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To cite this article: Ihsan Abbas Jasim *et al* 2021 *IOP Conf. Ser.: Earth Environ. Sci.* **779** 012021

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# Evaluating the urban structure of Al-Kut city according to sustainability

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**Abstract.** The research attempts to assess the urban structure of Kut city - as a sample of Iraqi cities - according to the requirements of sustainability and the extent of their consistency or their distance from the requirements of achieving sustainable urban development. By studying the main urban components of Kut city, analyzing the spatial distribution of land uses, the nature of the neighbourhood, and the spatial distribution of population densities in it, road network and spatial distribution of urban land prices. The research concludes that the study area's urban spatial structure is ineffective and has many defects. The city is spread over a large area, and the population densities are distributed unorganized. Most of the population densities are far from the centre area; this leads to long, random and erratic trips. Traffic problems in the city are exacerbated by the absence of a hierarchy of roads and weak links between parts of the city as a result of the spread of the city between the two banks of the river and the lack of adequate bridges.

**Keywords:** urban structure; sustainability; Kut city.

## 1. Introduction

There is a relationship between urban structure and sustainable development, but it is not simple and straightforward. A sustainable city's urban structure assumes the achievement of a city-size suitable for cycling, walking, and efficient public transport. It improves long-term health and the social and environmental state of cities. It achieves land-use efficiency, less car use, ease of access, resource efficiency, reduced pollution and waste, restoration of natural systems, good housing and living environments, and a healthy and social environment. Numerous research studies have indicated that compact cities that depend on public transportation, provide a hierarchy of activities, and socially integrated activities achieve sustainable urban development requirements in all its aspects. It is a sensible solution to respond to serious challenges facing the world by thinking holistically and acting from a local perspective.

Kut city suffers from many problems that have led to a decline in the quality of life, caused by a defect in its urban structure, such as social isolation, congestion, traffic accidents, an increase in the length of trips, and various pollution problems. The research aims to assess the urban structure of Kut city - as a case study for the Iraqi city - according to its sustainability and its consistency with the requirements of achieving sustainable urban development.

The research also aims to create a sustainable urban environment by studying Kut city's urban structure's current status and whether it is compatible or fulfils the requirements of sustainable urban development. The research assumes that the efficient urban structure of any city must fulfil the requirements of sustainable development.

The process limits for the research are the municipal boundaries of Kut city, shown on the map of the Master Plan. The research adopted the methodology of comparative descriptive analysis and the use of GIS analyzes.

The research structure is divided into two parts; the first is the concept of urban form and the urban structure. In contrast, the second part deals with the analysis of the components of the urban structure



of Kut city, such as the spatial distribution of land use, the nature of the neighbourhood in the city, the spatial distribution of population density, the road network, and the spatial distribution of urban lands according to their prices.

