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Urban Geomorphology and Its Impact on Determining the Trends of Urban Expansion in The City of Kut and Its Future Expectations Using Geographic Information Systems

By

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Abstract

Geomorphology is concerned with the topographic units that make up the Earth's surface. These take many forms, such as mountains and rivers, and include many dangers such as landslides, landslides and erosion. Many studies appeared in this field to analyze its effects and risks resulting from it, including urban studies, to determine the trends of optimal urban expansion and its geomorphological interactions. The results showed that the city of Kut originated and expanded near the course of the Tigris River and its branches, and it suffers from unbalanced urban expansion, due to the high rate of population growth, and overcrowding in housing units with the growth of urban land uses in it, which prompted the city to extend horizontally and vertically and use land New at the expense of the lands and areas surrounding the city of Kut. To do so, this research dealt with determining the trends of current and future urban expansion of the city of Kut, and the detection of geomorphological controls that determine that expansion through the geographical characteristics of the city. The research relied on the descriptive, analytical, historical and quantitative method, collecting data through field studies and relevant government institutions, and using satellite visuals and GIS techniques in analyzing data and drawing conclusions. It has become clear from the research that there are natural determinants represented (rivers, marshes, Sabkha, natural resources) and they outweigh the effect of human determinants represented (orchards and agricultural lands, industrial areas, government and military structures, landfills, quarries and brick factories), which is due to poor planning. The override on the city's base map scheme, and therefore these determinants restrict that expansion or increase its cost, determine its direction and reduce the city's absorptive capacity. As for the best available directions for the future urban expansion of the city, they are towards the northwest along the (Kut-Baghdad) road, and towards the southeast along the (Kut-Nasiriya) road, because there are no geomorphic or human determinants that impede the spatial expansion of the city towards it. Thus, defining and measuring the trend of urban expansion will be faced with the various natural-geomorphological determinants, which must be considered among the priorities of any strategic plan for developing urban areas, and protecting them from geomorphological risks.

Keywords: *Urban Geomorphology, Kut City, Determinants of Urban Expansion, Expansion Trends, Geographic Information Systems.*

Introduction

In the past decades, researchers have directed towards studying the interaction between

the environment and human occupation processes, and with regard to urban geomorphology, it is concerned with the problems related to planning and environmental management of engineering projects in the city, in light of the escalation of human activities and the horizontal and vertical expansion in land uses and exploitation of natural and economic resources, and human asylum to exploit marginal environments and scarce resources in order to meet its growing needs (Aucclli et al., 2020). This research dealt with the city of Kut to be an applied model to study the impact of urban geomorphology on the morphological development of the city, through the field study and the use of modern digital technologies, in detecting, controlling and interpreting the city's expansion and land uses in it at a different time stage, and analyzing the causes and trends of that development by building a database It can be used in future planning for the expansion of the city, especially since some natural factors and processes are characterized by instability, which makes them vulnerable to change and the attendant geomorphological risks and environmental and geological disturbances that affect human activities. appropriate on the planner and decision maker (García-Soriano et al., 2020).

In the last period after 2003, the city of Kut witnessed a remarkable urban expansion, in view of the improvement in the economic situation and the allocation of soft loans to support the Housing Fund, which stimulated an increase in demand for residential lands, and put pressure on the neighboring areas that are the back of the city. However, sometimes the city does not expand in all directions due to some geomorphic determinants, which this research attempts to determine, if any, and to develop solutions or alternatives to modify or direct urban growth. Previous efforts for similar studies in the field of urban expansion. It mainly focused on the natural features and geomorphic processes that help or limit the process of planned urban expansion, as well as the effects of urban sprawl and its risks. As for the city of Kut, there is no study that deals with the interaction between geomorphological units and urban expansion in it, and this is the scientific gap that this research attempts to cover. Therefore, the research problem revolves around: What are the geomorphic determinants affecting the urban expansion in the city of Kut, and which of them are more influential, and the extent of the city's response to these determinants, and has it worked to direct the city's expansion in certain directions? What are the trends of urban expansion expected in the future? What are the geomorphic dangers that may accompany this expansion and the areas most exposed to it? This research aims to highlight the role of applied geomorphology in the planning of urban centers, by determining the nature of the land units on which the city of Kut arose and developed, and to calculate the impact of natural and human geomorphic determinants on the expansion of the city through the historical morphological stages of its former growth, and the current determinants in the back of the city It affects the trends of its future expansion, which may constitute a potential geomorphic danger that must be avoided or addressed when planning and implementation begins. Preparing a geomorphological map showing the overlap of the urban fabric with geomorphic features is a useful tool for understanding that overlap and potential impacts. Thus, there are natural and human determinants that affect the expansion of the city of Kut and are working to direct the expansion of the city in different directions, and that ignoring these determinants and not treating them results in geomorphic risks that are reflected on the city, and the city's expansion will certainly be in the direction of the least potential for risks and costs.

