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Human activities and their impact on the city's climate (Hillah city as a model)

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Abstract
The research aims to identify the mutual relationship between climatic characteristics and human activities, as it is clear from the data obtained that the mutual influence between them clearly affected the drawing of the climate map of the study area. The researcher relied on identifying the mutual influence through the data obtained from the relevant departments and analyzing them statistically. Among the results he reached is that the type and density of urban uses clearly affected the nature of the climatic characteristics, which in turn clearly affected the movement and activity of the population within the city.

Keywords: Urban uses, climatic characteristics, linear relationship

Research problem
What is the nature of the mutual relationship between each of the climatic characteristics and human activities?

Research hypothesis
The mutual influence between climate and human activities clearly shows the dialectical relationship between them, as the clear effect of climatic characteristics on human activities appears, and of course those activities draw a detailed climate within the region.

Study area
The study area is the city of Hillah, located at a point where latitude (29° and 32°) north intersects with longitude (26° 44°) east.
The city represents the administrative center of Babylon Governorate. Map (1).

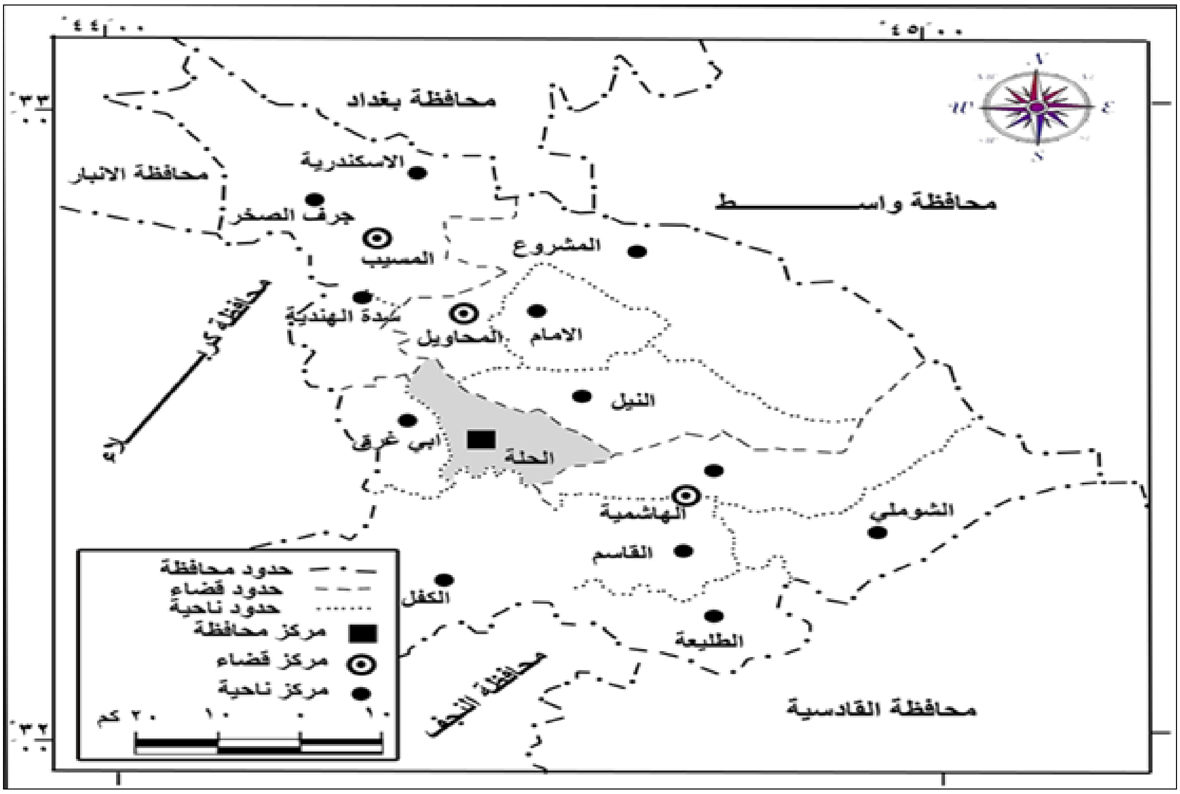
Introduction
Some climate research is interested in studying the relationship between climate and humans, as climate and humans are interconnected and each affects the other, as climate affects all activities carried out by humans, and humans intentionally or unintentionally change the climate of their environment as a result of their activities and continuous attempts to benefit from available resources. If deforestation and canal digging operations changed the regional climate conditions, then every residence, factory and building in the city changes the climate not only inside it but also outside its walls. Once the city grows and its height expands and its population increases, it creates for itself a type of local climate of its own that arises from the nature of life in it and is known as the city climate or urban climate, as it is known that cities form their climates, especially after this great growth in urbanization, industry, transportation and communications that occurred in the second half of the twentieth century.
In general, the variation in the distribution of population density, buildings, industrial facilities, and the industrial heat emitted from concrete blocks, bricks, and reinforced concrete walls of those buildings and facilities, air conditioning units, cars, railways, and asphalt in the streets, and the resulting variation in the albedo ratio, which decreases with increasing land use and increases in open spaces. All this leads to variations in climate characteristics between one region and another within the urban extension of the city on the one hand, and between the inner urban area of the city and its marginal outer areas on the other hand. Temperature is the most important climatic element affected by the geographical situation and functional structure of the city,

so this chapter aims to study the factors that can affect the city's temperature.

