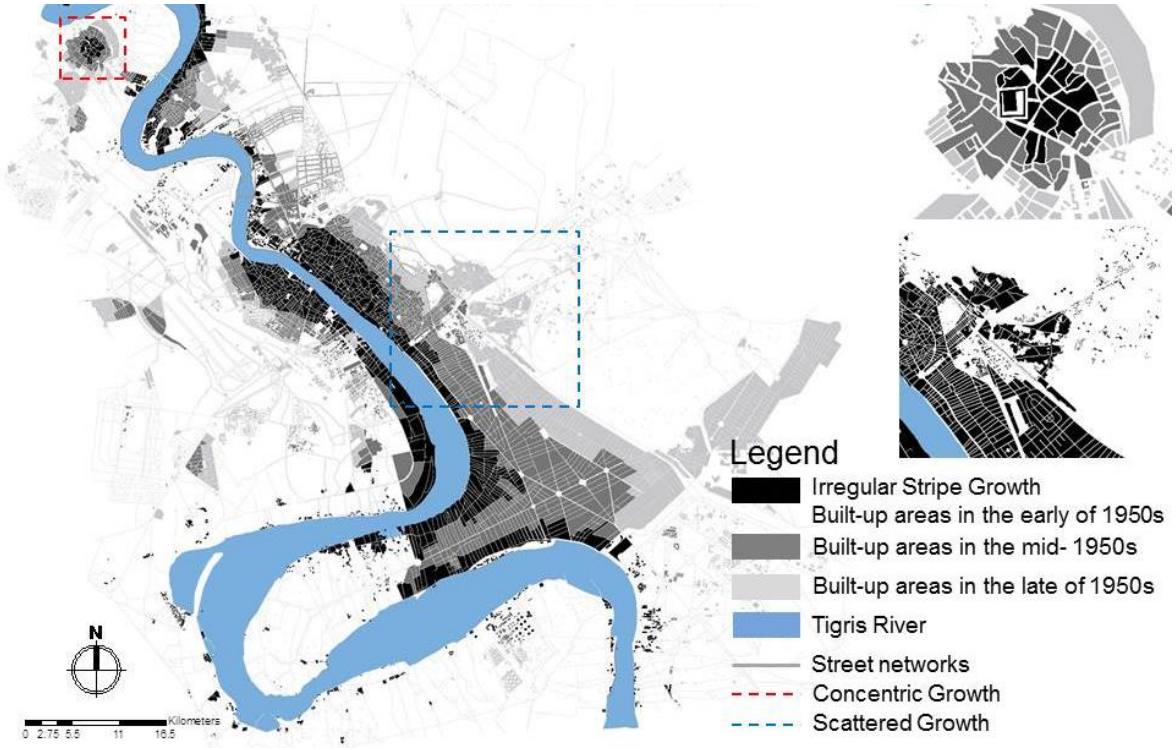

Figure 3. Image of the concentric, irregular stripe, and scattered growth patterns.

4.1.4 Multi Nuclei Growth

Multi-nuclei growth centered on three historic cores marked Baghdad's growth in the 1970s. Old Baghdad, al-Kadhimiya, and al-Adhamiyah, see **Fig. 4**. Each of these cores drew various functions to it, with commercial activities mainly located in Old Baghdad, and al-Kadhimiya

and al-Adhamiyah containing residential clusters. By the end of the 1970s, these prestigious parts of the city had expanded to become surrounded by modern urban growth.

4.1.5 Sectoral Growth

Between the 1970s and 1990s, growth in Baghdad followed a sectoral form that was homogenous, with blocks of urban cells expanding away from Old Baghdad and away from transportation routes. In contrast with Hoyt's proposed model, the growth sectors in Baghdad were irregular and had a mix of land uses, each reflecting complex development processes of the city, see **Fig. 4**.