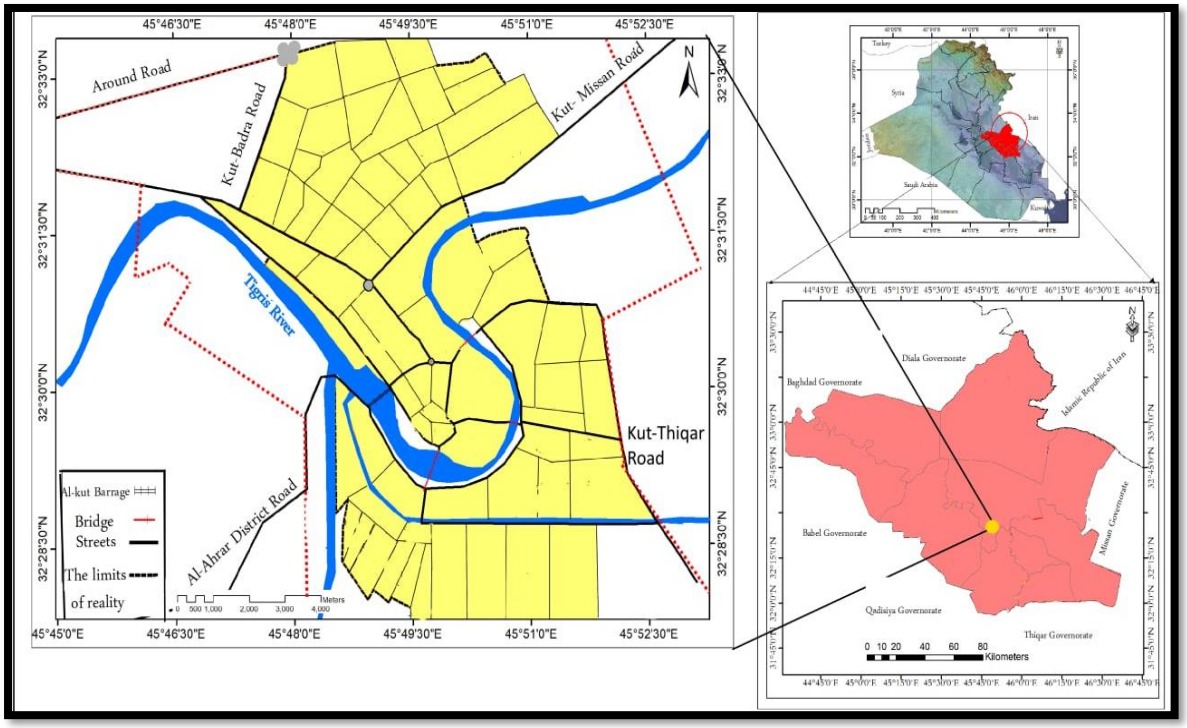
The Study Site

The spatial boundaries of the research were confined to the municipal and administrative boundaries of the city of Kut, which is the administrative center of the district of Kut and Wasit Governorate and its largest city. It is located in central Iraq near the Tigris River, to the south of the capital Baghdad and is 180 km away from it. To the south is the city

of Al-Muwfaqiya, and to the east are the cities of Wasit and Sheikh Saad. This shows that the city of Kut has a distinguished location that links the capital, Baghdad, with the southern governorates. It is also considered a land corridor towards the Iraqi Iranian border towards the city of Badra, making it an important stop for travelers to rest and provide services to them, in addition to possessing a cultural and historical heritage that requires care for the harmony of its urban expansion.

The city is located astronomically between two latitudes (27 32 º - 33 ¯ 32º) in the north, and longitudes (46 º 45 º - 54 45º) east, with an area of 61.22 km², and it includes 55 residential neighborhoods. Note the map 1). As for the time limits of the research, they were determined by the morphological stages of the expansion of the city of Kut for the period (1812-2022).

***Map* (1).*The* Location of the Study Area form Wasit Governorate, Iraq**



Source: (The General Directorate of Urban Planning, 2014), (Wasit Governorate Municipalities, 2020), (The Satellite Visual of Iraq, 2018).

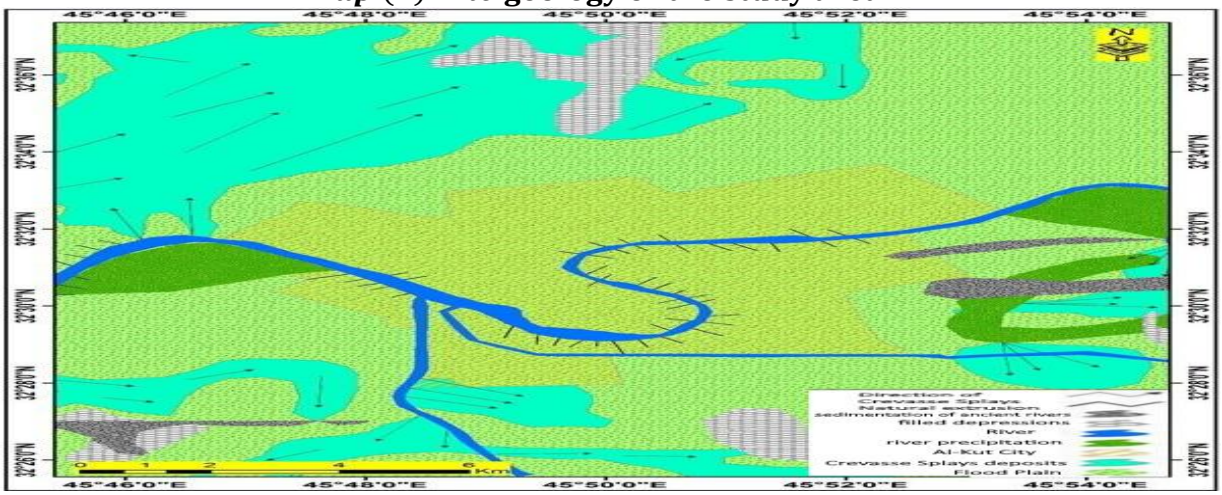
Stratigraphic and tectonics Geology

Stratigraphically, the study area is completely covered by the sediments of the Quaternary age, and these sediments are divided into sediments dating back to the Pleistocene era, and modern surface deposits dating back to the Holocene era, and the latter is the most widespread in the city of Kut, Note Map No.2.

tectonics, the area is part of the sedimentary plain range, which represents a secondary range of unstable pavement areas of the sub-Tigris belt affected by alpine movements, and it includes tectonically active subsurface structures, which worked to change the course of the Tigris River over long periods of time, thus affecting the distribution of settlements The most important of these structures is (Tal Al-Hawa) at the Tigris and Dujaila rivers, and (Al-Ahdab) near the Tigris and Al-Gharraf rivers. One of the most important outcomes of the collision of the Arab plate with the Iranian plate is the occurrence of a number of folds and faults, the most important of which is the Salman Fault, which crosses the Tigris River in a cross-section (Barwary & Yacoub, 1992; Vasyliev & Vasylieva, 2021). Near the city of Kut, note the map

