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Iraq Green Buildings Code Effect on Improving Outdoor Thermal Comfort for Residential Complex

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Abstract: Iraq is one of the countries facing a noticeable rise in temperatures caused by climate change in recent decades. This generated an increased feeling of thermal discomfort among humans. Previous studies submitted many research works in the field of outdoor thermal comfort in cities, but the study of the role of the Iraqi green buildings code in improving outdoor thermal comfort for the residential complex was not adequately addressed, especially at the local level, which was the research problem. The research proposes that the adoption of Iraq Green Buildings code will increase outdoor thermal comfort in residential complexes. The Bismayah residential complex in Baghdad was chosen for this study and tested with ENVI-MET 4.4.2 software. The simulation is based on PMV assessments performed before and after the green building code was implemented. It was found that the implementation of green buildings code improved by increasing the percentage of vegetation, trees and water bodies. Also the change in façade materials to light colours, and the type of pavement materials. had a significant role in increased (PMV) during the day by about two degrees from the model before the change.

Key words: Predicted mean vote (PMV), ENVI-MET 4.4.2 software, residential complex.

Introduction

During the last few decades, many researchers had emerged to reduce the impact of global warming in cities. The influence of changing urban geometry on urban microclimate remained unknown until the 1970s when climatologists T.R. Oke and H. Langsberg published their primary works, which became the theoretical foundation of reference for much subsequent work on environmental design. The effect of climatic change on outdoor temperature, solar radiation, and wind speed, produced by the city's "structure," results in modified energy usage. The wind pattern and sun access in urbanised regions are highly influenced by the orientation, density, and typology of the urban fabric, as well as the microclimatic conditions of outdoor and inner spaces. The study of Kustysheva (2017) undertook an analysis of the city of Tobolsk's current development dynamics. The article discusses ways to make better use of urban space in order to prevent negative natural and manmade effects. While (Turner, 2008) the morphological factors such as the sky visibility factor, the shadow factor, and the height-to-width value of the particular thermal comfort were studied in the valley of the street for the temperate climate. The results of this investigation revealed an inverse link between the factor of sky visibility and shadow factors after evaluating the samples. When the roadway width was equal to double the height of the buildings, thermal comfort was achieved (Turner, 2008). Shishegar (2013) has discussed the impact of street design on urban climate and examined the effects of street engineering on airflow

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and solar radiation arrival in urban valleys. The earth receives more solar radiation than the vertical surfaces (walls) in the same valley street, where the H/W ratio affects the ground more than the walls (Johansson, 2006). Shishegar (2013) has discussed the impact of street design on urban temperature, as well as the impact of street engineering on air flow and solar radiation arrival in urban valleys. The lower the H/W ratio, the more solar energy is obtained from the street surfaces because the earth gets more solar radiation than the vertical surfaces (walls) in the same valley street, where the H/W ratio influences the ground more than the walls. In Iraq, many studies examined the impact of the built environment on the environment and thermal comfort (Hassan, 2018; Hassan et al., 2020; Hyader and Hassan, 2020). In the study of Hassan et al. (2019) indicated the importance of the residential buildings grouping pattern on the local climate and thermal comfort in the desert climate of Baghdad. The results showed that the optimal groupings of buildings were low and medium height with U-shaped configurations also the study of Abrahem et al. (2022). The study presented research on the effect of water bodies in residential complexes on the external environment and climate factors such as temperature, humidity and solar radiation, and compared the results using a program of Envi-met with a number of models of external surfaces of concrete or green surfaces, and the water bodies had a more effective impact on improving the external environment and (PMV) compared to the rest of the models (Iraqi Green Buildings code, 2019). This research work mainly hypotheses that introducing Iraq Green Building code effect can improve outdoor thermal comfort in residential complexes built in hot desert type of climate.