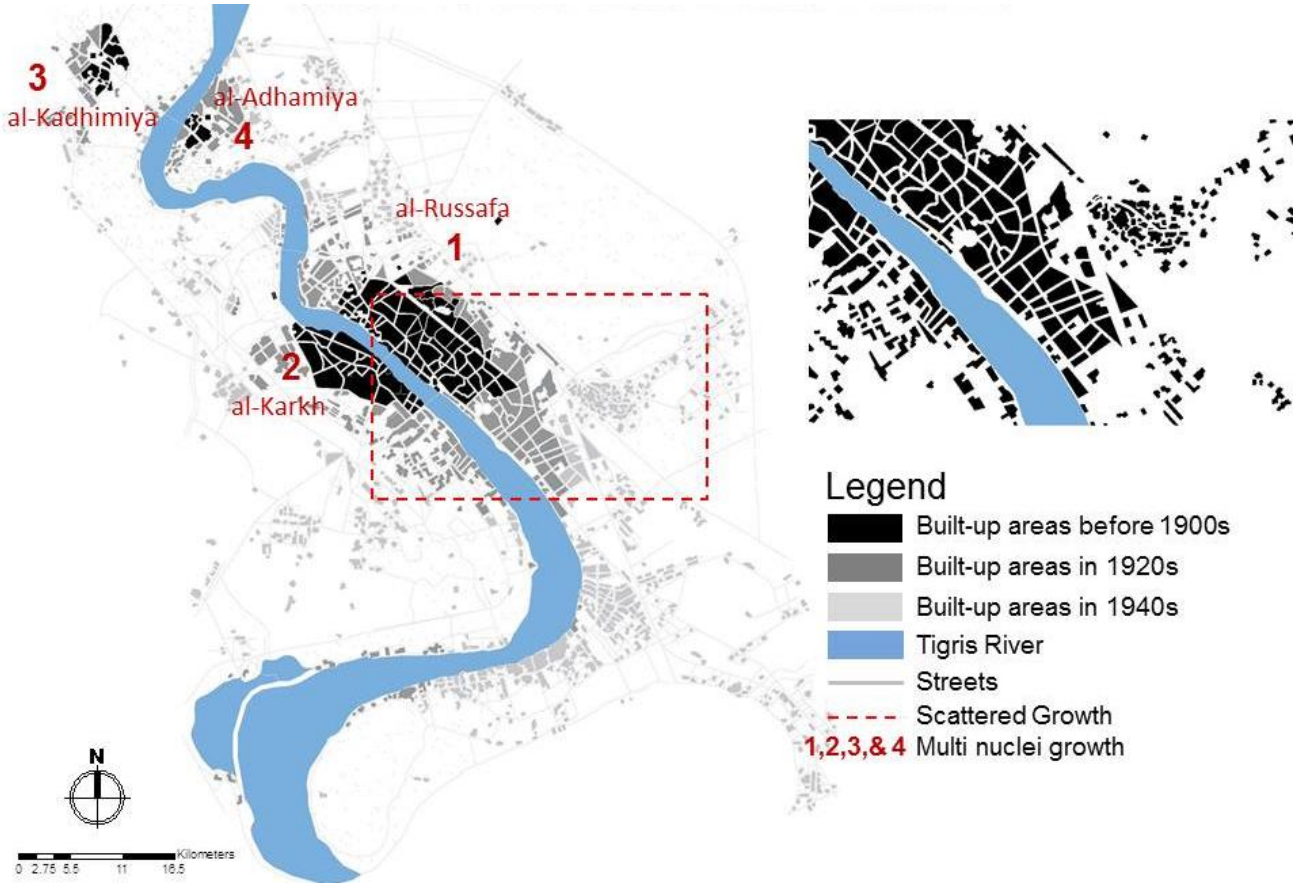

Figure 4. mage of the scattered and multi nuclei growth patterns.

4.1.6 Instant Growth

A striking feature of modern planning in Baghdad is the speed with which it has expanded across large empty spaces along the northeast-southwest axis, deploying rectangular urban blocks and gridiron street patterns, see **Fig. 5**. Prime examples of this overnight explosion are the overcrowded Sadr City, built over agricultural lands in less than two decades. Although such districts are dispersed throughout Baghdad with location and topographical variations, they all were gradually filled in with the growth of repetitive subdivisions.

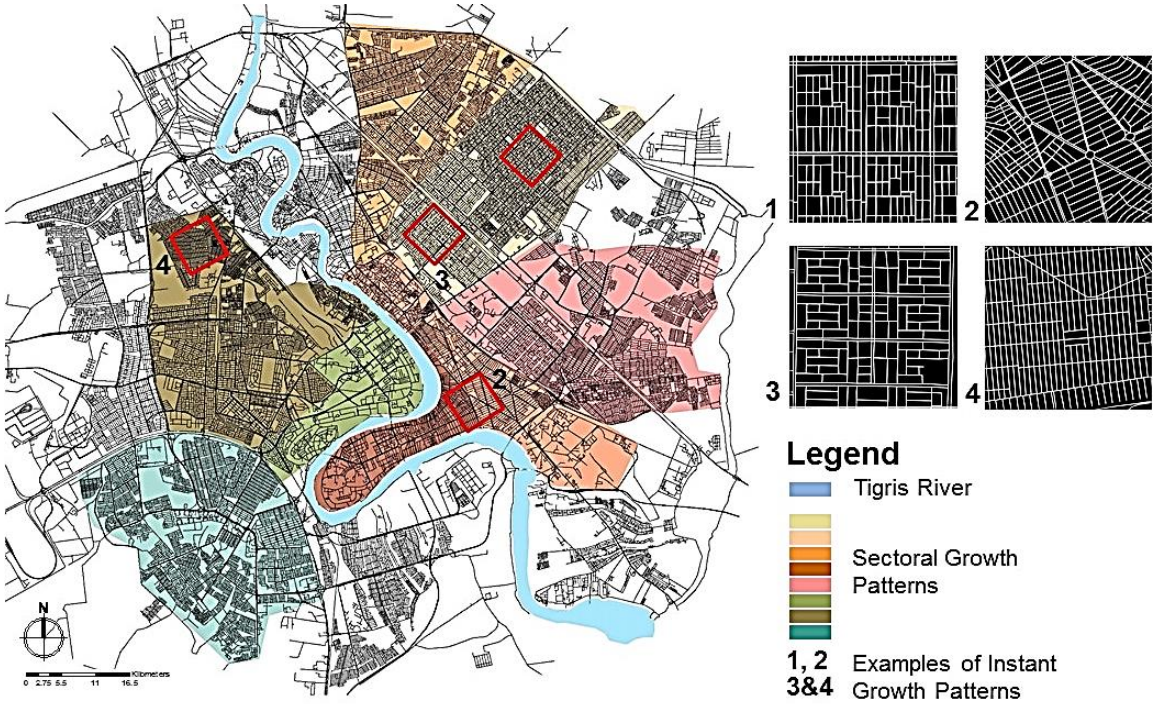

Figure 5. Image of the sectoral and instant growth patterns.