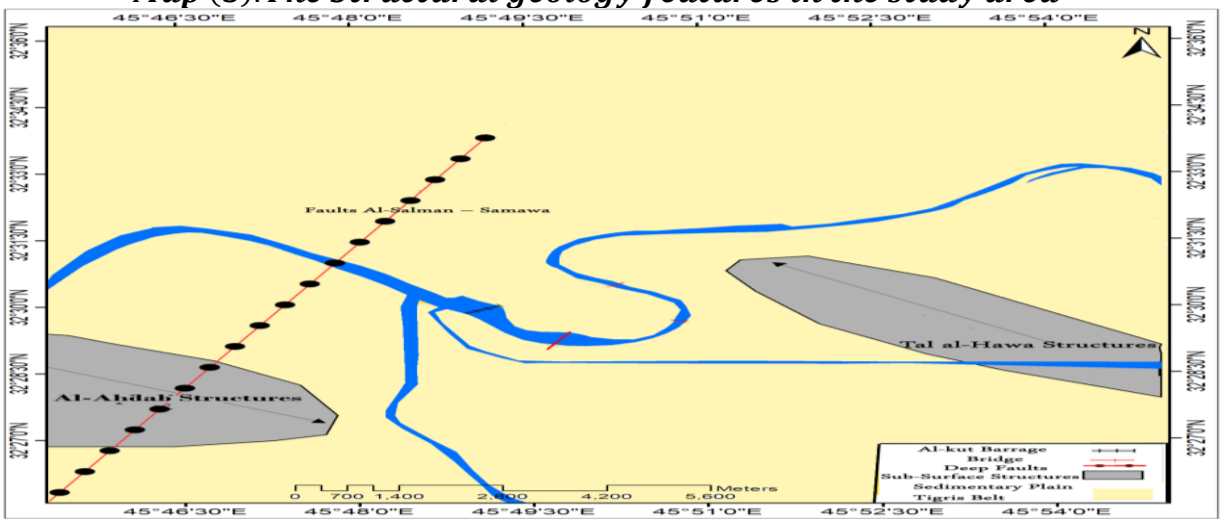
No.3.

***Map* (2).*The* geology of the study area**



Source: (Barwary & Yacoub, 1992). Geological Map Of AL-Kut Quadrangle Sheet NI-38-15. (GM-27). State Establishment of Geological Survey and Mining. Scale 1:250 000.Edtton 1994. Gis, Arc Map.V10.6.

Map* (3).*The Structural geology features in the study area



Source: (Buday & Jassim, 1984), (Al-Sakni, 1993)

The Soil

The soil in the study area is alluvial deposited by river floods. It is divided into two types. The first is: the soil of the shoulders of the rivers extending on both sides of the stream, occupying high bands 2 m from the soil range of the neighboring river basins, characterized by its fertility, lack of salt, depth and good permeability, which facilitated the process of natural drainage of excess water downstream The adjacent river (Vishlenkova & Sharykin, 2021; Vodolagin et al., 2021). The second type: the soil of river basins adjacent to the first type and extends to wider areas than it, but it is lower than it and has a softer texture due to the high percentage of silt and clay compared to the low percentage of sand. As the percentage of areas of saline soils in (Al-Kut district) is 31.37%.

Rivers

The Tigris River is the main factor in the emergence of the city of Kut, as the population

has settled since ancient times near the course of the Tigris River and its branches in the study area, and most of the urban expansion extends linearly along the riverbeds in more than one direction, for the purpose of securing a stable water source for its various uses, especially domestic and industrial And agriculture, given the nature of the dry climate and fluctuating rains, and the river made it a commercial city through its river port, which is located in the middle of the navigational distance for river-sea trips between Baghdad and Basra, surrounding the city, in addition to the tourist side of the city, given the distinctive river view. Picture No. (1).

picture No. (1) Side of Kut City showing the extension of residential neighborhoods and urban uses on both sides of the Tigris River

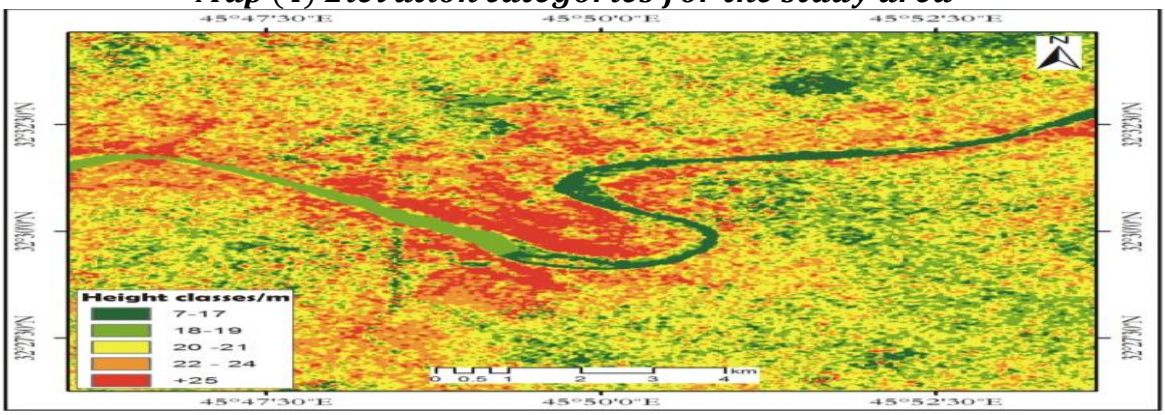
Surface Charastirsics

The variation in surface characteristics affects all human activities. The urban mass in the city of Kut extends in the plain area, and has moved away from its origin in the neighboring Hamrin Hills areas, as the altitude factor is a geomorphic determinant of urban expansion in certain directions. The extension of the city of Kut over a wide plain area, made it suitable for urban development without the obstacles of erosion and slope, but the low surface at this level may expose it to other risks. This topic will be detailed as follows:

A. Height Charactrsitics

The surface of the city is characterized by general flatness and simple gradual decline in most of its parts, as it is located within the flood plain area, as the height of the city's surface ranges from 20 m in the northwest to 16 m above sea level in the far southeast. Note the map (4).