First: Population density

Population density is one of the factors affecting the city's temperature. It is a product of the relationship between area and population. This means that the increase in population density is the increase in the density of human activity within the populated area, which in turn leads to an increase in energy consumption through the increase in the number of cars, shops, service workshops and other forms of human activity, and with the difference in the distribution of population density across the city, the temperature varies from one place to another within the city. The effect of the increase in population density on the city's temperature is not limited to the amount of heat added to its atmosphere from various human activities only, but rather extends to the amount of thermal energy generated by his body that he exchanges from the external environment in which he lives, either in the form of sensible heat through the processes of (convection, conduction and radiation) or in the form of latent heat through visible and invisible evaporation. This heat added from the human body to the city's atmosphere is not at the same rate throughout the day, as this heat is directly proportional to the movement of the human being, see Figure (1). Figure (1) the linear relationship between human movement and the amount of heat energy lost from his body by radiation, convection and respiration

Source: General Authority for Survey, location of Hillah city in relation to Babil Governorate, scale 1: 50,000.



Source: General Authority for Survey, Location of Hillah City in relation to Babylon Governorate, Scale 1:50,000.

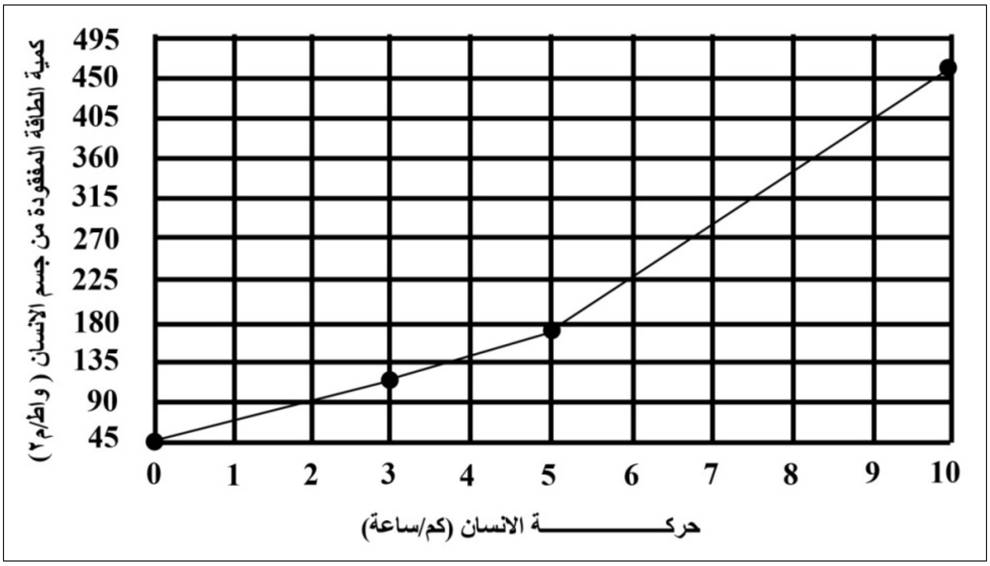
Map 1 Location of Hillah city in relation to Babylon Governorate

Introduction

In general, the variation in the distribution of population density, buildings and industrial facilities, and the artificial heat emitted from concrete blocks, bricks, and reinforced concrete walls of those buildings and facilities, air conditioning units, cars, railways and asphalt in the streets, and the resulting variation in the albedo ratio, which decreases with increased land use and increases in open spaces.

All this leads to variations in climate characteristics between one region and another within the urban extension of the city on the one hand, and between the inner urban area of the city and its marginal outer areas on the other hand. Temperature is the most important climatic element that is affected by the geographical situation and functional structure of the city, so this chapter aims to study the factors that can affect the temperature of the city. First: Population density Population density is one of the factors affecting the temperature of the city. It is a product of the relationship between area and population. This means that the increase in population density is the increase in the density of human activity within the populated area, which in turn leads to increased energy consumption through the increase in the number of cars, shops, service workshops and other forms of human activity. Depending on the distribution of population density across the city, the temperature varies from one place to another within the city. The effect of increased population density on the city's temperature is not limited to the amount of heat added to its atmosphere from various human activities only.

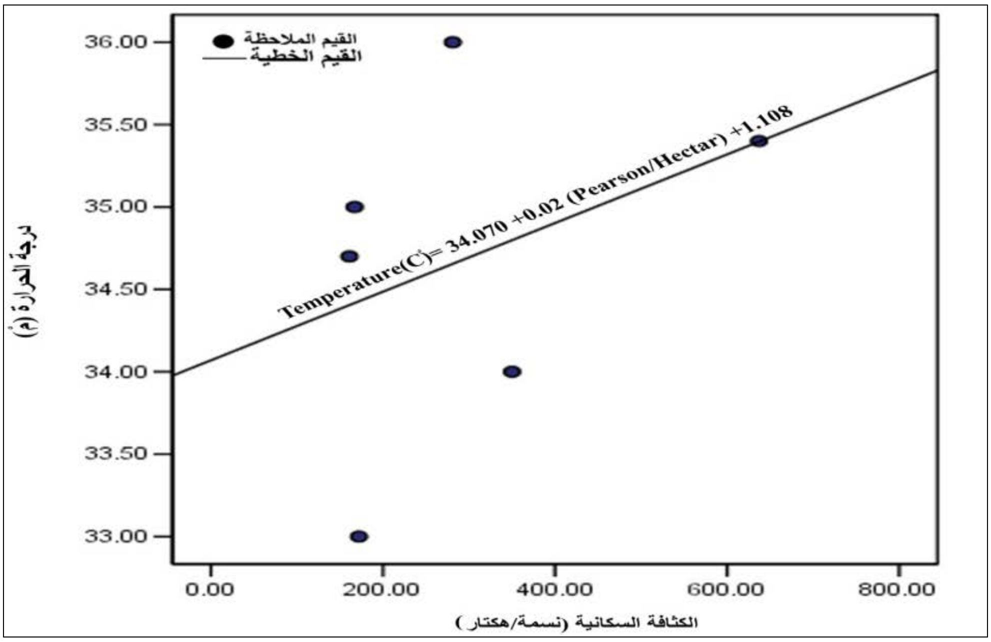
Rather, it extends to the amount of thermal energy generated by his body that he exchanges with the external environment in which he lives, either in the form of sensible heat through the processes of (convection, conduction and radiation) or in the form of latent heat through visible and invisible evaporation. This heat added from the human body to the city's atmosphere is not at a single rate throughout the day, as this heat is directly proportional to the human movement.