Iraq Green Buildings Code

The Green Buildings algorithm was created to simulate expected models that might be used to reduce harmful effects on the human environment. It consists of a set of determinants tailored to each country's specific climate. Although there are a few constants among them that can be summarised as follows:

- Site planning
- Energy efficiency and renewable energy
- Quality of the internal environment
- Rationalise, conserve and recycle resources
- Direct and indirect environmental impacts
- Community issues

Iraqi Green Architecture Code contains many determinants at the urban level, individual buildings and residential complexes. It also includes the special assessment system (Al-Nahrain), which determines the most prominent environmental specifications that must be provided in the buildings (Iraqi Green Buildings Code, 2019).

Iraq Green Buildings Terms for Site Selection

Iraq Green Buildings' terms for site selection deal with the topic of choosing a site, determining its basic dimensions, and indicating its importance in reducing the sources of environmental pollution and the general consumption of energy sources and respect the sites and also deals with addressing the environmental problems in the newly established cities (Iraqi Green Buildings code, 2019). With the study of environmental design for cities, and the instrument for activating it, it contains many sections (Distance from urban centers, protecting agricultural sites and nature reserves, preserving heritage sites, interconnection with urban neighborhoods, dealing with the topography of the site, infrastructure, greening, empowering people with special needs, encouraging the use of bicycles, ease of access to the site, parking, green open spaces, reducing the effect of urban heat islands, shading sidewalks and roofs, noise pollution).

Outdoor Thermal Comfort (PMV)

The Green Buildings code was created to simulate expected models that can be implemented while reducing negative effects on the human environment. It is made up of a variety of determinants that are tailored to the local environment in each country. Although there are a few constants that can be summarised as follows:

- +3 = hot
- +2 = warm
- +1 = slightly warm
- 0 = neutral
- -1 = slightly cool
- -2 = cool
- -3 = cold

The PMV model includes the main variables that affect thermal sensation and quantifies the absolute and relative influence of environmental factors represented in air temperature, radiation temperature rate, air velocity, and relative humidity, in addition to the activity level, and the thickness of clothing. The level of activity is measured in terms of metabolic rate or a unit called met, and the thickness of clothing is measured in the unit clo (Fanger, 1982).

Research Objectives

The main objective of this research is to contribute to Iraqi green buildings code in improving outdoor thermal comfort for residential complexes in Baghdad city as an example of a hot desert climate. This goal can be achieved through:

- Case study: select one of the major housing complexes in Baghdad by conducting software measurements before and after the change in the specifications of the housing complex according to the Iraqi green buildings code.
- Clarify the change in the outdoor thermal comfort (PMV) achieved in the tested residential complex according to the Iraqi green buildings code.

Methodology

Case Study (Bismayah Residential Complex)

Baghdad, Iraq's capital, is the site of the case study project. Baghdad is situated in the desert climate (hot dry climate) at latitude 33.18 north and longitude 44.24 east, with a height of 31.17 meters above sea level, according to Köppen's classification. The Bismayah residential city project was chosen, which is located in the province of Baghdad in the southeast, around ten kilometers from Baghdad's international road borders. It stretches across 1,830 hectares. It was built to house around 600,000 people and contains 100,000 housing units. Main streets, power, and water, as well as other infrastructure, will be created. The Iraqi government will create a network of infrastructure, including key streets, power, and water, as well as public and service utilities, such as commercial, religious, recreational, and educational facilities, as well as sewage and water treatment plants. The Bismayah residential complex was chosen since it is the most current housing project completed in Iraq. This housing project is divided into eight sectors, each of which is divided into various neighbourhoods, each of which comprises a number of housing units in buildings with ten floors, each of which contains twelve residential apartments.