Map* (4) *Elevation categories for the study area



Source: The authors based on digital elevation model (DEM) data using Arc Map.V10.6

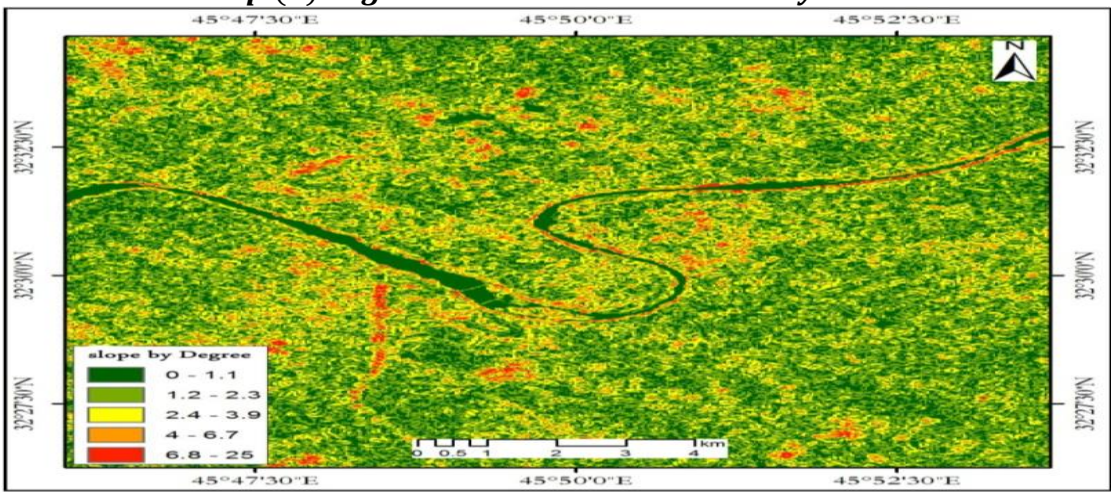
The surface height of the lands located on both sides of the Tigris River varies, as the

lands on the left side of it are about 3 m higher than the lands on the right side, as the lands of the left side range in height between (18-20 m), Rather, it rises to (22-25) near the neighborhoods of the old city, while the height of the lands on the right side ranges between (18-16 m) and drops below that at the river tongue in the Anwar al-Sadr neighborhood. This has an impact on the direction of flow, movement of materials, construction and construction. As for the areas of the back of the city towards the northwest, they are higher, reaching more than 22 m, while they decrease to less than 14 m towards the north and north-east due to the presence of Mar Al-Shwija, which ends with a group of valleys descending from the Hamrin Hills, as well as gradually declining southeast and southwest to under 16 m.

B. Sloping Charactristics

The general direction of the decline of the city of Kut is gradually from the northwest to the southeast, and this matter resulted in several things, including the direction of the flow of the Tigris River and its branches and the movement of soil and materials in the same direction, note the map (5), as for the degrees of decline, they range between flat lands (0.5 - 2.3)º degree, which occupies the largest area of the city, to a very light ripple ranging (2.4-4.5)º degree, which is scattered scatteredly in the study area, especially in the central, northern and northwestern parts, while what exceeds (4.5) are limited areas in a way Pysometric heights, and thus, the degrees of slope are encouraging for urban expansion, as the planning standards indicate that the slope of the residential areas does not exceed (8.5)º, and on the contrary, increasing the slope of this ratio is a challenge fraught with great geomorphic risks.

Map* (5) *regression classes in the study area



Source: The authors based on digital elevation model (DEM) data using Arc Map.V10.6.

C. Surface divisions and landforms

The city of Kut is generally located on the flood plain, which is one of the most important sections of the surface in Iraq, and this plain includes a number of distinctive landforms resulting from the variation of geomorphic processes, and the city's back is surrounded by other landforms:

- ***The course of the river:*** The length of the course of the Tigris River in Medina is (20.24) km, Al-Gharraf (6.31) km, and Al-Dujaila (8.87) km, and the width of the course of the Tigris River ranges from (130) m near Al-Anwar Bridge to (643) m near the Kut Barrage.

- ***The river*** islands: the study area includes three river islands, located in the middle of the river behind the Kut Barrage. Because of the proximity of the water source and its fertile soil, which supports urban food security, and it is possible to benefit for tourism purposes, such