Source: Hussein Ali Abdul Hussein Al-Abadi, the Thermal Island of Diwaniyah City, Master's Thesis, College of Arts, University of Al-Qadisiyah, 2001, p. 101.

Fig 1 The linear relationship between human movement and the amount of thermal energy lost from his body through radiation, convection and breathing

At dawn, there is a relative activity of movement within the residential units, while the movement of the population increases during the morning and evening, and therefore the variation of the population density shown, and the variation of the thermal energy lost by humans during the day on the other hand, had a clear effect on the variation of temperature, and this is what the result of the correlation coefficient indicated. The correlation coefficient reached (0.87). This was clearly reflected in the degree of slope of the regression line in representing the relationship between population density and temperature. See Figure (2)

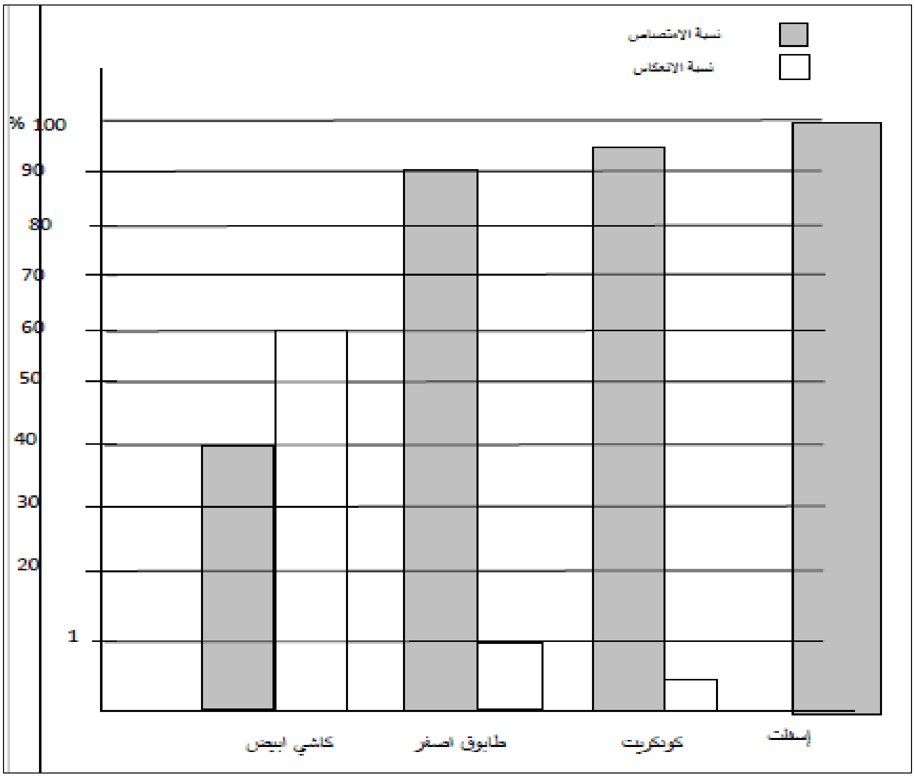


Source: Researcher's work based on

Fig 2: Regression line of population density with temperature

Second: Building density

It is natural that the distribution of residential building density agrees with the distribution of population density, and each of them is a variable that affects the distribution of temperature in the city. The high density of buildings means an increase in the heat emitted by those stone blocks that they acquired during the period of sunshine, which in turn leads to an increase in the temperature of the surrounding air. The integrated residential city block represents a strong intervention in the local climate conditions by releasing warmth or heat around it in what is known as the heat island. The color and type of concrete surfaces and other building materials have a clear effect on increasing the amount of thermal energy stored and the transfer of that energy by (radiation, convection and conduction) in a manner that exceeds what is the case in the green and barren areas adjacent to the area occupied by construction. During the day, they absorb most of the solar rays falling on the roofs of buildings in general and residential ones in particular, and their roofs store that energy. At night, the buildings lose most of their thermal energy, making the air layer in contact with them have a higher temperature than is the case in the neighboring green areas. It is worth mentioning that residential use occupies the first place among land uses in the city, as it reached in (1977) about (375) hectares and a percentage of (33.3%), and in (1981) it rose to reach (500) hectares and became a percentage of (38.9%), and in (1984) it reached (830) hectares and a percentage of (48.3%), while in (1997) its area reached (1850.48) hectares. And became a percentage of (44.9%). Naturally, residential use grows as an inevitable response to the development of other functions undertaken by the city, and the extent of its development depends on the amount of development affecting urban activities. This use is distributed in most parts of the city, which gives it different patterns of residential roles within the urban area. The increase in the absorption capacity of the surfaces of these residential buildings or buildings for the thermal energy transmitted by solar radiation is in fact an inevitable result of the decrease in the reflectivity (albedo) of most building surfaces, see Figure (3). This leads to an increase in the amount of stored energy, then an increase in the amount of thermal energy transmitted by radiation and convection from surfaces covered with a layer of cement, and an increase in the amount of thermal energy transmitted by conduction through them in a way that exceeds the reality of heat transfer to the rest of the surfaces within the urban environment of the city. This in turn leads to an increase in the temperature of the air in contact with residential buildings in a way that exceeds the temperature of the neighboring surfaces that differ in their response to thermal gain, especially (green use).

