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Sustainability between Authenticity and Contemporaneity to Achieve Thermal Comfort

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ABSTRACT: This research deals with identifying the elements of sustainable cities that contribute to thermal comfort. The main aim of the study is to suggest means and mechanisms to assess new cities around the world in order to achieve sustainable environments. In order to face the rapid urban development and challenges associated with it, the study focuses on means of reducing the consumption rates of available natural resources. This can be done by benefitting from the heritage features and using them in new settlements for the success of sustainable development programs. In this study two new settlements in Cairo, Egypt is studied and compared by utilizing a simulation tool to compare thermal comfort and hence to identify the successful features that contribute in achieving successful sustainable future cities.

KEYWORDS: Contemporary, Envi-Met, Heritage, Sustainability, Thermal Comfort, Urban Design

I. INTRODUCTION

There are many elements that affect the efficiency of designing and using external urban spaces when designing any external public space in the city. It is important to achieve a sustainable design that contributes to raising the efficiency of urban spaces in cities. How to select features and architectural vocabulary heritage, which are still valid and consistent with the conditions of the times and employ them in the urban fabric in a contemporary way is rather an important matter. Through sustainable procedures one can achieve thermal human comfort It is important to maintain environmental balance between integrating sustainable elements and contemporary reality.

II. URBAN SPACES

Urban spaces are the direct façade of urban and architecture and one of the most important components of the city and a major hub of development, so the thermal comfort of the users of the vacuum must be provided, meet their needs and connect them to their communities through good design.

III. URBAN DESIGN

There are many definitions that scholars have dealt with, and the most famous of them is the concept formulated by “José Luy Sirt” at the 1956 Harvard Conference" is that part of the planning that deals with The urban formations of the city” as he also defined it as “the creative stage in the planning of cities that Imagination and artistic abilities have a large share Accordingly, “SIRT” presented at the beginning of the conference an ambitious goal, which is to “create the overall basis for joint action.” For the architect, site coordinator and city planner, "This basis is urban design, as it is the broadest in the spectrum of these three professional disciplines."

IV. URBAN DESIGN METHODS

A. The traditional style of urban design:

Depends on the designer's expectations and his personal view of life individuals

B. Modern methods of urban design:

It includes analysis of the social, physiological and psychological characteristics of the project users, analysis of climatic and geographical conditions of the site, analysis of available building materials, structural characteristics, construction method, economics of buildings and any other Specifiers for building requirements and codes.

V. HERITAGE

The term heritage is called the sum total product of previous civilizations that are inherited from ancestors to successors and are the product of human experiences, desires and feelings, whether in the fields of science, thought, language or literature, and not only that, but it extends to include all the material and emotional aspects of society, such as philosophy, religion, art, urbanism, etc., and folkloric and economic heritage as well.

A. Urban Environmental Treatments with Urban Heritage

- Employing the topography of the land and choosing the appropriate location.
- The buildings are contiguous and close (the combined fabric).

- Employing plant elements in environmental conditioning and minimizing the impact of climatic conditions.
- Efficiency of the use of natural energy (sun - wind)

B. Architectural Environmental Treatments with Urban Heritage

- Take care of the orientation of the building.
- Dependence on local materials such as clay, stones, etc.
- Use of thick walls.
- Use of internal courtyards and air catapults.
- Take care of the choice of shapes and sizes suitable for windows and openings.

VI. THE RELATIONSHIP BETWEEN URBAN HERITAGE AND CONTEMPORARY URBANISM

It is the relationship through which the appropriate balance between heritage and contemporaneity is reached, and heritage meanings are reshaped to meet contemporary functional needs, i.e. "reading heritage with the eye of contemporary", to create compelling urban forms for our present.

VII. METHODOLOGY

A. Study area

The Sixth of October City is one of the cities of the Egyptian Governorate of Giza, one of the urban areas of the Egyptian capital Cairo and thirty-two kilometres from the centre of the capital, located on the west bank of the Nile River, and the coordinates of the city are limited between 295610° towards the north, and 305537° towards the east, and the total area of the city is about four hundred square kilometres. 6th of October City is affected by the very hot desert climate, in which temperatures vary between day and night periods, The city is considered one of the most important projects undertaken by the Ministry of Planning.

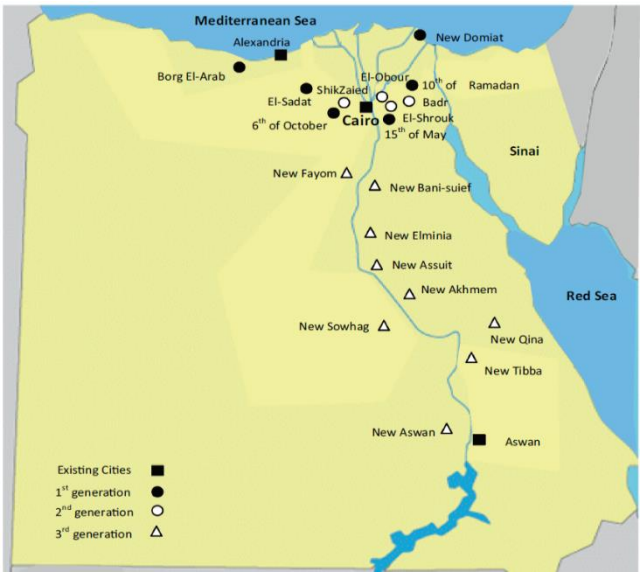

Figure 1: New urban communities planned by NUCA, adopted from NUCA website,

B. Computer simulation

The ENVI-met program was selected to perform a simulation of the two study compounds in 6th of October City, Rabwa and Ganna in Sheikh Zayed City, to study its relationship with urban formation in an attempt to infer and estimate the values of air temperature, wind speed, relative humidity and thermal comfort for users.