as the island of Baghdad and the tourist island of Sinbad in Basra**.**

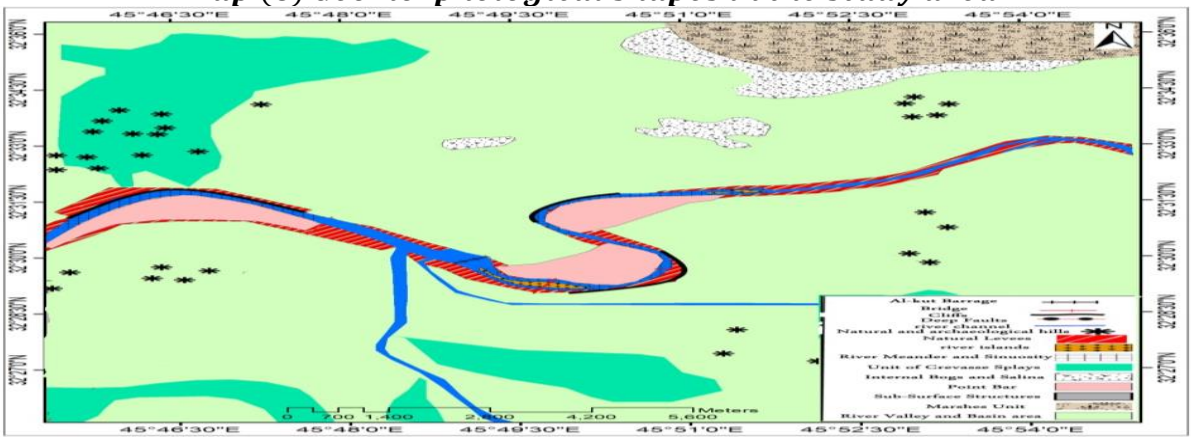
- *River Meander:* The course of the Tigris River in the study area is characterized by its meanders, as a group of torsions were formed in view of the slow river flow in silt-silt formations and a low-sloping flood plain, which increases the breadth of the stream width at the expense of its depth by the effect of carving the spiral stream in the concave side , and the deposition of the return current load from it on the convex side. The study area includes the Khajia torsion with a zigzag ratio (1.46), the Kut bend (1.8), the Anwar bend (1.7), and Kardia is outside the city limits, but it may expand towards it., as its meander ratio is (1.67) according to the law of inflection coefficient, and with these twists and turns, it adapts the shape of the city and its neighborhoods and its urban fabric.

- *Natural Levees:* they are the natural shoreline of the river, representing a different topographical feature that extends in narrow transverse bands (less than 1 km) parallel to the two sides of the river course, and is relatively high by about 2-3 m above the level of the flood plain.

- *River basin range:* It represents a region adjacent to the shoulders of the river in which fine and fine materials of clay, silt and fine sand were deposited, which moved away from the course and shoulders of the river towards the interior of the flood plain and the marshes.

- *Point Bar:* They are new banks that have become part of the dry land on which a person can practice his activities. The study area includes a large river tongue in front of the Kut Barrage on the left bank, with an area of (258785) m2, part of which is submerged in water, and it has been subjected to a large dredging operation. By in order to reduce the momentum of the sedimentation process and its products in front of the Kut Barrage, this river tongue can be used to establish temporary useful tourist sites. Note the map No, 6.

Map* (6) *Geomorphological shapes in the study area



Source: From the work of the two researchers based on the digital elevation model DEM produced by SRTM for the American satellite Landsat 8 using the ARC MAP GIS V. 10.6 program.

- *The cliff: the* shoulder side of the river, which is very steep, comprising three cliffs, concentrated in the concave side of each river bend.

- *Flood Plain:* The wide flat lands around the river, covered by soft silt deposits, as the large river floods with the sediments they carry contributed to its formation, and its expansion increases in the lower course of the river, especially the study area.

- ***Crevasse Splays:*** Weak points in the shoulders of the river that collapse during the flood, so the water flowing from it is a secondary outlet for the drainage of some of the river's water to the neighboring depressions due to the momentum of the flood force. And one on the Dujaila, most of which were subjected to burial due to human deposits.

- ***Sabkha:*** they are evaporative geomorphic features that are found in the low areas of the flood plain. It is spread in the study area in the soils of river basins that are relatively far from the course of the river.

- ***Marshes and swamps:*** they represent ponds or low ground in the floodplain, which are permanently or seasonally flooded with water. Marshes Al-Shwija is considered one of the most important geomorphological features adjacent to the study area. It is considered an urban geomorphological heritage at the governorate level that requires its maintenance and preservation, Picture No. (2).

- ***Units of human work***: they are units and sediments resulting from various human activities, and man represents the strongest geomorphological factor that can change the parameters of the earth's surface and create new forms that suit his needs, such as ancient and modern urban settlements, agricultural lands, industrial quarries, road works, irrigation canals, excavations, hills and sites Archaeological and military cemeteries and landfills ... and others that represent the deposits of modern features above the surface of the earth and natural sediments, and they appear in different parts of the city.

picture No (2) Marshes Al-Shuwaijia north of Al Kut city near (Kut - Badra Road)

Research Methodology and Method of Work

The research adopted the descriptive approach, the analytical approach, the historical approach, the quantitative method, and the method of office work based on documentary field visits, in order to track the stages of city expansion and determine the impact of geomorphic manifestations in directing urban expansion. Data and theoretical information were collected based on similar studies and related government departments, as well. Download (Landsat) visuals and digital elevation model (DEM) for study periods from the USGS site and perform data derivation, analysis and processing operations, such as engineering correction, matching, radiological calibration, optimization, classification and others using RS and GIS techniques, in order to continuously monitor the place and extract geomorphic information such as geomorphic units and terrain elements such as elevation and slope characteristics.... In order to draw the geomorphological map, this determines its interaction and impact on the size and trends of urban expansion in the city of Kut and modeling its future expectations according to the nature of the appropriate land use for each geomorphic unit.

Results

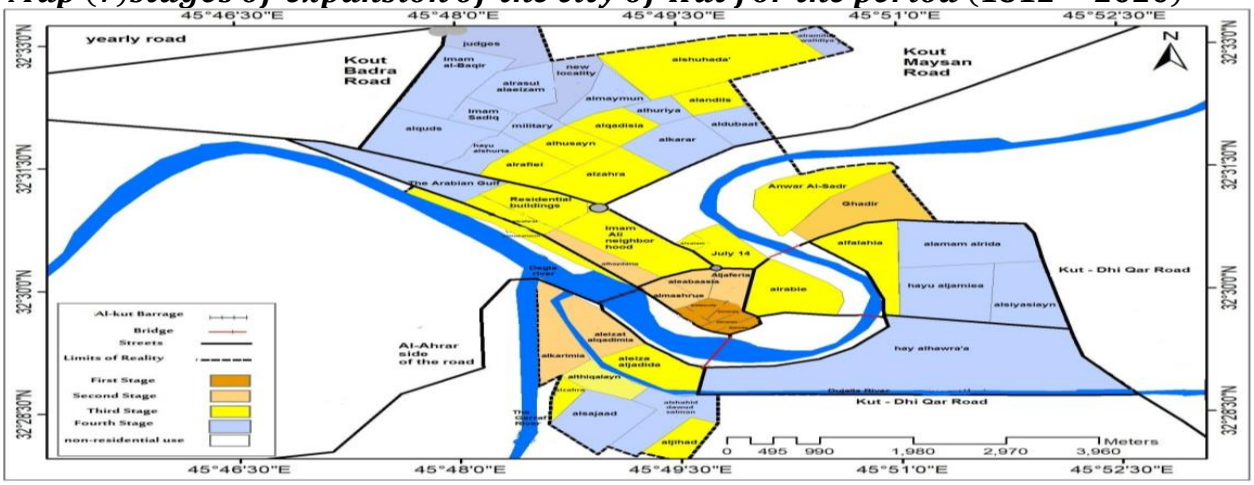
Morphological stages of the emergence and expansion of the city of Kut