## 2. Urban structure and sustainable development

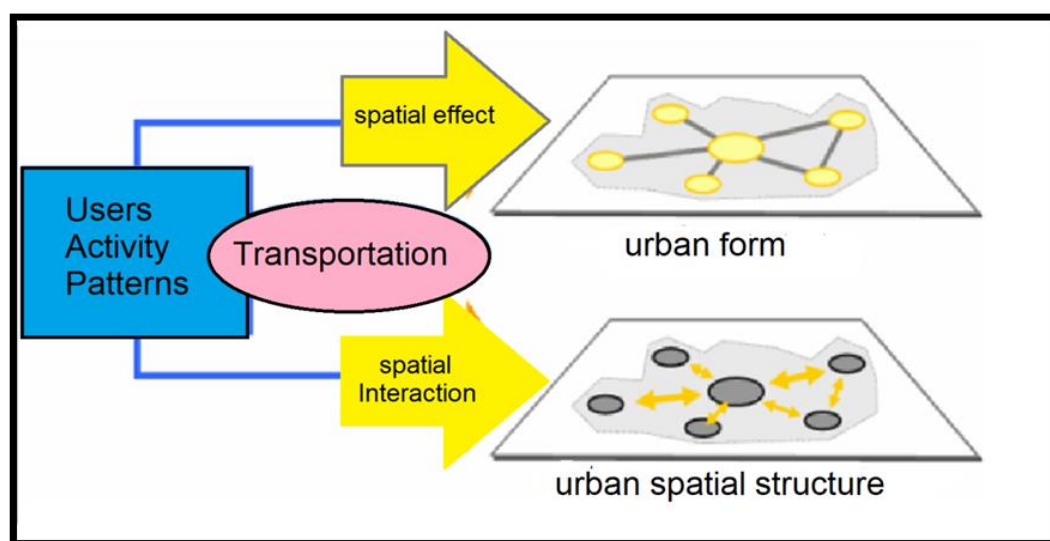
### 2.1. preface

A sustainable city's characteristics should have an appropriate size model for cycling, walking and efficient public transportation, and improve the long-term health and social and environmental condition of cities. It achieves land-use efficiency, less use of cars, easier access, more efficient use of resources and less pollution and waste, restoration of natural systems, good housing and living environments and a healthy and social environment [1]. The compact cities achieve the requirements of sustainable urban development in all its aspects. They reduce the space used for each person and thus reduce the ecological footprint by reducing the energy used, and this is called the multiplier of urban sustainability [2]. Sustainability at the level of a single building has become possible to achieve. Still, when we expand our perceptions to a wider environment, which is the neighbourhood. Other challenges will overlap on a large scale such as car use, energy production and waste recycling, so the neighbourhood level is a wide area where a problem appears sustainability clearly[3].

### 2.2. Urban structure

The urban structure is the city's physical form or structure reflected on all city joints, especially the movement of transport and economic activities [4]. It can also define the spatial pattern or arrangement of individual elements such as buildings and land uses and social groups of economic activities and public institutions within the urban area and the population's distribution and the networks that link them. In contrast, the spatial structure is the spatial distribution of the population and land uses within the urban area, or it is the pattern of daily trips within Urban area [5]. The urban structure is associated with developing the transportation system[6], as shown in figure (1). In order to develop planning tools that are in response to a complex interaction between transport and land use, it is useful to know the typical characteristics of development with urban structure.

The relationship between transportation and land uses complex. An urban structure has feedback relationships with transportation, and demand for trips is the first step towards understanding these aspects of the transportation planning process.

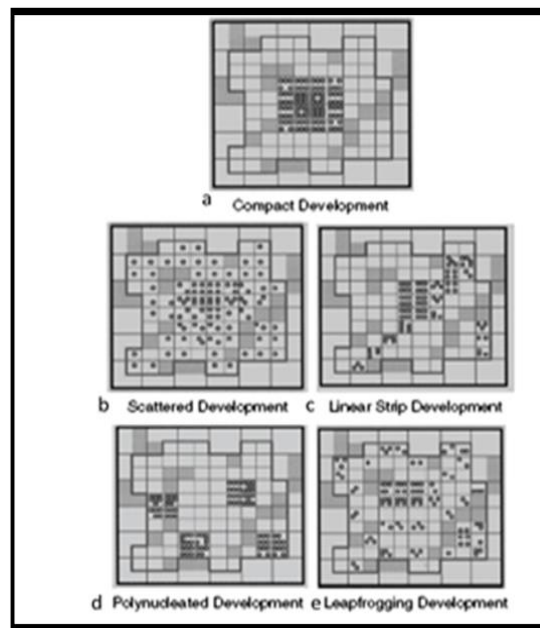


**Figure 1:** the effect of activities and transportation on the urban form and spatial structure

The spatial structure of the city is complex. It is the unnoticeable natural result of the functional relationships that arise between the city's activities (housing, trade, industry, services) on the one hand, and the controls and determinants of the emergence of these events (the land market, building regulations and legislation, community behaviour) on the other hand.

The spatial structure of the city is complex. It is the natural result of the functional relationships that arise between the activities of the city (housing, trade, industry, services) on the one hand, and the controls and determinants of the emergence of these activities (land market, building regulations and legislation, community behaviour) on the other hand. It must be noted that the planning legislation is one of the main mechanisms that lead to achieving an urban structure compatible with the needs and requirements of individuals and society to organize the neighbourhood's work of health, security, safety and comfort. Therefore, which contributes to achieving a sustainable urban environment with a distinctive identity for social communication[7]. The spatial structure has a clear impact on the various jobs in the city. Accordingly, different activities take an effective distribution for them, and cities, in general, can be mono-centred or multi-centred. This concept is what should be taken into consideration to assess the urban structure. When evaluating multi-centre cities with single cities, this factor is assumed to be considered to obtain accurate results. Two types of cities can be distinguished through the movement of public transport lines if the public transportation lines are connected with the city centre only, and there are no lines between the city's neighbourhoods without going through the centre, the cities are single-centred, while the multi-centre cities, the general traffic movement is effective between the outskirts of the city as well as Movement with the centre

There are multiple patterns of the city's shape, which is related to topographic and social factors and economic factors [8], as shown in figure (2).