4.2 Trends and Scales in Growth Processes

It could be said that the character of the urban growth of Baghdad has been distinctive and has shown an outcome reflecting a more complex interaction among historical, socio-economic, and planning forces. This part investigates further the mosaic character of the urban development of Baghdad and the collective way in which fragmentation, diffusion, and densification, along with large-scale separation, have impacted the overall landscape of the city. These growth processes operate at the scales of spatial processes, which vary from the micro-level fragmentation of urban blocks to the macro-level division of metropolitan areas, and in the process, they provide a comprehensive understanding of all the dynamic and changing processes that characterize the urban fabric of Baghdad. These processes do not only explain how the city adapts to different pressures and opportunities but also show how difficult it is to manage sustainable urban growth in a rapidly changing environment.

4.2.1 Fragmentation at Small Scales

After WWII, new planning schemes to control sprawl in Baghdad led to explosive building around the pre-existing urban cores. The fractured structures emerged at different distances from the old urban cores, commonly at the scale of urban blocks from the 1940s to the 1960s. These new forms of building spread mostly at the periphery and edges of the city, filling unoccupied urban blocks, with a notable frequency in the eastern areas bordering the Channel Army **(Pieri, 2008; 2016; Pyla, 2008a; 2008b)**, see **Fig. 6**.

4.2.2 Diffusion at Medium Scales

Historic cores and organic nuclei of Baghdad expanded concentrically with intricate street patterns for pedestrians and horse carriages **(Lassner, 1968; 1970; AlSayyad, 1991; 1992; Hakim, 1994, 2007; 2013)**. This historic growth is visible from the early 20th century to the

mid-1960s at medium scales, generally spanning 1.6 to 7.8 square kilometers (1 to 3 square miles). Examples include Old Baghdad, al-Kadhimiya, and al-Adhamiya, see **Fig. 6**.

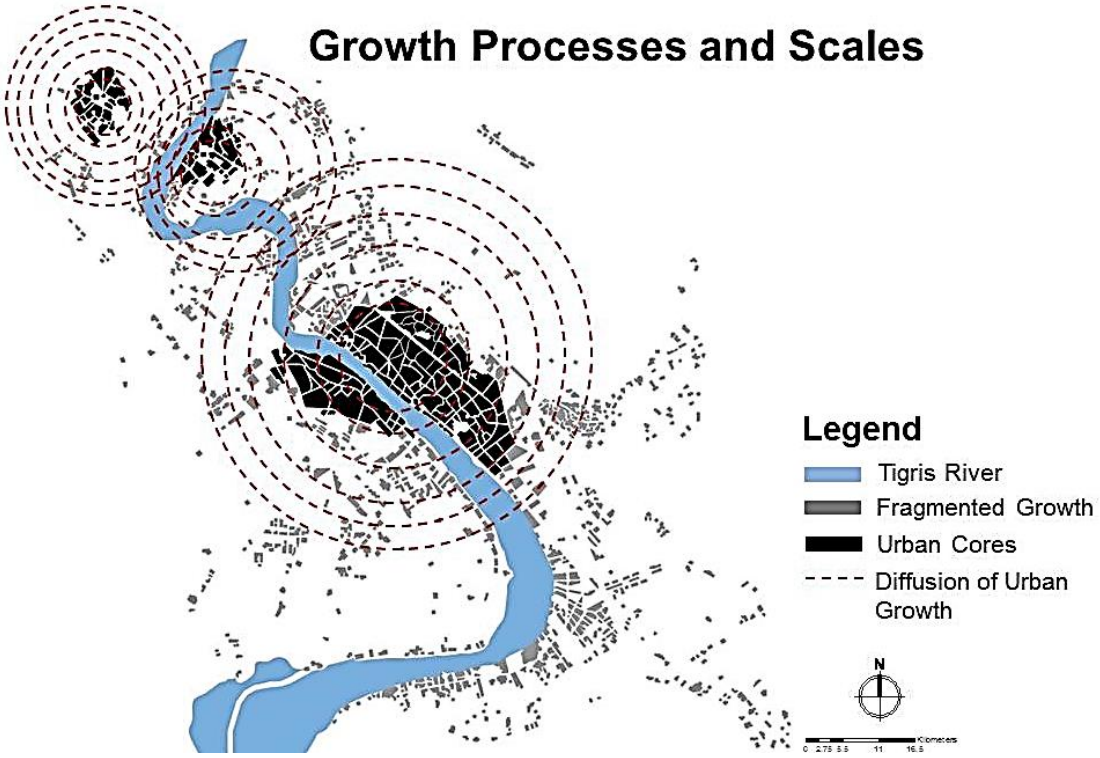

Figure 6. Shows the fragmentation and diffusion of urban development during 1940s.