Al Kut owes its existence to the unique features of the natural features that have shaped its development patterns over the past 200 years. The city of Kut arose on the left bank of the Tigris River in the inner side of the river's twist. It was a small village that included a group of mud huts. The factors of abundance of water, its fertile soil and its geomorphological situation were suitable for agriculture and housing, so it began to expand in successive stages, the most important of which was the first stage in the period (1812-1934). As the city included (5) neighborhoods, note the map (7), and these neighborhoods were in a circular shape surrounded by a wall of clay 2 meters high, with four doors in different directions. The area of the city at this stage was 2.39 km2, or 3.9% of the total area current.

The second phase, the period (1935-1960) the city started to grow outside the wall and (4) new neighborhoods appeared near the previous ones, then the expansion of the city headed for the first time to the other side of the river towards the southwest, after the construction of the Kut Barrage in 1939 that connected the two sides of the city and the plain Crossing the population and moving to that side, as the (Al-Azza Al-Odima) neighborhood was established between the outer convolution of the right bank of the Tigris River and the Dujaila River, then the (Al-Karimiyah) neighborhood was created between the Dujaila and Al-Gharraf rivers. The area of the city at this stage was 10.22 km2, or 16.7% of the current total area.

The third phase, the period (1961-1990) continued the expansion and built several bridges on the rivers and a network of paved roads, so 19 neighborhoods appeared. However, this trend came to accommodate the increasing demand for housing units due to population growth, rural migration towards the city, and high urbanization rates, in conjunction with the difficulty of expansion in light of the limited area of the city. At this stage, the city's area reached 18.61 km2, or 30.4% of the current total area.

***Map* (7)*stages of expansion of the city of Kut for the period* (1812 – 2020)**



Source: (The General Directorate of Urban Planning, 2014), (Wasit Governorate Municipalities, Basic Design Maps for Previous Years), (Wasit Governorate Council, 2022).

As for the fourth stage, the period (1991-2022) is considered the most important stage as it included the largest number of newly developed neighborhoods and expresses the final image in which the urban authority of the city appeared, as (25) neighborhoods were created. Al-Khadra, Al-Naft, Al-Kut Al-Jadida, Umm Hillel, Al-Amiri), the neighborhoods of overtaking within the city (Bustan Hajji Abboud, Bustan Al-Chalabi), the area of the city at

this stage reached 30 km2, or 49% of the current total area.

That urban expansion coincided directly with population growth, as the data indicate that the population growth rate in the city of Kut during the past seven decades ranged between (2.5-6.5)% and recently settled at (3.7)%, as the city's population in 1947 amounted to about (15,936 (population)) and in 2017, it reached (47,0532) people, () and it is expected that the population in 2022 will reach (583566) people, and their number in 2040 will reach (940,100) people.

Geomorphological and urban indicators

These indicators help to identify the extent of the impact of the characteristics of the Earth's surface on the expansion of the city of Kut, as the values of these indicators range between (0-1) whenever the value approaches one, it indicates the strength of the indicator, and if the value moves away from it and approaches zero, this indicates the weakness of the indicator. Table (1) represents a guide to determine the degree of each indicator, and these indicators can be addressed as follows:

***Table* (1)** *Classification Index of Urban Geomorphological Indicators Grades*

Ranges	Class	Degree
0.6>	1	High
0.6-0.3	2	Moderate
0.3<	3	Low

Source: (Al-Dulaimi, 2018), a comparative study from its inception until 2017 using geographic information systems (Arc Map).

Topographic Symmetry Index (Stability)

This indicator shows the degree of symmetry of the features of the Earth's surface with the city in which it originated and expanded, according to the following equation:

$$T = Da/Dd$$

As:

Da = the distance from the left or right of the river to the end of the floodplain.

Dd = the distance from the left or right of the river to the end of the city limits.

After applying the equation and taking measurements based on the Arc Map Gis V10.6 program, it became clear that the value of this indicator (0.25) is within the category of low symmetry with the characteristics of the earth's surface, as a result of the nature of the plain land on which the city expanded. Note Table (2).

Table (2) Results of measurement of geomorphological indicators

Degree	Value	Indicator
Low	0.25	T
Low	0.0042	SD
Low	0.23	AF

Source: The two researchers based on the satellite image of the Kwik Bear satellite with a resolution of 1 m and a digital elevation model DEM with an accuracy of 30 meters, and two outputs from the Arc Map Gis V10.6 program.

Indicator of time and place in terms of variables (SD)

This indicator measures the value of the spatial change of the city's growth over time, and from the application of the equation below, its value is (0.0042), which is also within the category of low symmetry between the area of the entire district and the expansion of the city through the stages of time.