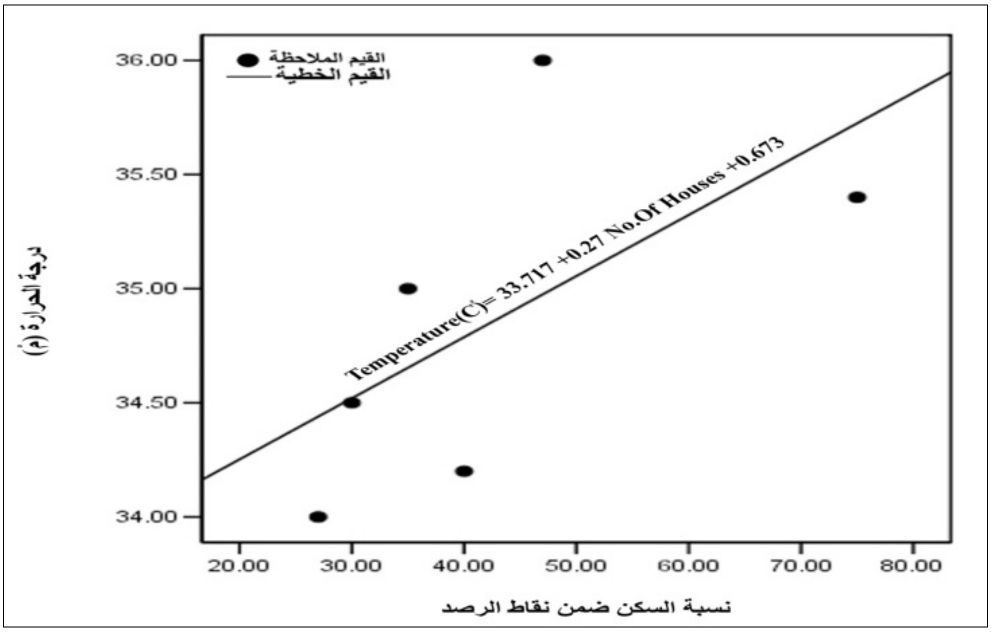


Source: Hussein Ali Abdul Hussein Al-Abadi, The Thermal Island of the City of Diwaniyah, Master's Thesis, College of Arts, Al-Qadisiyah University, 2001, p. 74.

Fig 3: Variation of the ratio of reflection (albedo) and absorption on different surfaces within the urban environment

Therefore, the reflectivity of any object is one of the important indicators affecting the thermal properties of that object and then the air in contact with it. This is due to the existence of this inverse relationship between the ability of the surfaces of objects to reflect radiation and the heat emission of those surfaces. Because the increase in the process of reflecting incident rays means an increase in the rebound of some solar radiation waves as soon as they reach the surface of objects without leaving a thermal effect on them. This is what was indicated by the correlation result that was applied to the data of the third axis as it is the best axis in clarifying the variation in housing density from the city center to the outskirts. The correlation coefficient reached (0.86), which clearly explains to us the nature of the strong relationship between the independent variable and the dependent variable, which was reflected in the regression line in representing the relationship between housing density and temperature, see Figure (4).

Based on the above, controlling sunlight in buildings is one of the most important factors affecting the thermal structure of buildings, especially in hot, dry areas as is the case in the study area. Solar radiation affects buildings in two ways.



Source: Researcher's work based on field observation.

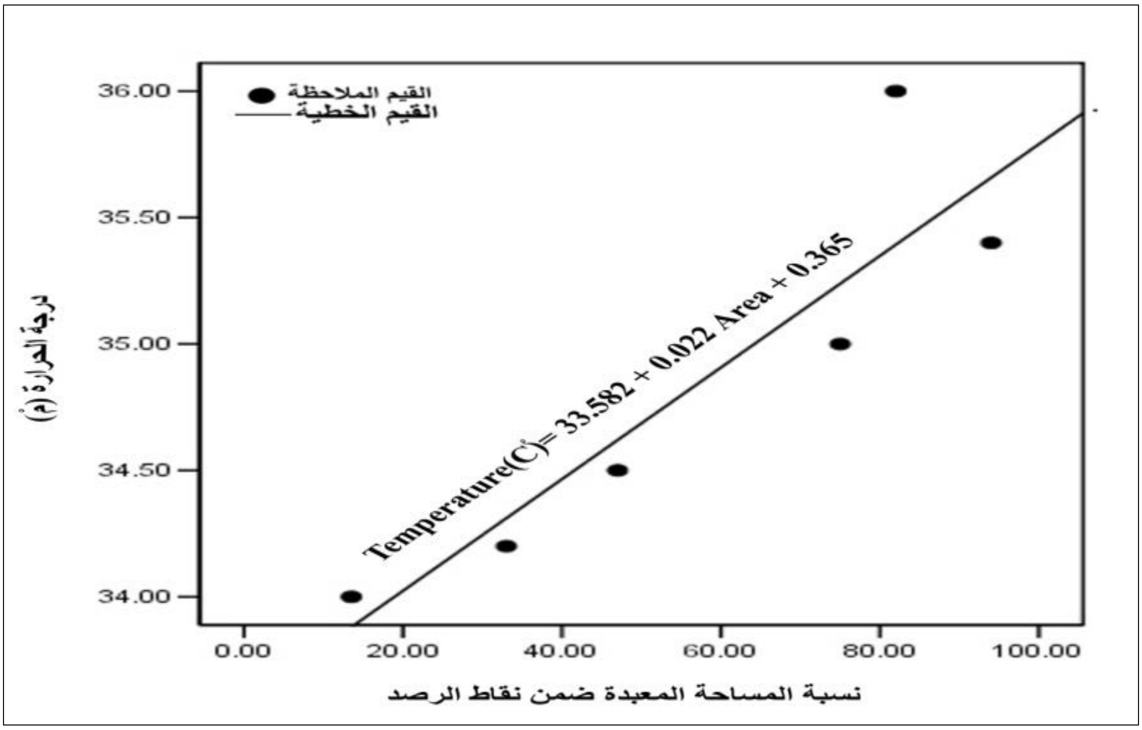
Fig 4: Regression line of housing density with temperature