4.2.3 Densification within Existing Grids

As traditional urban contexts decayed, road transport systems with broad roads simply expanded to accommodate new urban growth, even at the expense of parking lots and public spaces, see **Fig. 7**. The original super-grid expressway and boulevard system supported efforts at densification, especially by the mid-1970s when rural in-migrants began seeking their niches in Baghdad. New neighborhoods with rectilinear patterns and complementary public uses helped regulate growth around the Channel Army.

4.2.4 Large Scale Separation

The metropolitan scale of growth is determined by both natural and artificial planning elements **(Kostof, 1991; Southworth and Owens, 1993; Pyla, 2008a; 2008b)**. In Baghdad, the Tigris River and Channel Army have divided the city into three primary sections, each with distinct physical characteristics in the form of plot forms and street patterns. These sections are (1) areas west of the Tigris River (WTR), (2) Central areas (CA) located between the Tigris River and Channel Army, and (3) areas east of Channel Army (ECA), refer to **Fig. 7**. Areas east of Channel Army show a consistent trend of high-density development, while areas west of the Tigris River exhibit a parallel but moderate-density diffusion trend. Conversely, in the areas between the Tigris River and the Channel Army, growth has been stable, characterized by either inward expansion or upward development. Inward growth involves filling open spaces or further subdividing existing urban subdivisions, while upward growth entails constructing multi-story buildings to meet urban development

demands. Consequently, urban density in this central area has significantly increased in recent years, placing strain on existing infrastructure **(Al-Akkam, 2013)**. This developing trend has resulted in a heightened sense of separation between different parts of the city at the metropolitan scale.

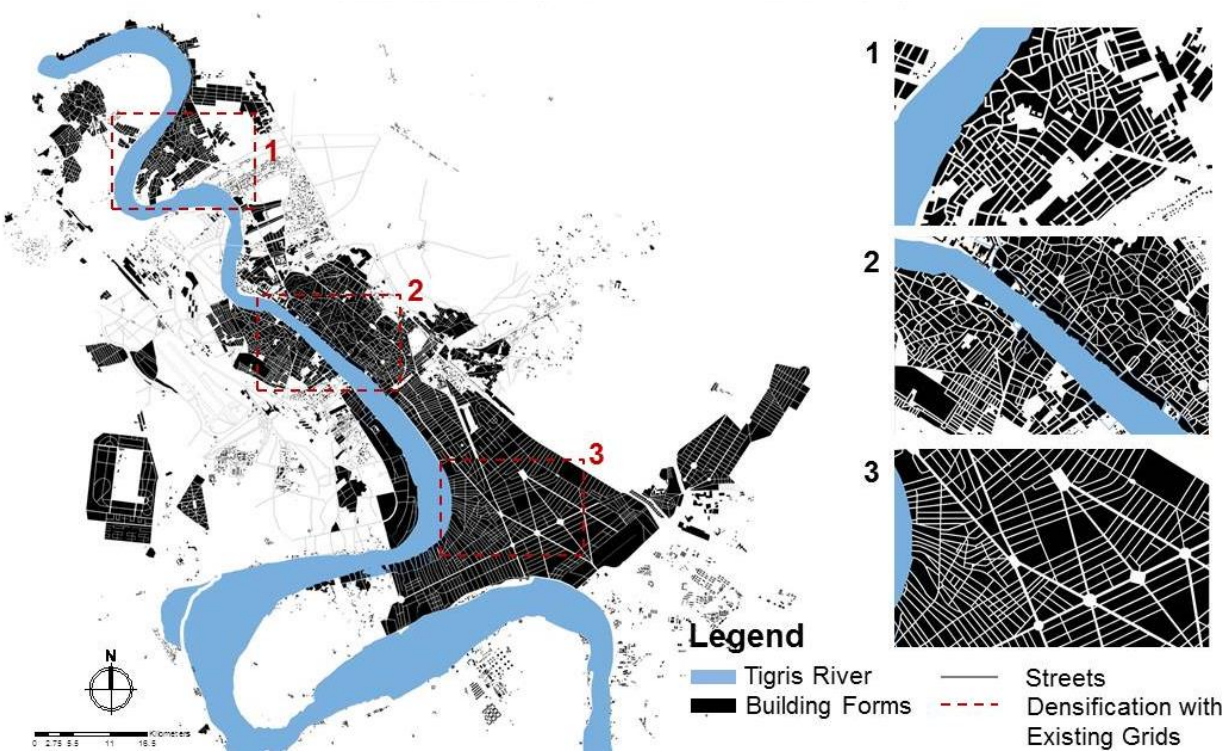

Figure 7. Shows the densification of urban development during 1960s.

5. URBAN DESIGN IMPLICATIONS

The typology of growth is mainly influenced by physical and spatial features. Observations of Baghdad's growth history reveal several factors shaping the character, trends, and scales of growth:

- This research identified two growth trends in Baghdad: large scale and small scale. Large scale trends, such as the modern rapid growth in areas like Sadr City and 9 Nissan, foster controlled urban fabrics with spatial homogeneity and repetitive infill. These areas feature rigid gridiron structures with regularly spaced parallel streets, resulting in urban blocks lacking distinct character and contributing to monotony **(Marr, 2011)**.