SD = the area of the side (right or left) of the city - the area of the floodplain in the (right or left) side *of the range / The total area of the district - the area of the side (right or left of the city) x 100*

Asymmetry Factor

This indicator determines the asymmetry of the spatial growth of the actual residential uses in the city to the total area of the city through its various stages, and from the application of the equation below, its value reached (0.23) and it indicates the dispersion and asymmetry of the distribution of residential use over time. The city of Kut, for several reasons, including the features of the surface and the bifurcation of rivers.

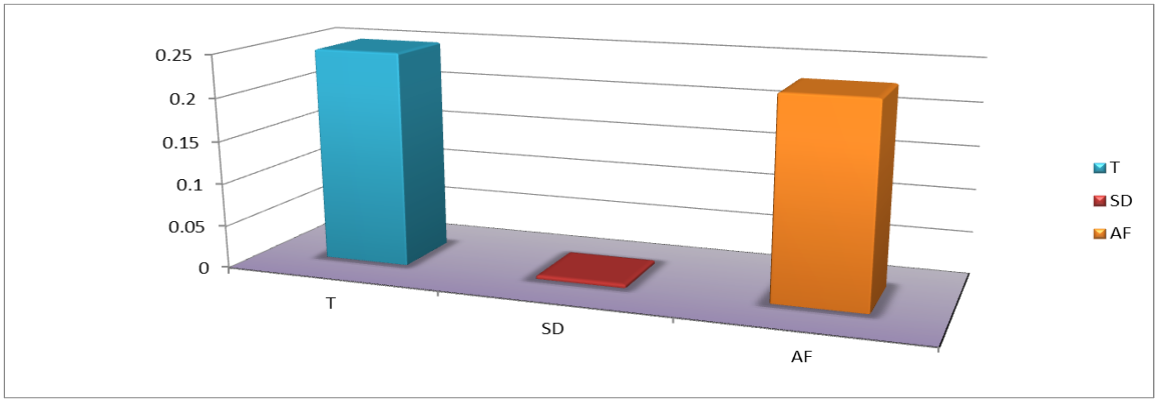
$$AF = AR/AT$$

As:

AR = actual area of residential use in the city.

AT = total area of the city.

Figure* (1)*Results of measuring geomorphological indicators



Source: Table (2)

Discussion

Through the study of the natural characteristics of the study area, it became clear that the faults represent weaknesses in the base rocks that affect the multi-storey urban expansion, and that the sub-surface structures cause kinetic activation that has an impact on the stability of buildings and infrastructure, and may lead to changing river courses, as happened to the phases of river courses Tigris in the study area throughout history, and this represents a geomorphic danger that threatens the existence of the city, and perhaps the control and storage facilities have reduced the severity of the recurrence of this danger. On the other hand, these geological structures are rich in oil. Al-Ahdab is currently being invested in the neighboring city of Al-Ahrar, and it is possible to invest in the installation of Tal Al-Hawa in the city of Kut in the near future, which makes it a determinant of the city's expansion towards the east.

The variation of the type of soil and its characteristics has a significant impact on determining the extent of its ability to withstand the pressure caused by urban expansion, in terms of the type and size of construction and the number of floors on which it is built, as well as its suitability to extend and develop the network of infrastructure services, and in general, both types (Natural Levees and river basins) are suitable For urban expansion, the first is more suitable, but it is preferable to use it for agriculture and tourism use. As for the second type (river basins), it is also suitable for urban expansion, because what matters for the soil suitable for construction is its texture and structure, not its fertility, and a large number of

neighborhoods of the city of Kut are spread over it.

However, some of its types are less valid because of the high salts in them and the slag soil that causes some construction problems for buildings. On the other hand, the process of geomorphic sorting of silt sediments between the first and second zones made the soil of this zone an excellent raw material for building housing, represented by quarries of clays that are converted into (milk) dried on the sun, or made by furnaces of brick factories scattered east of the city.

The Tigris River is the most important geomorphic manifestation that helped in the emergence of the city of Kut, and on the other hand the river acts as a determinant of the city's expansion, as the city's location at the branching of the Gharraf and Dujaila rivers from the Tigris contributed to cutting the urban cohesion to four sides around those rivers, and those rivers were not straight The geomorphic processes worked to form two opposite rivers in the Tigris River, making it like semi-islands that embrace the city's neighborhoods on three sides. Here, human technology intervenes to reduce the impact of geomorphic determinants for the purpose of modifying urban expansion, as (11) bridges were built in the city, the most important of which are (Al-Kut Barrage, Al-Anwar, New Glory, Military Iron, Iron Karama, Jihad, Al-Gharraf, Al-Dujaili...), worked to link neighborhoods of the city together. At the same time, the city's approach to this extent around the riverbeds may expose it to the dangers of flooding, especially since the study area includes (Al-Kut Barrage), which increases the rise in water levels, so it is higher than the level of some residential areas adjacent to the origin of the Barrage provider. The anthropogenic sediments and impermeable layers made by the city distorted or altered the natural water drainage system, the thickness of the soil, the vegetation cover and the nature of the seepage. Artificial modifications to the drainage network, slope, and to natural features in general accelerate the interaction between the city and geomorphological processes and thus increase exposure to natural hazards.

The surface was an encouraging factor for the expansion of the city of Kut, as it extended on a flood plain, with a low slope, stimulating the achievement of most human activities and infrastructure, devoid of geomorphic risks (except for flooding and salinization), and this surface includes several geomorphic features, the most important of which are (streams, islands, Meander, Natural Levees, basins, Point Bar, cliffs, Crevasse Splays, Sabkha).