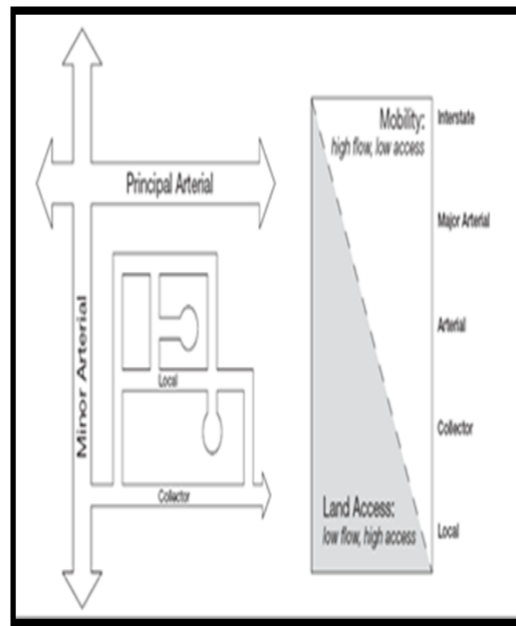


**Figure 2:** Patterns of urban form

The first form (a), which is the compact (compact) pattern, is considered the best of these patterns (as indicated), and the pattern (b) is the diffuse pattern that spreads over a wide area and randomly. The linear or longitudinal pattern (c) is often associated with growth around the movement's axes, to take advantage of the economic opportunities. Type (d) is a multi-core pattern and often occurs when cities grow in size, and it isn't easy to provide services from one centre to the large city extension. And the last pattern (e), which is known as a jumping frog, leaves areas without development and is crossed and the areas that follow develop.

### 2.3. Road Network

A good city shape requires an efficient road hierarchy, as the road hierarchy determines the carrying capacity and speed of the roads. Capacity is the number of cars per hour that can move at a specific point. Roads range from highways to local streets, and between them is a Collective, arterial, major arterial. Each has its advantages and disadvantages. Some of them provide movement, and some provide better accessibility [9], as shown in figure (3).



**Figure 3:** hierarchy of road density by function

Each type of road has its function within the city structure. The hierarchy should achieve connectivity, which means the degree to which the road connects with other parts of the road network and the link with different land uses [10]. Therefore, the movement between the beginnings of the trips will be generated through arterial roads that distribute the main movement towards the job sites ending with a graded network of Local methods, reduce penetration axes and increase intersections that negatively and affect the flow of traffic.

The spread of the car in western countries caused a lot of problems. Therefore, since the fifties of the last century, the idea of broad boulevards began to accommodate the large numbers of cars and provide easy access and achieve a flow of traffic as well as to provide an appropriate environment for pedestrians from sidewalks and trees, to provide both types of transportation tasks. It is to achieve ease of access and provide service for land uses.

### 2.4. Progressive land use:

The neighbourhood unit is the basic nucleus of the city structure in Iraqi cities. According to the model (the neighbourhood unit - district - city sector), the smallest part of the city is the residential neighbourhood (the neighbourhood unit), which are the ideas of Clarence Perry in (1929)[11].

Clarence Perry wrote this theory as part of the New York City Regional Plan Report to guide urban development. The neighbourhood unit formula emerged due to Perry's interest and influence of the absence of improvements in social and urban settings where poor random housing, traffic congestion, deterioration, and social collapse were among the most important urban problems in America during the first quarter the twentieth century. He indicated the value of good quality urban design in promoting



good spirituality, creating a neighbourhood's personality, and creating a plan for an ideal neighbourhood [12].