First: Through its entry into windows and its absorption by the interior surfaces of buildings, raising its temperature.

The second: It is absorbed by the walls and external surfaces of the building, causing the temperature of those walls and surfaces to increase and penetrate to their internal surfaces, then radiate into the building, causing its temperature to rise. Naturally, this is undesirable in hot, dry areas in the summer because it reduces human comfort inside the building, which requires the use of various cooling methods, and the high cost of establishment and operation that accompanies them. At present, as a result of modern technological development and the rapid change in values and concepts, planning and design considerations have become numerous and dealing with them comprehensively as it was in the past has become a difficult process. Therefore, climatic considerations have not received clear attention in the planning and design processes of buildings and have become of secondary importance. Planning and design foundations have been borrowed from countries with climatic conditions that differ from our climate conditions, and buildings have subsequently been unable to limit the negative effects of climatic conditions or respond to the positive effects in them. Mechanical methods have also been relied upon to create an environment inside buildings that is balanced with the requirements of human thermal comfort, and mechanical intervention has become the basis for climatic treatments. This has led to the neglect of The importance of climatic elements in planning and designing buildings and taking advantage of natural methods to control them, which created an extreme state of contradiction between new variables and the local environment, especially climate. Therefore, we must take advantage of the wise architectural solutions of previous generations in planning buildings, especially residential ones. Ancient architecture represents a natural development of human experience and knowledge of the prevailing climatic conditions and then his attempt to overcome them and adapt them to his advantage. It is also original architecture because it is a faithful reflection of the social, economic, religious and climatic conditions, local materials and local construction methods known at the time and any other influential factors. We are not required to build a copy of traditional architecture, but we must make an accurate evaluation of it and understand what is appropriate for our climatic environment and try to develop it to suit the present with the variables presented to us with modern science and the global technological revolution.

Third: Paved roads

The percentage of land occupied by transportation services varies from one city to another. Bartholomew estimated it at about (18%) of the total area of the city, including railways and train stations, but in general it was found that the share increases as the city expands and its size increases. The urban expansion witnessed by the city of Hillah had a major impact on increasing the number and areas of internal streets, and the ring roads that were established to isolate transit traffic from entering the city and connected to the internal streets in the city had an impact on the development of this percentage. The area of land allocated for transportation has developed over the stages of the city's development. It reached about (450) hectares, at a rate of (40%) in (1977) of the city's area, and in (1981) this use occupied an area of (460) hectares, at a rate of (29.1%), until it reached an area of (660) hectares in (2001) at a rate of (14.3%). The wide asphalt paved streets in cities with hot dry climates, including Hillah, are a negative factor in their climates, especially if we know that the percentage of radiation absorbed by asphalt surfaces is high, reaching an average of (95%) for all solar radiation waves. Which in turn leads to an increase in the amount of energy acquired and stored. It is worth taking into consideration the fact that asphalt surfaces absorb light waves (visible), and part of infrared thermal waves. Because the absorption rate is an indicator of the amount of thermal energy acquired, stored and transferred by heat transfer methods, we notice that the asphalt surfaces absorb light and infrared waves at a rate of (93%). Which in turn is reflected in the increase in the emissivity rate due to the dark color, and the increase in the amount of thermal energy transferred by ground radiation to the air in contact with those surfaces and their continued emission of heat compared to other surfaces within the study area. As for the direction and width of the streets, the direction (north-south) prevails in most of the streets of the world's cities in temperate and cold regions, so that the facades of buildings and the roofs of the city receive the largest amount of solar radiation, and the amount increases as the street increases in width. However, if the streets of these cities extend in an (east-west) direction, then they are not preferred because they receive less solar radiation or do not receive it compared to the side facing south, so it becomes less attractive in choice. While we see the opposite in the lower hot latitudes, the shade on the side facing north in the northern hemisphere provides climatic comfort and is preferred in choice. As for the width of the street, it narrows so that the facades of buildings and the roofs of the city protect the sidewalks of pedestrians from solar radiation, but this situation is not achieved in most of the streets of Hillah. We find that most of the streets extend in a (north-south) direction, which makes the opportunity for their exposure to large and direct solar radiation greater, which contributes to raising the temperature of the city. As a result of the conditions achieved for most of the streets of Hillah city, the result of the correlation coefficient between the percentage of paved area and the difference in temperature was strong, as the correlation coefficient reached (0.78). This was reflected in the regression line in representing the relationship between paved area and temperature, see Figure (5).