- In contrast, small-scale incremental and concentric growth patterns in Baghdad's historic core create organic, compact urban fabrics with spatial variety. These areas, with narrow, zigzagging streets and cul-de-sacs, offer diverse structures and shorter block lengths, providing flexibility for future needs and options for users and visitors. The hierarchical transition from private to public spaces is evident in dense urban units along main roads, with landmarks like al-Maidan as focal points for concentric growth **(Marr, 2011)**.

- Topographical features, social customs, and forms of government significantly impact Baghdad's growth trends. The Tigris River's course dictated open topography for urban additions within and beyond city walls. Social customs emphasizing privacy in Arab-

Islamic society led to residential clusters around cul-de-sacs. Governance structures, from tribal leaders to Islamic rulers to modern governments, also shaped the city's form. The 1920s British influence promoted development outside Old Baghdad along the river, while modern planning practices in the late 1950s guided growth from northeast to southwest **(AlSayyad, 1991; Fethi, 1978; Lassner, 1968)**.

- Understanding the physical features, forms, scales, and growth trends aids urban designers and planners in anticipating the implications of emerging urban patterns. Observing Baghdad's growth processes provides valuable insights for developing new guidelines to enhance city planning and design.

6. GUIDELINES FOR URBAN DESIGN

The purpose of these guidelines is to address the present development stages of Baghdad and propose measures of restraining the spread of towns and cities to peripheral areas. The development of new affordable housing on the periphery has been made easier through the highway system, which has also resulted in unsustainable growth due to the problems it creates in the built environment. Other planning principles and remedies such as demarcation of boundaries to growth should be considered for a better city like in Portland, Oregon USA and London UK (Jun, 2006; Williamson, 2010; Addison et al., 2013; Koster, 2024). Also, historical patterns of expansion provide useful guidance.

- The expansion of the city upwards can help to restrict the spread of the city and encourage sustainable development by using the land within the city more efficiently.

- Urban design needs to address human scale deficit through issues such as main street block lengths, development setbacks building lot sizes among other things while creating spatial frameworks that promote connectivity linkages between revitalizing but isolated cores through integrative designs.

- All city developments should focus on connectivity with their neighboring areas to have a more harmonious and unified urban environment. Promoting the connections will be able to increase transport systems which can provide social interactions among various residential areas in a neighborhood.

7. CONCLUSIONS

Tthe study of the urban morphology of Baghdad has a complex interplay of historical and socio-economic influences and planning that has shaped city growth patterns and urban form. By indicating six distinct growth typologies—concentric, irregular strip, scattered, multi-nuclei, sectoral, and instant—tied to the different phases of urban development, the following research illustrates how an urban evolution is a dynamic process connected with a multifaceted force driving urban transformation.

A key message is the need to embed these historic urban landscapes within contemporary planning to cope with sustainable urban growth. The findings greatly stress the need for vertical development to contain sprawl, providing better connectivity between new and old urban fabrics and humanity in scale urban design. All of these are the keys to issuing guidelines for the promotion of cohesive and sustainable urban environments: guidelines that ensure new developments fit well within the existing urban fabric and further safeguard

the cultural and historical integrity of a town. Besides, the methodological approach of the study, which is based on the association of historical maps with modern satellite imagery and the analysis of geographical-morphological data, gives a reliable framework through which to analyze the processes of urban growth. Such an approach makes the study an invaluable guideline for respecting urban conservation and sustainable development in other cities of history that are going through the same transformation processes. The research contributes to the field of urban morphology by providing an in-depth examination on how this kind change occurs while giving suggestions that can be helpful when planning real-life cities. It places great emphasis on values such as historical context, connectivity and human scale that form part of Baghdad's growth strategy as well as other ancient towns grappling with fast expanding urban centers without destroying themselves through congestion or overcrowding. For all who are concerned with issues related to sustainable development it so important for them to learn these things so that they may help come up with measures which can work well depending on some good knowledge instead following unrealistic ideas proposed by someone who doesn't know anything about what might happen tomorrow in urban life.

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Credit Authorship Contribution Statement

Dhirgham Alobaydi: Writing – review and editing, Writing – original draft, Validation, Software, Methodology. Mahbub Rashid: Writing – review and editing, Validation, Software, Methodology.

Declaration of Competing Interest

The author states that there are no known financial conflicts of interest or personal relationships that could have influenced the work presented in this paper.

REFERENCES

Adams, D., 2012. *Urban planning and the development process*. Routledge. https://doi.org/10.4324/9780203857007.

Addison, C., Zhang, S. and Coomes, B., 2013. Smart growth and housing affordability: A review of regulatory mechanisms and planning practices. *Journal of Planning Literature*, *28*(3), pp.215-257. https://journals.sagepub.com/doi/10.1177/0885412212471563 .

Al Hashimi, H., Alobaydi, D., 2023, March. Measuring spatial properties of historic urban networks. In *AIP Conference Proceedings*, 2651(1). AIP Publishing. https://doi.org/10.1063/5.0117077.

Al-Akkam, A. J., 2013. Urban heritage in Baghdad: Toward a comprehensive sustainable framework. *Journal of Sustainable Development*, 6(2), P. 39. https://www.ccsenet.org/journal/index.php/jsd/article/view/24042 .

Al-Ashab, K.H., 1974. *The urban geography of Baghdad,*Doctoral dissertation, Newcastle University. https://theses.ncl.ac.uk/jspui/handle/10443/1059 .