Simulation Procedures

Bismayah residential complex city is the most current housing project in Iraq. This housing project is divided into eight sectors, each of which is divided into various neighbourhoods, each of which comprises a number of housing units in buildings with ten stories, each of which contains twelve residential apartments. In the hot season of the year, the model was simulated in the software and then environmental analysis was performed (2020). The greatest temperature (39) and lowest temperature (25) were recorded, as well as northwest wind movement (315 degrees from north) and wind speed (2.5 m/s). The simulation was done for an hour on the day (1-2 noon) on the fourteenth and nineteenth of June and reflects the peak hour. The model rotates from the north of the grid, where the scenario was constructed from the model with the grid size (190 * 200 * 17) and accuracy (2 m * 2 m * 2 m) (90 degrees). The square's urban space is divided into five tested selective (five) locations (A, B, C, D, and E), with point C being the one closest to the building space within the figure (see Figures 1 and 2).

Simulation Procedures After Changes

Changes according to the selected Iraqi green code terms for a site selection, to the same above residential complex scenario. This includes the following changes:-

- The percentage of water bodies from 0% to 6%
- The types of plants were changed from ground grasses to trees with a height ranging between 8 and 15 meters
- The afforestation of footpaths
- The percentage of plant coverage was increased from 20% to 27%

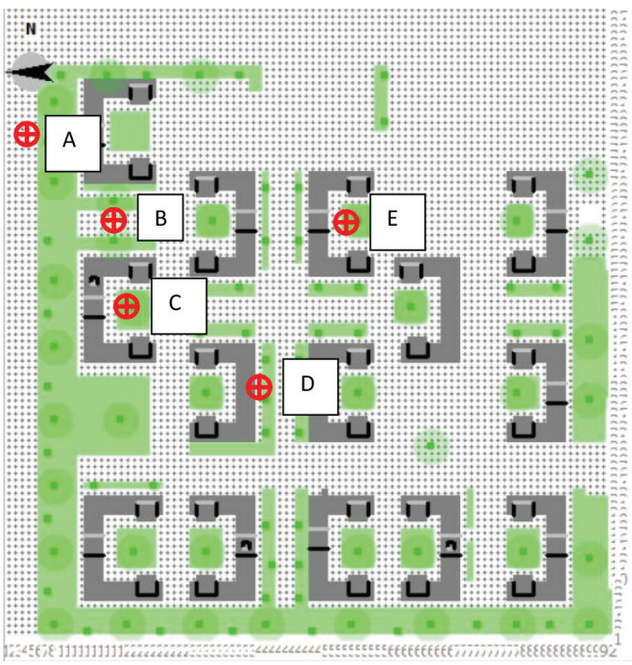


Figure 1: The case study of Bismayah residential city block B, with selective tested points.