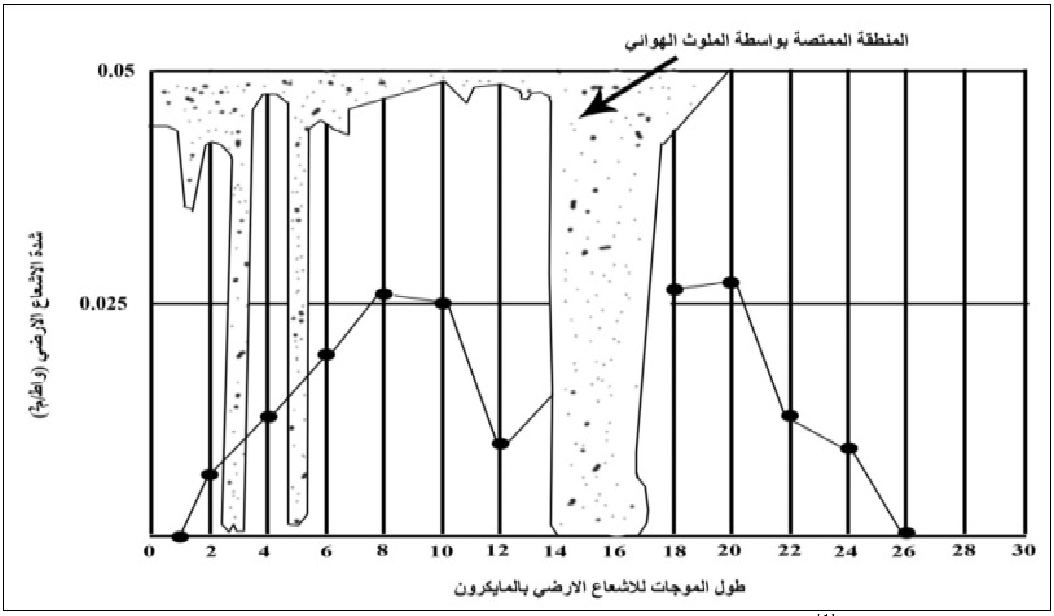


Source: Researcher's work based on field observation

Fig 5: Regression line of the percentage of paved area with temperature

Fourth: Commercial use

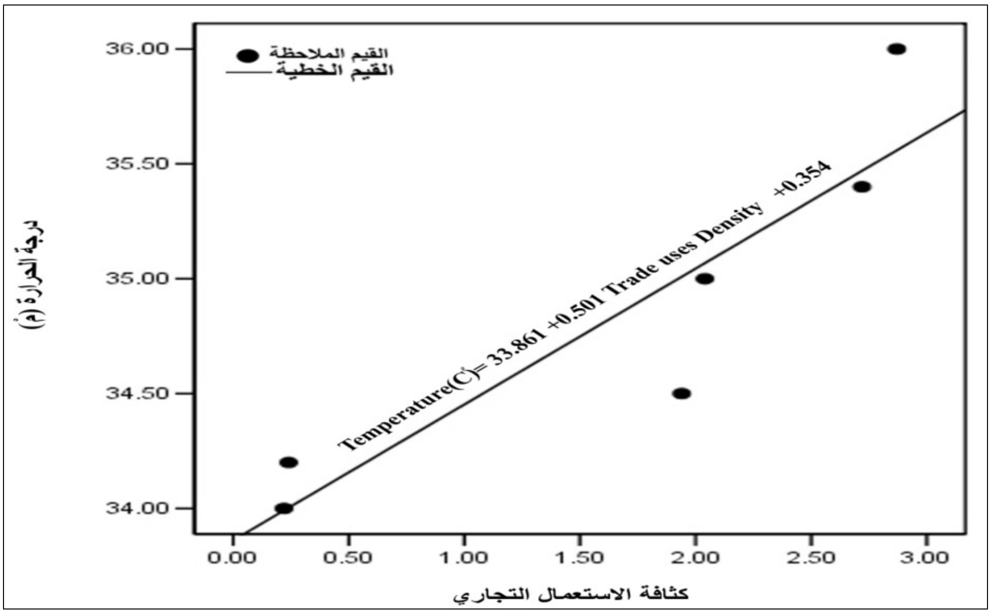
Commercial use is one of the important uses in the city, and this function expresses its importance not only in the percentage of open or built-up land it occupies and its effect on the radiation balance, then the thermal balance. This leads to raising the temperature of the air in contact with it. In this, it does not differ from the heat added by residential use. Rather, this importance is reflected in its indirect effect in raising the air temperature, through this use acquiring the highest traffic density in the city (pedestrians and cars), which leads to an increase in the percentage of heat-trapping pollutants transmitted by convection. Hydrocarbon materials increase according to the increase in traffic density and vice versa. Which leads to raising the air temperature? This is because the radiation balance is affected by the degree of air purity. This balance is responsible for the reality of the temperature. See Figure (6). This is naturally a result of the physical nature of the trapping gases that affect the amount of thermal energy transmitted by convection from the Earth's surface. Which leads to the emergence of a new local thermal path? It is worth mentioning that the area occupied by commercial use in the city of Hillah expanded to reach (30) hectares in 1977, which was (2.6%) of the total area of the city, and increased to become (35) hectares, or (2.7%). It continued in this manner until it became (103.75) hectares in 2001, or (2.25%). Naturally, there is a strong relationship between the realities of Figure (6) Terrestrial radiation waves absorbed by (CO_2) gas in the urban environment



Source: Karim Dragh Mohammed, Modern Trends in the Climate of Iraq between (1941-1980) [1], Master's Thesis, College of Arts, University of Baghdad, 1981, p. 30.