Albabely, S., Alobaydi, D., 2024. Analyzing Movement Densities in AlKarkh Districts: A Comparative Study. *Journal of Engineering*, *30*(04), pp.134-151. https://doi.org/10.31026/j.eng.2024.04.09 .

Al-Haidary, A., 2009. Vanishing point: the abatement of tradition and new architectural development in Baghdad's historic centers over the past century. *Contemporary Arab Affairs*, *2*(1), pp.38-66. https://brill.com/view/journals/jcaa/2/1/article-p38_4.xml .

Alobaydi, D., Rashid, M., 2024. The Evolution of street structures: a morphological study. *Journal of Engineering*, *30*(10), pp.203-219. https://doi.org/10.31026/j.eng.2024.10.12 .

Alobaydi, D., Al-Mosawe, H., Lateef, I.M. and Albayati, A.H., 2020. Impact of urban morphological changes on traffic performance of Jadriyah intersection. *Cogent Engineering*, *7*(1), p.1772946. https://www.tandfonline.com/doi/full/10.1080/23311916.2020.1772946 .

Alobaydi, D., Bakarman, M.A., and Obeidat, B., 2016. The impact of urban form configuration on the urban heat island: the case study of Baghdad, Iraq. *Procedia Engineering*, *145*, pp.820-827. https://www.sciencedirect.com/science/article/pii/S1877705816301126 .

Alobaydi, D., Rashid, M., 2015. Evolving syntactic structures of Baghdad: Introducing 'transect'as a way to study morphological evolution. In *The 10th Space Syntax Symposium (SSS10) from* (Vol. 13), pp. 40.1-40.14.

Alobaydi, D., Rashid, M., 2017. A Study of the Morphological Evolution of the Urban Cores of Baghdad in the 19th and 20th Century. In *Eleventh international space syntax symposium at Instituto superior Técnico, University of Lisbon, Portugal*, pp. 38.1–38.12.

Alobaydi, D.M., 2017. *A study of the urban morphological processes of Baghdad: Implications and guidelines for urban design and planning in Middle Eastern cities*, Doctoral Thesis, Kansas, US: Faculty of the University of Kansas.

Al-Rahmani, S.F., Wager, J.F., 1986. *Principles for urban renewal in Iraq: A study to develop town planning principles for the renewal of the Iraqi Cities with particular reference to Baghdad Central Area*. Doctoral Dissertation, University of Manchester.

Al-Saaidy, H.J.E., 2020. Urban form elements and urban Potentiality (literature review). *Journal of Engineering*, *26*(9), pp.65-82. https://doi.org/10.31026/j.eng.2020.09.05 .

Alsaffar, N.H., Alobaydi, D., 2023, March. Studying street configurations and land-uses in the downtown of Baghdad. In *AIP Conference Proceedings*, 2651 (1). AIP Publishing. https://doi.org/10.1063/5.0105420 .

AlSayyad, N., 1987. Space in an Islamic city: Some urban design patterns. *Journal of Architectural and Planning Research*, 4 (2), pp.108-119. https://www.jstor.org/stable/43029486

AlSayyad, N., 1991. *Cities and caliphs: on the genesis of Arab Muslim urbanism*. Greenwood Pub Group.

AlSayyad, N., 1992. *Forms of dominance on the architecture and urbanism of the colonial enterprise*. Avebury.

ALslik, G.M.R., Majeed, F.A., 2014. Succession of urban structures of the city of Baghdad. *Journal of Engineering*, *20*(12), pp.1-30. https://doi.org/10.31026/j.eng.2014.12.11 .

Beatley, T., Wheeler, S.M. eds., 2004. *The sustainable urban development reader*. London, UK: Routledge.

Bianca, S., Yamada, S., Fethi, I., and Lombardi, G., 1984a. Synthesis Report of Rusafa: Study on Conservation and Redevelopment of Historical Centre of Baghdad City, 2A, pp. 1-111. Baghdad, Iraq: Amanat Al Assima (Municipality of Baghdad).

Bianca, S., Yamada, S., Fethi, I., and Lombardi, G., 1984b. Synthesis Report of Rusafa: Study on Conservation and Redevelopment of Historical Centre of Baghdad City, 2B, pp. 1-135. Baghdad, Iraq: Amanat Al Assima (Municipality of Baghdad).

Bianca, S., Yamada, S., Fethi, I., and Lombardi, G., 1984c. Technical Report of Rusafa: Study on Conservation and Redevelopment of Historical Centre of Baghdad City, 3A, pp. 1-87. Baghdad, Iraq: Amanat Al Assima (Municipality of Baghdad).

Clifton, K., Ewing, R., Knaap, G.J., and Song, Y., 2008. Quantitative analysis of urban form: a multidisciplinary review. *Journal of Urbanism*, *1*(1), pp.17-45. https://www.tandfonline.com/doi/full/10.1080/17549170801903496 .

Coleman, A.F., Eisenman, T.S., Locke, D.H., and Harper, R.W., 2023. Exploring links between resident satisfaction and participation in an urban tree planting initiative. *Cities*, 134, P.104195. https://www.sciencedirect.com/science/article/abs/pii/S0264275123000070?via%3Dihub .