After the neighbourhood in the hierarchy comes the residential district, which consists of 3 to 5 neighbourhoods, then the residential sector consists of 3 to 5 districts. The city includes a number of sectors.

Most land uses are graded with this hierarchy, so we notice that commercial use begins with simple uses that provide the neighbourhood's daily needs, leading to the largest commercial activities in the city centre, which are not practised in the rest of the city.

### 3. Kut city's Urban structure

#### 3.1. Preface

The urban structure of Kut city was greatly affected by the waterways that divide the city. The Tigris River divides the city into two parts, the southern and northern, which contain most administrative, commercial and service activities and contains the city centre, whether in the centre itself or the rest of the district's northern part [13]. This concept led to poor distribution of uses in a manner that is not appropriate for the population densities in the southern part. The city is divided into five sectors, the northern part of the city includes two sectors, and the southern part includes three sectors, as shown in figure (4).



**Figure 4:** Sectors of Kut city Ref: Researchers depending on the division of sectors in Kut Municipality

The industrial area is far from the city centre and is located towards the Kut- Amara axis, and includes non-polluting industries. However, many industries are still present inside the city, whether complementary industries related to the commercial area or industries that do business overrun in the centre, such as the blacksmithing and carpentry workshop in Al-Kass Street Mashro'u, Al- Abbasia and inside residential neighbourhoods.

There is a kind of traffic in the city within the city itself, and there is a second type of traffic between the city and its regional surroundings city[14]. However, public transport requirements were not

available when planning for the city in that period. The main streets are not ready for public transportation or anticipating the future to accommodate public transport.

Al-Zahra area was developed at the end of the sixties in a low-density pattern. The area of the plot reaches 600 square meters. These patterns spread in western countries and were applied in Iraqi cities without regard to the Iraqi city's specificity. The idea of boulevards contributing to an effective urban structure was not adopted, so we notice that its application in Iraq was only on a small scale. Kut city was not among these cities.

Kut city expanded significantly after 2003. This expansion had several reasons, the most important of which is the improvement in the economic situation and the increase in the number of cars. Both factors strongly affect the demand for land. The danger remains not in the large land area that has been exploited, but in the quality of that land, as most of the illegally exploited lands were fertile agricultural lands suitable for agriculture. It happens because Kut city's location is a branch of several rivers and the areas surrounding the city, all agricultural lands. It must be built without design and any legal action by the competent authorities. Excesses and violations are among the most dangerous measures that affect the sustainable urban development of the city.

There are two notes about the design and distribution of residential stores in Kut city, as shown in figure (5). The first note is not taking public transportation considerations into account when designing the neighbourhood unit. The goal is to provide an appropriate walking distance to the neighbourhood unit's centre and not to the public transport station.



**Figure 5:** The neighbourhoods of Kut City Ref: Directorate of Urban Planning of Wasit, 2008

The far part of the station or the public transportation route will have to walk twice the distance to the centre of the district; in other words, half of the neighbourhood unit area will be suitable for comfortable and possible walking.

Note that the neighbourhood unit is designed to prevent transit traffic through it, that is, there are no direct roads to public transport stations, which will increase the distance travelled by public transport passengers.

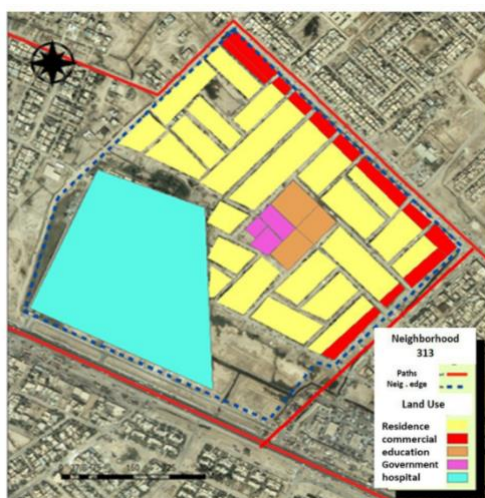
There are also doubts about the feasibility of locating the market in the centre of the neighbourhood to serve the population evenly, due to the ineffectiveness of the markets despite the construction of some of them by the municipality of Kut, which resulted from the lack of a population that cannot provide a threshold for an effective market. This matter may apply to other services that are planned to serve the neighbourhood. This problem can be solved by locating part of these services in the neighbourhood's vicinity instead of the centre. Modern technology represented by communications imposed its new principles in social and spatial interaction, which necessitates a reconsideration of a neighbourhood's concept.