Fig 6 Terrestrial radiation waves absorbed by (CO_2) gas in the urban environment

Traffic density and concentration and expansion of commercial use, which was reflected in the nature of the relationship of the correlation coefficient between temperature and commercial use density that was applied to the axis of the Nader neighborhood, which represents the best axes in terms of the gradation in commercial use density starting from the center and reaching the outskirts of the city, as the result of the correlation coefficient reached (0.84). Which in turn affected the nature of the slope of the regression line in representing the relationship between temperature and commercial use density, see Figure (7).



Source: Researcher's work based on field monitoring

Fig 7: Regression line for commercial use density with temperature

Fifth: Industrial use

Industry is the distinguishing feature of most cities, which gives the city air additional pollution, and makes urban areas a major source of pollutants. Naturally, the percentage of pollution in the city air is much higher than in neighboring areas. Factories lead to loading the city air with solid, liquid and gaseous materials, and (80%) of small solid pollutants can remain suspended in the city air if the air is still. These solid materials lead, on the one hand, to reducing solar radiation reaching the city's land, but at the same time they work to reduce terrestrial radiation escaping into space from the city's land. A high percentage of liquid materials consists of water vapor, which has the ability to absorb long-wave terrestrial radiation, thus helping to reduce the percentage of terrestrial radiation leaking into space from the city's land. Since the process of burning fuel always releases a high percentage of carbon dioxide, the high percentage of this gas in the air leads to an increase in temperature through its ability to absorb terrestrial radiation, as it works with water vapor like greenhouses in raising the temperature. And the process of reducing the leakage of terrestrial rays will balance and sometimes overcome the blocking of part of the solar rays reaching the city's land, which consequently leads to an increase in the temperature of industrial areas compared to neighboring areas. It is worth noting that the industrial function in the city of Hillah witnessed a remarkable development throughout its development stages, as the area of industrial use in the city in (1977) reached about (110) hectares and a percentage of (9.7%) of its area, then it became in (1981) (120) hectares and a percentage of (9.3%) until it reached (135) hectares in (1984) and a percentage of (7.9%). In (1997) it reached (597.79) hectares and its percentage increased to reach (14.5%).

In the year (2001) it reached (647) hectares and a percentage of (14.5%). Industrial use in the city is spread in the form of patterns represented by:

The first: in the central area which includes the industrial units located in the central business district (C.B.D). These sites include simple industries that require only small areas of land, such as goldsmiths, saddlery, blacksmithing and tailoring shops.

The second: is represented by the central sites and represents the areas surrounding the central business district and is represented by containing various industries and it combines small and medium-sized units, and includes trade and blacksmith workshops, ovens and mills.

The third: It is represented by the suburban sites, as industrial clusters are distributed in the urban outskirts of the city. This area is represented by the industrial district, as it includes a large number of large industrial establishments, including textile, blacksmith, trade, grain milling, soft drinks and sweets factories, molasses factories, car repair services, and other industries. This has clearly contributed to the increase in air temperature as a result of the increase in the amount of thermal energy generated by the factories and plants located within the spatial area in which they are located, and this is what the results of field monitoring of the temperature have proven. The density of industrial activity in the industrial area (Nader 3 district) has contributed significantly to the emergence of a secondary heat island despite the location of these industries, which is located near the city suburb. This clearly proves the relationship between the density of industrial use and temperature.

Sixth: Green Areas

Green Areas represent a natural environment that occupies the largest part of the open space designated for recreational purposes within the city. This concept has been defined in many ways, including:

The researchers (Hubbard and Kimb) defined green areas as open spaces within the urban framework, aiming to connect the individual with nature and improve the general surrounding conditions.

As for (G. Eckbo), he defined them as the component part of the natural city landscape (City land: cape) that humans developed and coordinated outside the scope of buildings and residential neighborhoods to be close to the natural environment. They were also defined as open urban spaces that people use to practice outdoor activities.

The company (Ball Service) defined green areas as garden shapes that separate the main streets and those located near them, such as those found in service departments and centers, nurseries, orchards, and tree planting areas.

The Directorate of Planning and General Engineering has defined green areas as gardens and parks of various sizes, such as factory gardens, schools, kindergartens, home gardens, zoos, and sports complexes. And green spaces with a protective character such as protective strips surrounding industrial areas or along streets. No matter how different these definitions are in determining the concept of green areas, they all confirm that green areas are open spaces and a form of garden coordination that contain the elements that make up the natural landscape and complement the internal spaces of residential neighborhoods, aiming to meet human needs and benefit from them inside and outside the city through their multiple functional effects, including:

1. Climatic function
2. Environmental function
3. Aesthetic function
4. Recreational function
5. Production function

Regarding the climatic function related to the research, (V. Olgyay) confirmed that plants are one of the most important means that can be used in public urban spaces to treat climatic conditions that fall outside the scope of thermal comfort and, as a result, create a suitable detailed urban climate.