Conzen, M.R.G., 1960. Alnwick, Northumberland: a study in town-plan analysis. *Transactions and Papers (Institute of British Geographers)*, (27), pp.1-122.

Conzen, M.R.G., 1975. Geography and townscape conservation. In *Anglo-German symposium in applied geography* (pp. 95-102). GiessenWürzburg-München, Lenz, Giessen.

Dempsey, N., Brown, C., Raman, S., Porta, S., Jenks, M., Jones, C., and Bramley, G., 2010. Elements of urban form. *Dimensions of the Sustainable City*, pp.21-51. https://pure.strath.ac.uk/ws/portalfiles/portal/122929756/Dempsey_et_al_2010_Ch2.pdf .

Farhan, S.L., Alobaydi, D., Anton, D., and Nasar, Z., 2022. Analysing the master plan development and urban heritage of Najaf City in Iraq. *Journal of Cultural Heritage Management and Sustainable Development*. https://hdl.handle.net/11441/143428 .

Fethi, I.A.W., 1978. *Urban conservation in Iraq: the case for protecting the cultural heritage of Iraq with special reference to Baghdad, including a comprehensive inventory of its areas and buildings of historic or architectural interest*. Doctoral dissertation, University of Sheffield. https://etheses.whiterose.ac.uk/10302/3/455394_1.pdf .

Gebauer, M.A. and Samuels, I., 1981. *Urban morphology: an introduction*. Oxford Polytechnic Joint Centre for Urban Design.

Gorgol, N.K., 2024. What is a resilient smart city? blue–green infrastructure as a strategic feature of smart urban form: empirical evidence with a particular focus on the songdo IBD and aspern seestadt in Vienna. *Sustainability*, *16*(5), p.1758. https://www.mdpi.com/2071-1050/16/5/1758 .

Gulick, J., 1967. Baghdad: Portrait of a city IIM physical and cultural change. *Journal of the American Institute of Planners*, *33*(4), pp.246-255.

Hakim, B.S., 1994. The "Urf" and its role in diversifying the architecture of traditional Islamic cities. *Journal of Architectural and Planning Research*, pp.108-127.

Hakim, B.S., 2007. Generative processes for revitalizing historic towns or heritage districts. *Urban Design International*, *12*(2), pp.87-99.

Hakim, B.S., 2013. *Arabic Islamic cities rev: Building and planning principles*. Routledge.

Huang, G., Qiao, S., and Yeh, A.G.O., 2024. Multilevel effects of urban form and urban functional zones on housing prices: evidence from open-source big data. *Journal of Housing and the Built Environment*, pp.1-25. https://link.springer.com/article/10.1007/s10901-023-10109-y .

Jun, M.J., 2006. The effects of Portland's urban growth boundary on housing prices. *Journal of the American Planning Association*, *72*(2), pp.239-243.

Koster, H.R., 2024. The welfare effects of greenbelt policy: Evidence from England. *The Economic Journal*, *134*(657), pp.363-401. https://zenodo.org/records/8260847 .

Kostof, S., 1991. *The city shaped*, pp. 9-39. Boston, MA: Little, Brown and Company.

Kropf, K., 2009. Aspects of urban form. *Urban Morphology*, *13*(2), pp.105-120.

Lapidus, I.M., 1973. The evolution of Muslim urban society. *Comparative Studies in Society and History*, *15*(1), pp.21-50.

Lassner, J., 1968. The Caliph's personal domain: The city plan of Baghdad reexamined. *Kunst des Orients*, *5*(H. 1), pp.24-36.

Lassner, J., 1970. *The topography of Baghdad in the early Middle Ages: text and studies*. Wayne State University Press.

Mahdi, H.J., Maythm, A.B., and Ubaidy, A.L., 2023. Evaluating roads network connectivity for two municipalities in Baghdad-Iraq. *Journal of Engineering*, *29*(06), pp.60-71. https://doi.org/10.31026/j.eng.2023.06.05 .

Makiya, M., 2005. *Baghdad:* London, Alwarrak Publishing Ltd.

Marr, P., 2018. *The modern history of Iraq*. Routledge.

Mohammed, L.R., Alobaydi, D., 2020a, March. Evolution of the urban form of historic hit citadel: Deriving a schematic model for Iraqi fortified cities. In *IOP Conference Series: Materials Science and Engineering*, 745(1), P. 012180. IOP Publishing. https://iopscience.iop.org/article/10.1088/1757-899X/745/1/012180 .

Mohammed, L.R., Alobaydi, D., 2020b, July. Studying sustainable actions of syntactic structures of historic hit citadel: A morphological approach. In *IOP Conference Series: Materials Science and Engineering*, 881(1), p. 012034. IOP Publishing. https://iopscience.iop.org/article/10.1088/1757-899X/881/1/012034/meta .

Moudon, A.V., 1997. Urban morphology as an emerging interdisciplinary field. *Urban Morphology*, *1*(1), pp.3-10.

Næss, P., 2022. Compact urban development in Norway: Spatial changes, underlying policies and travel impacts. *In Advances in Transport Policy and Planning,* 9, pp. 95-133. Academic Press.

Portugali, J., 1999. *Self-organization and the city*. Springer Science & Business Media.