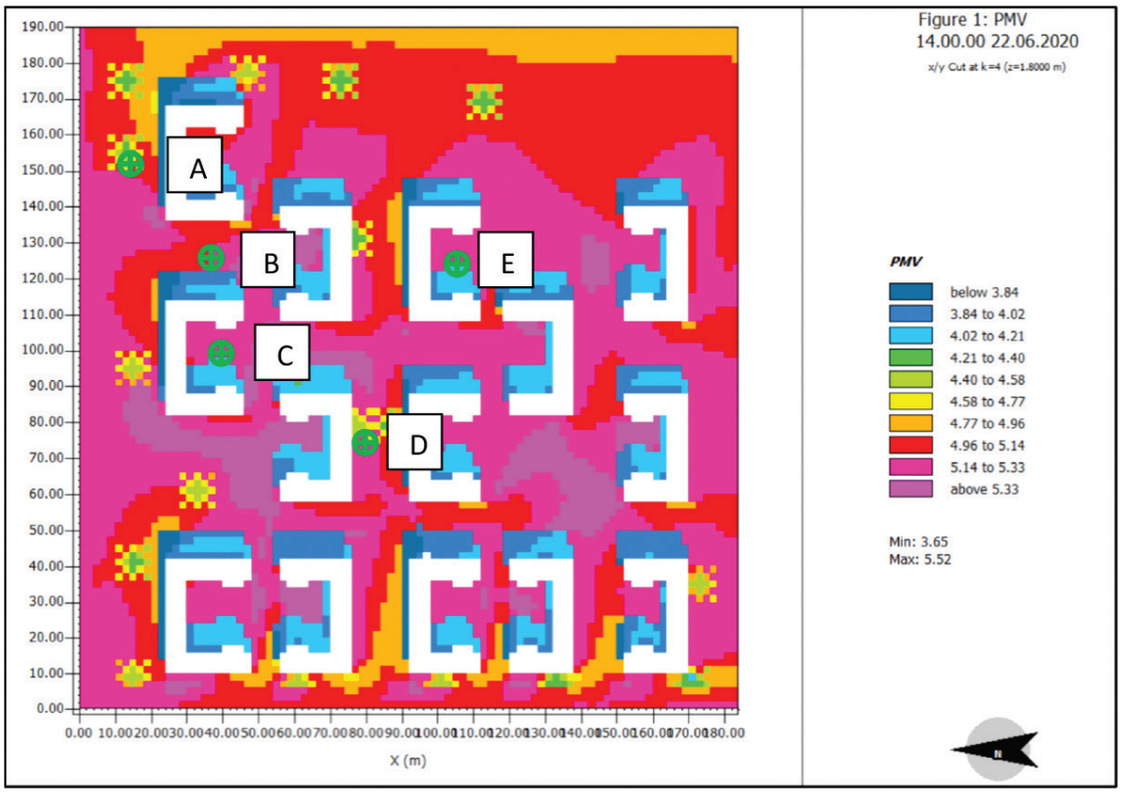


Figure 2: The results of the PMV at 2 pm for a scheme before the change.