(C. Philip) also emphasized the efficiency of green areas, especially trees, in controlling climate elements through their positive effects on those elements. And creating a more moderate local climate in terms of temperature, humidity and wind speed. Of course, climatic conditions vary from one plant surface to another depending on the type, density and height of the plant cover. Not only that, but the climate differs within the area in which it grows for tall trees, so that the levels close to the soil surface are climatically different from the middle parts of the plant area and the upper parts, as well as the plant crown area. This is all reflected in the climate of the atmosphere close to the top of the plant cover (crown area). The plant cover plays an effective role in weakening and attenuating solar radiation. The process of weakening and attenuation is done by cutting off green plants, especially trees, from the path of solar rays, as they block a different amount of solar radiation falling on them according to the density of their leaves, the size of their shadow and their reflectivity. As radiation decreases by (86%) in green areas compared to barren areas. In general, the plant absorbs the largest part of the solar radiation falling on it and consumes it in the process of photosynthesis and transpiration, while the remaining part is exchanged with the contacting air, causing a slight increase in its temperature. In order for green areas to perform the climatic function with a high degree of efficiency and create a more moderate local climate in terms of temperature, humidity and wind speed, they must be determined and organized according to specific planning standards and measures in order to reach a specific goal, which is to create a suitable and comfortable urban environment. This goal cannot be achieved unless the following indicators are taken into consideration when setting these standards:

Natural and geographical conditions: including

1. Climate
2. Topography

Social conditions: including

1. Population
2. Civilization level

Economic conditions

The technological level of the country and the available technical capabilities

What concerns us in this is the planning standards on the basis of which the spatial requirements for green areas in the city are determined. Among the most important of these standards are the spatial standards through which the actual need for green areas within the city is estimated, as the actual need for green areas varies from one country to another and from one region to another due to the influence of the factors mentioned above. The need for them differs in cold areas than in hot areas, as well as in the humid climate facilitates the process of afforestation compared to dry areas. In Iraqi cities, including the city of Hillah, the actual need for green areas is calculated in light of the spatial measurements (0.4) m2 of green areas for every (1) m2 of the built-up area in the city. This means that (40%) of the city's area must be prepared as green areas. According to this ratio, the area of the city of Hillah, which is (2635.9) hectares, must include (1054.3) hectares of green areas. However, the actual reality of green areas within the city reveals otherwise, as the actually implemented area reached (441.94) hectares. This means that there is a deficit in the area of green areas.

Conclusion

The city represents a mass of multiple uses whose impact varies in creating a spatial variation in the amount of thermal energy reflected from the surfaces of those uses compared to the city region, which is reflected in the climatic elements, as the city records a difference in temperature and rainfall from its rural suburbs, as well as a difference in air humidity and wind flow. Naturally, climate and humans are intertwined, each affecting the other. Humans change the climate of their environment as a result of their activities and their continuous attempts to benefit from available resources. The nature of urban life within the city and its human activity leads to the disappearance of natural features of soil and natural plants, and the spread of human-made features that increase rapidly with the development of life. The city's climate came as a result of the relationship between human activity and the buildings they build and the roads they pave, in addition to other uses within the city, and the lack of exposed soil areas and natural and agricultural plants or their disappearance and lack of interest in them plays a major role in absorbing solar radiation and producing thermal energy and emitting it again within the city. Most of the city's streets are (north-south), which in turn contributed to obtaining the least amount of shade, which makes the opportunity to be exposed to sunlight greater, and thus increases the radiation emitted from those surfaces. Green spaces work to moderate the temperature inside the city, but the city in general suffers from a deficit and lack of green spaces, which were estimated at (611.3) hectares, and despite their scarcity, they suffer from continuous violations and the accumulation of waste in them. As for (Shatt Al-Hillah) and its role in reducing the temperature inside the city, despite its penetration into the city, its effect in adjusting its temperature is slight, especially in its central areas, despite the short distance separating the central area and the river, which was estimated at (100 m). This is due to the presence of tall buildings that extend along both banks of the river, especially on the right side. Here, the urban planner must have the final say in preventing the expansion of the heat island in the city, by increasing the percentage of green spaces in the city, especially in areas that suffer from a lack of green spaces, represented by the central area, in addition to areas that are centers of heat islands, represented by the intersection of the association and the industrial area located in the south of the city. This is in addition to exploiting empty spaces and converting them into parks and gardens and reducing the paved areas within the city, represented by the median islands, and trying to plant trees in them, and also finding a design model for buildings that is compatible with the prevailing climate in the city and not relying on imported planning models that are not compatible with the prevailing climate in the city. Also, taking into account the direction of urban expansion within the city in order to consider the possibility of modifying the direction of the streets in a way that can provide a greater amount of shade within the streets and reduce the area exposed to direct solar radiation, thus reducing the amount of absorbed solar radiation, which leads to a decrease in the emission of thermal energy stored by those streets, in addition to granting the Hillah Municipality appropriate powers in decision-making, which is represented by enacting laws and legislation that oblige city residents not to encroach on areas designated for green spaces. Also, allocating a portion of the plots distributed to citizens as green areas or so-called home gardens, such as (25%) of those plots, in order to contribute to moderating the local climate of the city, in addition to the contribution of the Hillah Meteorology Station in increasing the number of climate stations inside and outside the city that measure climate elements at their actual degrees in different parts of the city, in order to develop the necessary plans to reduce the negative impact that the city's climate can have on its residents. Different uses vary in their contribution to adding heat to the city's atmosphere. Residential buildings and paved roads contribute the most to the increase in temperature, as the density of buildings, the method of construction, and the type of materials contributed greatly to adding heat to the city’s atmosphere, in addition to the paved roads and their directions, which contributed to receiving the largest amount of solar radiation.

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