According to its construction goal, the second note is that the neighbourhood unit was not applied as a case. There are no featured centres that contain a clear-cut centre and contain the necessary uses, or by gathering a few neighbourhoods, a functional, coherent residential neighbourhood can be created. To clarify this note, we took two models: Al-Rafai'i neighbourhood (No.313), and the second is the total neighbourhoods of Al-Jihad district.

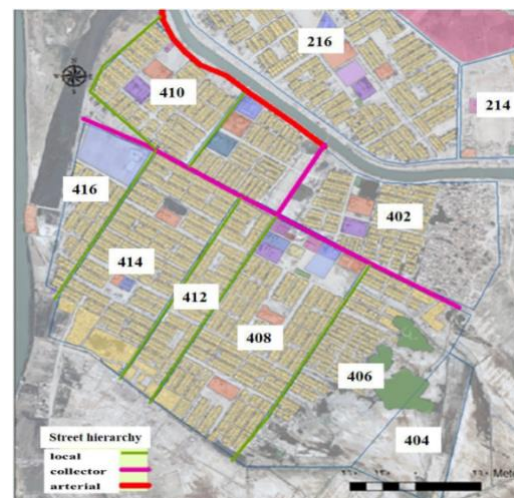
Figure (6) of Al-Rafai'I neighbourhood ( No. 313) noticed no distinct centre containing an elementary school and a group of shops that meet daily needs. It is noticeable that the commercial function spread abroad, along the main movement axis. The neighbouring centre included the educational position and three directorates of the Ministry of Interior (serving each province of Wasit). The centre also lacks green areas in the sense that there is no privacy for the neighbourhood.

Therefore, the neighbourhood should not be used firmly or recognized. Still, it can be adopted to guide the population's basic needs and provide the conditions for sustainable urban development. The term neighbourhood is non-specific and flexible, and it can take a wide range of shapes, density, and measures [15]. The neighbourhood does not resemble an existing isolated cell with its nucleus (the neighbourhood's centre). Instead, it is more like an overlapping network of places and common uses. It does not necessarily have simple bounds or a single centre [16].

The other model is the Al-Jihad district, which contains a neighbourhood group, as in figure (7). There is no distinct district centre that contains a commercial centre and service departments, and the rest of the uses according to the criteria. Rather, commercial activities are located on the movement hubs between the neighbourhoods. A part of them shares public transport lines, both of which are located on local streets with limited width and are not designed for such activities. The neighbourhoods' shapes are not compatible with the job required to achieve them, such as neighbourhood (No. 412) longitudinal and does not contain anything other than residential uses.



**Figure 6:** neighbourhood of Al-Rafii 313 Ref.:  
The researcher relying on urban planning data



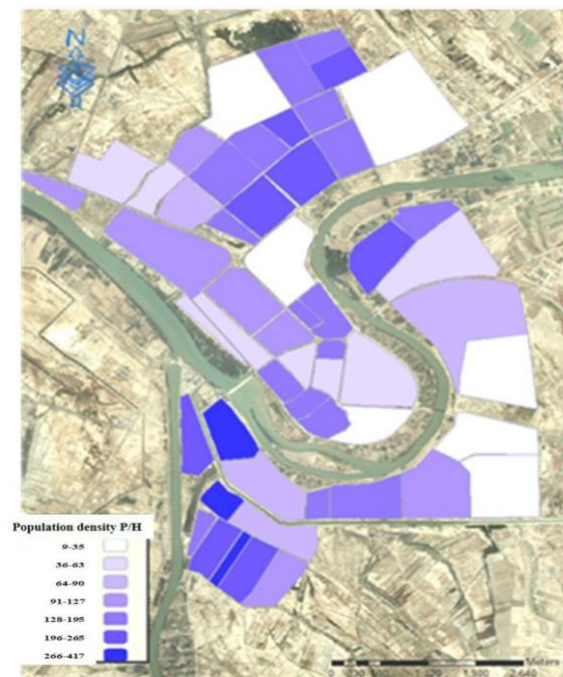
**Figure 7:** the neighbourhood of jihad Ref.:  
the researcher relying on urban planning data



### 3.2. Distribution of densities for Kut city.

It is the average density of the population divided by the area of the built-up area and an individual per unit area of land. It is one of the factors that give any site in the urban area its value, and these factors mean in return other dimensions of the density of the urban structure. And the value of the site means the degree of desire to take that site. When the desire for a certain location increases, the vertical construction is resorted to, increasing the building density. The human factor includes the density of the population among the city's neighbourhoods and the importance of services is measured by its ability to meet the needs of the population with the least effort and cost[17].