Al-watrya dam east of Kut City reduces the effect of the eastern valleys floods and the rise of the levels of Marshes Al Shuwaija that threaten the city, but it is subject to collapse or destruction from time to time, as happened during the rains and floods of May 2013. The rain and torrential rains October and November 2015, and the flooding of April 2019, have caused some tourist facilities to be drowned on both sides of the Tigris River in the Kut. Picture No. (3).

picture No (3) the Al- Raoucheh Resort was flooded in the flood
of April 5th, 2019, near Al-Kut Barrage in the city center

By following the stages of the city's expansion, two aspects are noted. The first: The city's area has doubled 26 times since 1812 until 2022. The city's expansion is only a response to the large and accelerating population growth and keeping pace with their increasing needs for various urban uses, which requires urban expansion paralleling population growth, and therefore It constitutes a heavy burden on the various resources and capabilities of the city, taking into consideration the geomorphic and human determinants that the city of Kut is facing to achieve. In terms of the area needed by the city in the year 2040 in light of population growth of up to 33 km2 according to the approved planning standard (100 2 / person) for various uses and services, taking into account the percentage of the housing deficit for the current area, meaning that the total area of the city will then be 94 2km.

The second aspect: the expansion of the city took several forms, the first: the external expansion by jumping towards the areas of the outskirts and the neighboring agricultural areas due to the low price of the land, the second: the dictated expansion that occupies the abandoned and scattered areas between the city's neighborhoods, the third: the trend towards vertical expansion that occurred in some empty areas From the center of the old city, or replacing the old buildings with modern buildings, due to the high value of the land and taxes in this central area of the city (Central Business District - (CBD), given the concentration of most governmental, commercial and industrial institutions in it and the ease of access to it. Fourth: Random expansion that does not adhere to the basic design rules in the city center or on its far outskirts. And the acceleration of the growth of slums doubles the pressure on the city's infrastructure and leads the city to expand in an unbalanced manner towards unplanned areas, which may include many obstacles and determinants of urban expansion, and thus slums are exposed to instability and are more exposed to geomorphic risks.

The topographic symmetry index and the time and place index in terms of variables were weak in view of the fact that the city's surface is flood plain. As for the asymmetry coefficient index, it indicated that residential use is irregular and symmetrical in its distribution over the city's land surface over time, as it leads to the dispersal of residential use. This is due to the branching rivers in the city. The topography of the current city is considered the least vulnerable area to geomorphic risks, but the continuous need for the city's expansion may make it expand towards areas fraught with problems and geomorphic dangers, which requires research and planning to avoid this.

In the field of evaluating the suitability of the lands for urban expansion, it became clear that there are some geomorphic determinants that prevent the expansion of the city in certain directions. The direction of the southwest of the city extends the oil structure of Al-Ahdab, and

the direction of the west is the wrong spatial signature of the Abu Ubaida military base near the city. The eastern direction extends to the composition of Tal al-Hawa oil, and the oil deposit of Kardia, as well as the forests and orchards of Kardia, which are the lungs of the city and its agricultural back Picture No. (4), knowing that these geological structures may cause kinetic activation that affects buildings and changes the course of rivers, or fires due to associated gas, The structure of Abu Amud's oil (in the district of Al-Hai outside the study region) caused several fires in the area of Al-Akkar, as well as cause environmental problems. when invested. As for the northeast direction, parallel to the (Kot-Amara) road, there are orchards and the industrial district. While the direction of the north parallel to the (Kot-Badra) road, it can be expanded, but within very restricted limits, meaning that the expansion must be stopped before reaching the swampy and low-lying areas near Hor Al-Shwija, the brick factories and the landfill, which makes the city exposed to the dangers of torrential rains, floods and salinization on the one hand, as well as Pollution by emissions of brick factories and sanitary landfills, on the other hand.

The restriction of the expansion of the city of Kut to the geomorphic determinants above led to a rise in the price of the land, which made it less attractive to the population. The city size and population are among the urban centers in Wasit Governorate.

In light of the results of the above-mentioned risk assessment, it is necessary to prioritize effective measures to mitigate the impact of these risks, through planning and proposing appropriate directions for the expansion of the city, which is devoid of geomorphic determinants. Tigris. The second direction: the southeast along the Kut-Nasiriya Road along the left bank of the Garraf River. Both directions meet the areas required for expansion, but before expanding towards the outskirts, the empty areas of the current master plan of the city must be filled with vertical construction, which accommodates larger numbers of residents. And keep up with the high prices of these areas.

picture No. (4) Kardia forests and orchards east of Kut on the right side of the Tigris River

Conclusions

We conclude from the foregoing that the geomorphic factors played a major role in the emergence of the city and in determining the direction of its expansion. The geological structure, soil, river course and flood plain played the largest role in this. Rivers contributed to cutting the cohesion of the urban fabric between the city's neighborhoods. And its two branches, Al-Gharf and Al-Dujaila, so man-built bridges in order to reduce the impact of the geomorphic limit and modify the direction of urban expansion. This matter was reached with the help of RS and GIS technologies, which gave a complete picture of the stages of city

expansion, and the trends of future expansion of the city. Balanced towards areas containing geomorphic hazards.

It has become clear that the basic design map of the city includes a number of errors that have become a determinant of the expansion of the city, the most important of which is the wrong spatial signature of the Abu Ubaida military base, as well as the industrial district, and the city suffers from restrictions on some urban growth paths related in whole or in part, as the research showed the presence of Geomorphic determinants in certain directions, such as oil compositions, salinization, and torrential rains coming towards Mar al-Shwijiyeh, as well as forests, agricultural lands and some human uses, and when applying three geomorphological and urban indicators, it was concluded that there is no topographical symmetry between the land forms and the city's expansion, given the city's extension on the floodplain. The best axes for the expansion of the city are the northwest direction along the (Kut-Baghdad) road, as well as the southeast direction along the (Kut-Nasiriya) road, and it meets the area required for the expansion of the city, estimated at 33 km2.

Based on these results, we suggest preparing a database of geomorphic hazards for the city of Kut and presenting it to planners and decision-makers, in order to limit urban expansion in areas exposed to these risks. As well as the formation of specialized committees to design an urban system for the city that achieves a balance in expansion, that is compatible with the natural and human components and obstacles, as well as consistent with the basic designs of the old city. These variables require repetition of such research periodically, in order to identify the changes in the expansion of the city and the geomorphic risks it faces.

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