Pyla, P., 2008a. Back to the future: Doxiadis's plans for Baghdad. *Journal of Planning History*, 7(1), 3-19.

Pyla, P., 2008b. Baghdad's Urban Restructuring, 1958: *Aesthetics and Politics of Nation Building. Modernism and the Middle East: Architecture and Politics in the Twentieth Century*, pp. 97-115.

Richardsen Moberg, K., 2024. Environmentally friendly urban development: changes in decision-makers' attitudes, problem perceptions and policy preferences over three decades. *Journal of Environmental Planning and Management*, 67(4), pp.919-941. https://www.tandfonline.com/doi/full/10.1080/09640568.2022.2142539 .

Sanders, P., 2008. Presenting the past: the impact of urban morphology in shaping the form of the city. In *Conference papers ACSP-AESOP Fourth Joint Congress Bridging the divide: Celebrating the city* (pp. 1-8). University of Illinois.

Saoud, R., 2002. *Introduction to the Islamic city*. FSTC Limited. https://www.muslimheritage.com/uploads/Islamic%20City.pdf

Southworth, M., Ben-Joseph, E., 1995. Street standards and the shaping of suburbia. *Journal of the American Planning Association*, *61*(1), pp.65-81.

Southworth, M., Ben-Joseph, E., 2004. Reconsidering the cul-de-sac. *Access Magazine*, *1*(24), pp.28-33.

Southworth, M., Ben-Joseph, E., 2013. *Streets and the Shaping of Towns and Cities*. Island Press.

Southworth, M., Owens, P.L., 1992. *The Evolving Metropolis: Neighborhood and Street Form at the Urban Edge*. University of California. Institute of Urban and Regional Development.

Southworth, M., Owens, P.M., 1993. The evolving metropolis: Studies of community, neighborhood, and street form at the urban edge. *Journal of the American Planning Association*, *59*(3), pp.271-287.

Whitehand, J.W., 2007, June. Conzenian urban morphology and urban landscapes. In *6th International Space Syntax Symposium*, 6, pp. 12-15.

Whitehand, J.W.R., 1977. The basis for an historico-geographical theory of urban form. *Transactions of the Institute of British Geographers*, pp.400-416.

Williamson, T., 2010. *Sprawl, justice, and citizenship: The civic costs of the American way of life*. Oxford University Press.

Wilson, S., 1983. Baghdad Comprehensive Transportation Study, Final Report. *Kirkpatrick and partners.*

Wu, C., Wang, Y., Wang, J., Kraak, M.J., Wang, M., 2024. Mapping street patterns with network science and supervised machine learning. *ISPRS International Journal of Geo-Information*, *13*(4), P. 114. https://www.mdpi.com/2220-9964/13/4/114 .

التطور المورفولوجي لمدينة بغداد: تحليل أنماط النمو الحضري وعمليات التحول

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الخلاصة

تحليل المناظر الطبيعية الحضرية أمر بالغ الأهمية لفهم ديناميات التحول الحضري، خاصة في مراكز المدن التاريخية. تتناول هذه الدراسة التطور المورفولوجي لبغداد، مع التركيز على تحولها من نواة تاريخية إلى منطقة حضرية واسعة. الهدف الرئيسي هو تحديد آليات التحول التي تحدث تغييرات في هيكل مركز المدينة. باستخدام مزيج من الأساليب الجغرافية–المورفولوجية، والخرائط التاريخية، وصور الأقمار الصناعية الحديثة، تحدد الدراسة ستة أنماط نمو حضري متميزة: النمو المركز، الشريط غير المنتظم، النمو المتناثر، النمو متعدد النوى، النمو القطاعي، والنمو الفوري. تشمل منهجية البحث جمعًا دقيقًا للخرائط التاريخية من مسافري الجغرافيا الغربيين في القرنين الثامن عشر والتاسع عشر وصور الأقمار الصناعية الحديثة لمقارنة الأشكال الحضرية التاريخية والمعاصرة. تم استخدام عمليات رقمنة البيانات لتحضير هذه الخرائط للتحليل، تلتها تحديد الحدود لتتبع توسع بغداد عبر الزمن. تدمج الدراسة هذه الخرائط الرقمية لإجراء تحليل زمني، موصّفة الفترات الرئيسية للتمايز المورفولوجي من النواة التاريخية إلى النمو الحضري الحديث. من خلال تحليل شامل، تكشف الدراسة التفاعل بين القوى الفيزيائية والاجتماعية والاقتصادية والسياسية في تشكيل الشكل الحضري لبغداد. تقدم النتائج رؤى حول تأثيرات هذه العمليات النمو على التخطيط الحضري والتصميم المعاصر. تبرز الدراسة أهمية دمج السياقات الحضرية التاريخية مع الممارسات التخطيطية الحديثة لإدارة النمو المستدام، ومعالجة التحديات مثل التمدد الحضري، والاتصال، والحفاظ على المقياس البشري في التصميم الحضري. تسهم هذه الدراسة في تقديم رؤى قيمة حول عمليات التحول الحضري وتقدم إرشادات للتنمية الحضرية المستدامة في بغداد والمدن التاريخية المشابهة.

الكلمات المفتاحية: النمو، النمط، التحول، الشكل الحضري، النمو العضوي، التخطيط الحضري.