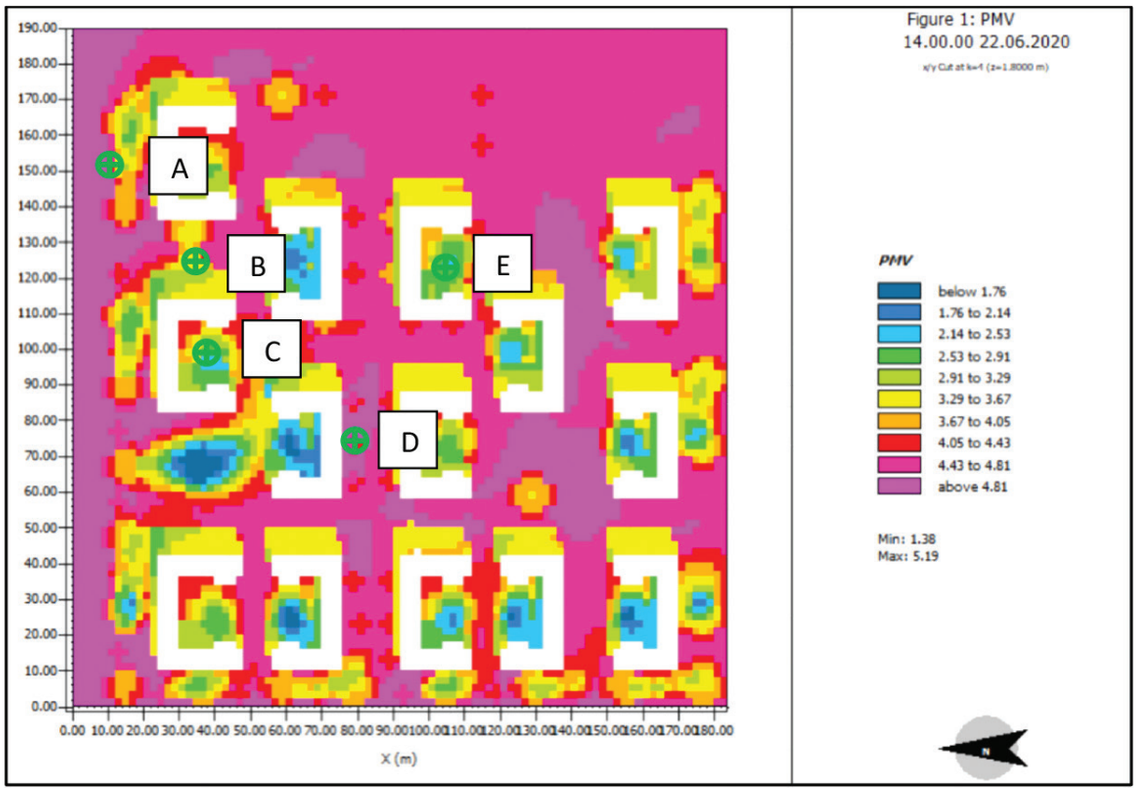
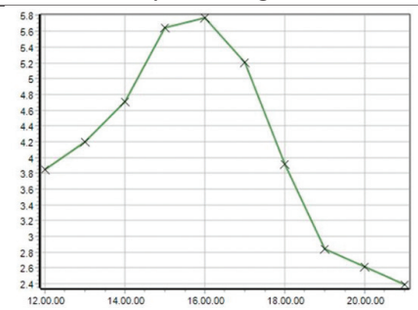
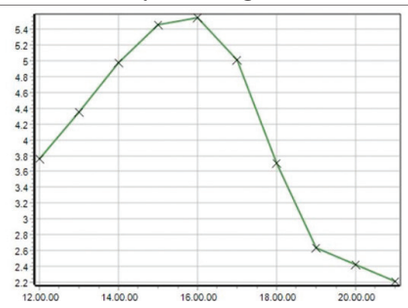
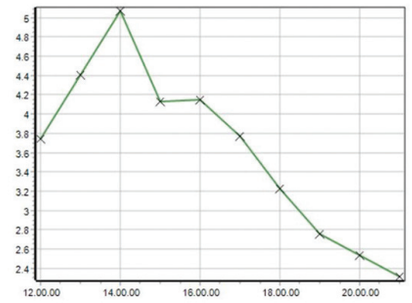
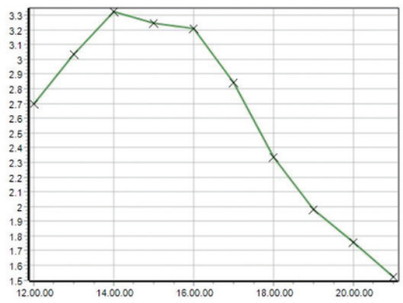
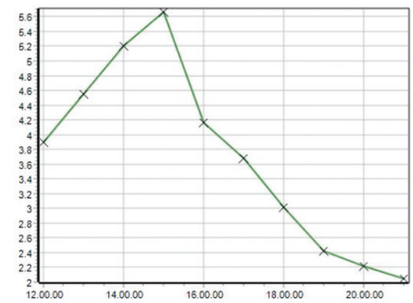
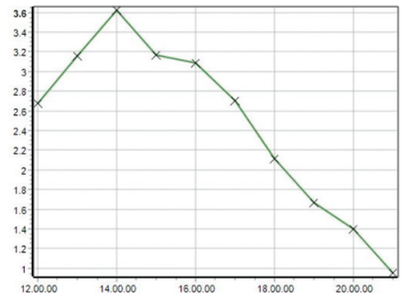
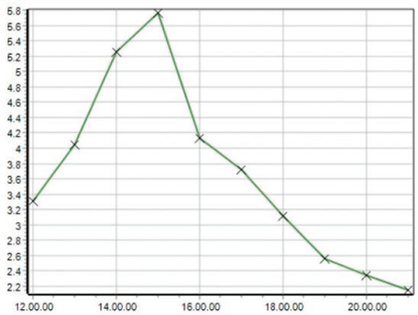
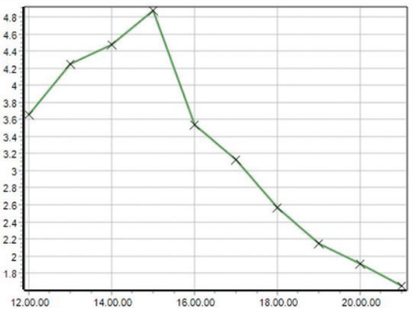
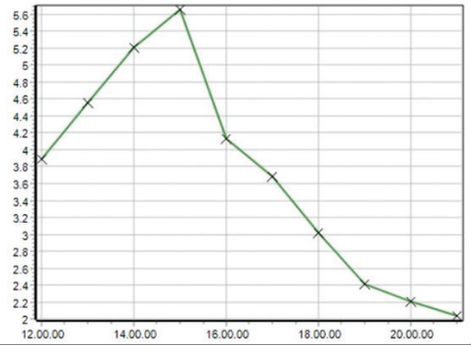
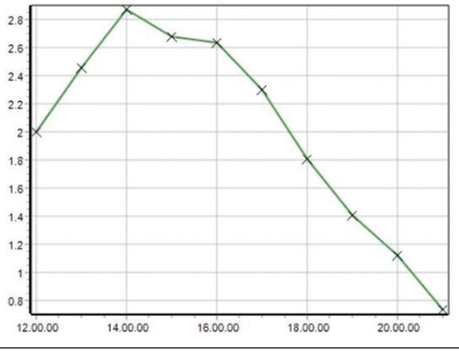