Figure (8) shows the population densities of Kut city that are not subject to a specific pattern. The higher densities are located on the outskirts (Al-Karamah and Al- Jihad) districts and are from the districts with the lowest income as we will see later. The medium densities are located in the city centre and the north-eastern and southern sides.



**Figure 8** population density for each locality of Kut city. Ref: Wasit Urban Planning Directorate

While the northern outskirts with separate districts in the east and south contain the lower densities, a prominent feature of the population distribution is the lack of a clear hierarchy. A single-centred city prefers that the higher densities be in the center and decrease toward the edges, which is a negative indication of its structure. Studies have found that the increase in the city centre's distance is accompanied by increased car trips and their length, thus increasing fuel consumption [18].

### 3.3. Hierarchy of the road network in Kut

Figure (9) shows the hierarchy of the road network in Kut city. We notice an imbalance in the hierarchy and the lack of correlation (highways and arterial roads) with the city centre. A good structure assumes that roads' highest rank is connected to the city centre and have the lowest rank on the outskirts.

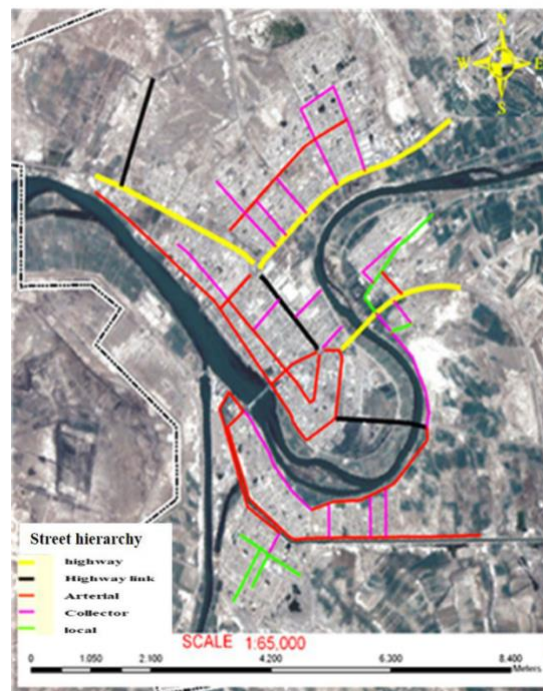


Figure (9) Hierarchy of the road network in Kut city. Ref: Wasit Urban Planning Directorate

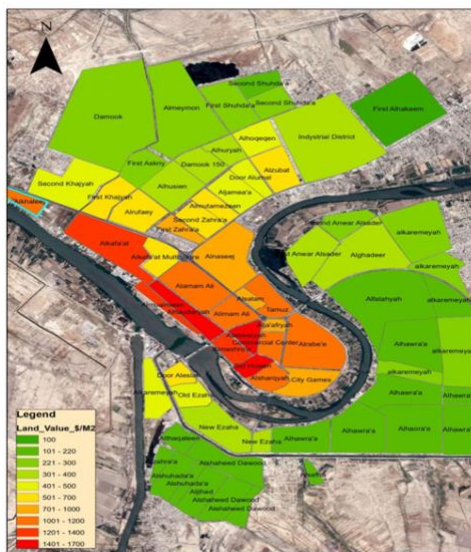
### 3.4. Spatial distribution of land prices

Land markets contribute to building the city's shape, so the differences in land prices can explain the direction of the future development of the shape of the city's spatial structure. Also, high land prices indicate a high level of demand, and therefore, in the long run, there will be pressure for higher densities [19], thus leading to more activities and movement move up.