Figure 3: Results of the simulation of the PMV at 2 pm for a scheme after the change.

Table 1: The results of the PMV for a scheme before and after the change

PMV		
Point	*Before changes*	*After changes*
A		
B		
C		
D		
E		

- Reducing the percentage of asphalt between buildings from 35% to 6%
- Adopting light colours in painting buildings
- The finishing materials changed for pedestrian paths from concrete to brick basalt (Figure 3).

Results

The simulation results in Appendix A, reveal that the average PMV in (June) in point A before the change was (4.65), in point B, was (4.85), in point C was (5.2), in point D was (5.3), and in point E was (4.1). Where the diversity in the average PMV after changes in the case study for the same points, the result was in point A (3.25), in point B (3.3), in point C (2.75), in point D was (4.4), in point E (2.8) (Table 1).

Conclusion

A comparison on the results of the environmental simulation emphasises the urban open space in the Bismayah residential city. The results indicated that vegetation cover has a clear effect on the PMV factor. It was found that the use of materials with high reflectivity (light colours) has a significant role in reducing surface temperatures, as these materials absorb less solar radiation and at the same time release the absorbed heat more easily. As a result, the heat transfer from the surfaces to the surrounding air decreases and this leads to a decrease in air temperatures and thus increases the level of external thermal comfort (PMV). It achieves the lowest exposure to solar radiation, which positively affects the improvement of the climatic environment by taking advantage of favourable winds and reducing the energy used in the building. Humidification and water evaporation as well as the use of trees and green spaces (grass) helped reduce the values of radiant temperatures (solar radiation) when the angle of incidence of sunlight in the space is vertical, while the lowest values of radiant temperature appear in the urban space in the near part of the surrounding building blocks. In space, when the sun's rays are diagonally over the space, the greater the percentage of misleading spaces it provides. The building blocks surrounding the spaces, and thermal level of comfort increased in these spaces due to the decrease in the values of air temperatures and the amount of solar radiation gained. Replacing the surface for the floor of pedestrian walkways and some spaces, and the addition of afforestation to some spaces for the sides of the streets for a model after the change, the rates of air temperatures, radiant heat and surface heat decreased, and the rate of wind speed decreased due to the sweat of trees, in addition to the presence of many trees which led to an increase in relative humidity significantly From the current model the average physiological temperature (PMV) during the day increased by about 2° from the model before the change.

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