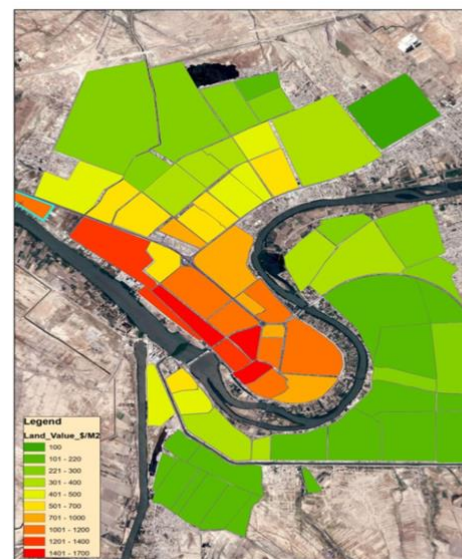
The higher price is often associated with the city centre, which is a positive indication of the city's structure because it leads to high demand for transportation to the city centre and shorter trips and efficient infrastructure services. Hence, as a general rule, land price decreases as we move away from the city centre towards the parties except for overlooking lands on the main streets, especially commercial ones, where they have relative accessibility. The commercial and financial job occupies the most expensive land and high-rented buildings, as businesses and individuals make a trade-off between transport costs and land costs [20].

Through figures 10 and 11, which show the spatial distribution of land prices for Kut city, we notice that the distribution of land prices in Kut city is not ideal, as the prices of the northern part are higher than the prices of the southern part, and that the prices of the center are the highest in the city and push the high prices towards the north towards districts Imam Ali and Al-Kafa'at, according to the interpretation of the sectors theory, and the city center can expand towards these districts, because the high prices are an indication of the high densities in the future and thus a larger transport movement that does not fit with the hierarchy of roads and thus will cause major problems for the urban structure in the future.

The spatial distribution of land prices indicates the income level in the city. Thus, it shows the extent of division or harmony in the city. The spatial distribution of land prices in Kut city shows the Tigris River divided the city socially into poor regions in the south and areas with higher incomes in the north, meaning a division city. This concept is a negative indication of the city's structure.



**Figure 10:** spatial distribution of land prices in 2012  
Ref: The researcher relying on the field survey



**Figure 11:** spatial distribution of land prices in 2012. Ref: The researcher relying on the field survey

#### 4. Conclusions

Through studying the spatial structure of Kut city, which was included in this topic, it was found that the urban spatial structure is not efficient. There are many faults, as the city spreads over a large area. The distribution of unorganized population densities and the most densities are far from the centre, which leads to the length and randomness of trips and irregularity in them.

The traffic problems in the city are exacerbated by the lack of a hierarchy of roads. As well as the poor connectivity between the parts of the city due to the spread of the city between, the two banks of the river, this has led to the formation of an urban environment that does not encourage the use of non-motorized transportation, and our cities are not designed for pedestrians or cycling. Still, many obstacles cause danger or discomfort, and lack of feeling comfortable or enjoying walking (aesthetic aspect).

The city also lacks a hierarchy of land uses. There is no precise planning for the residential neighbourhood or district according to the current planning standards. There is also social isolation between the two banks of the river and an imbalance in the distribution of services in the northern part, which is where the highest-income population lives.

The current urban development patterns (city expansion) in the Iraqi city are not the result of population growth alone, and therefore they are not inevitable. The horizontal expansion process and leaving many areas empty and zoning depends on the separation of uses must be changed time and adopt the vertical expansion, and mixed land uses.

#### 5. Recommendations

So research recommends

- The necessity of utilizing vacant lands within the city and increasing the density of some areas to encourage public transport on the one hand, and to create interaction by providing services and job opportunities to reduce traffic congestion in crowded areas such as the city centre on the other hand.
- To reduce the city's growth towards the north, make it in other directions, provide appropriate conditions for public transport work, and achieve interaction between activities.

- We are increasing the link between the parts of the city by constructing additional bridges between the two banks of the river, addressing the city's roads' hierarchy, and establishing a suitable road network for public transport.
- As for the level of neighbourhood planning, planning standards should be adopted by providing activities that support the neighbourhood's existence, whether at the planning level or the level of implementation and focus on the less-income areas as they suffer more deprivation.

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