C. Selection of the Evaluation Day

Based on the weather data of the study area measured at the 6th of October Airport terminal, the 8th of May 2021 was chosen, where the highest air temperature value was recorded at 43 ° C, the relative humidity was 10%, and the average air speed at an altitude of 5 m/s North direction.

D. Measurement method for applied study

Study the impact of the presence and proportions of some elements of the urban space (urban spaces - afforestation and green spaces - water bodies) and apply them to two residential communities with the same climatic conditions and compare the results.

E. Measurement Method for Applied Study

Three points were placed to measure climate variables and the thermal comfort scale for the study situation over 13 hours from six in the morning until six in the evening, and these points were chosen in different places throughout the study area.

To study the impact of the presence and attributes of some elements of the urban space (urban spaces-afforestation and green spaces-water bodies) and their application to two compounds with the same climatic conditions and comparison of results

F. Data to be extracted

The temperature, wind speed, relative humidity, and the thermal comfort scale for PMV, for both compounds and comparison between them, and all previous results will be extracted, at an altitude of 1.80 m from the surface of the earth, to express the average human height to monitor results close to reality.

VIII. FIRST CASE

It is one of the residential projects established by the Urban Communities Authority, it is an integrated service project, and it includes entertaining and marketing urban spaces and public facilities, and green spaces, and the project is designed entirely in modern engineering style, in the form of buildings of six roles

Figure 2: Ganna compound, Source Sheikh Zayed City , Authority

A. *Simulation area*

Three points taken
Point A beside building
Point B in garden between buildings
Point C in open space without any shad

Figure3:simulation area, source google maps

B. *Simulation results at 12:00 PM*

This hour was chosen as an example, as it represents the highest temperature over the evaluation day

C. *Air temperature*

Notice the decrease in the temperature inside the compound between 0.5 : 1.5 ° C, while the temperature gradually rises around the compound circumference

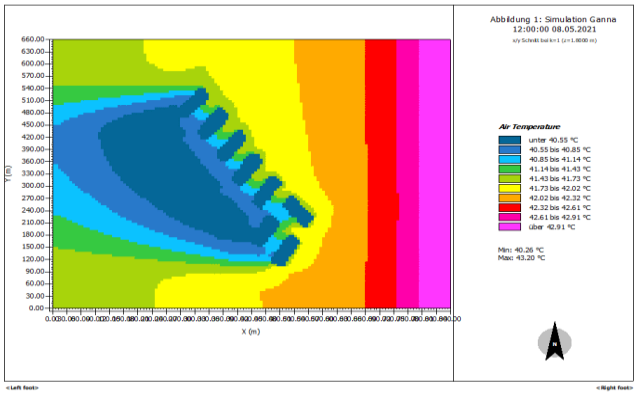

Figure 4: air temperature simulation at 12:00 PM, author

D. *relative humidity*

The percentage of relative humidity within the compound ranges between 12.12 % and 12.90 %, while the actual relative humidity was at that hour 10 % or less. This may be due to an increase in the percentage of green surfaces.

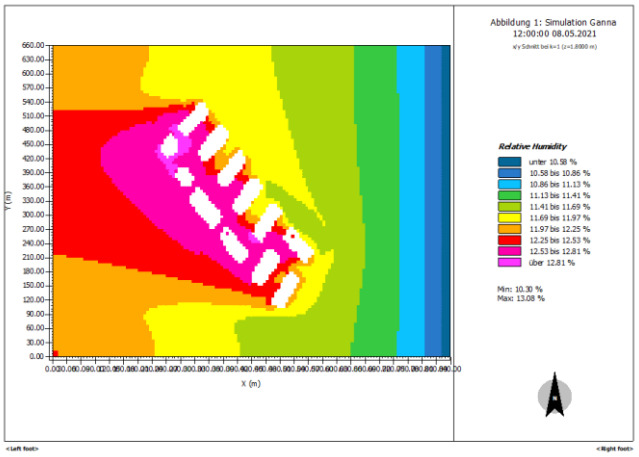

Figure 5: relative humidity simulation at 12:00 PM, author

E. *Wind speed*

The wind speed ranges between about 1 and 2.3 m / s in the voids between the buildings while they start to increase in the form of rings whenever we move outside so that it reaches 4.22 m / s

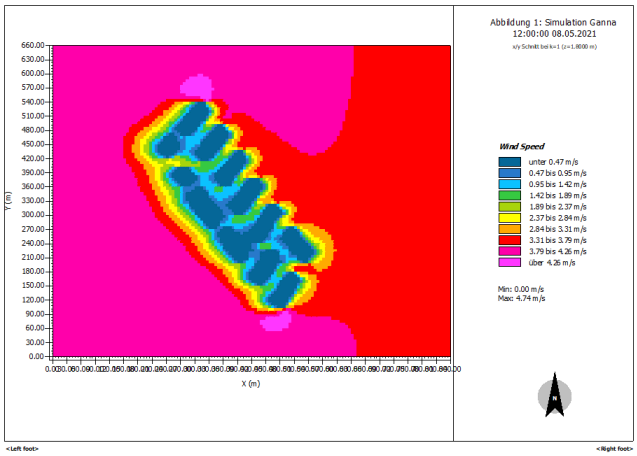

Figure 6: wind speed simulation at 12:00 PM , author

F. *Thermal comfort PMV*

Not a good indicator of thermal comfort in the intercourse between the buildings between the buildings ranges between 6 and 6.29, while we note the improvement of the thermal comfort index around most buildings directly according to their guidance so that it ranges between 5.26 and 5.55 but anyway that out of thermal comfort range.

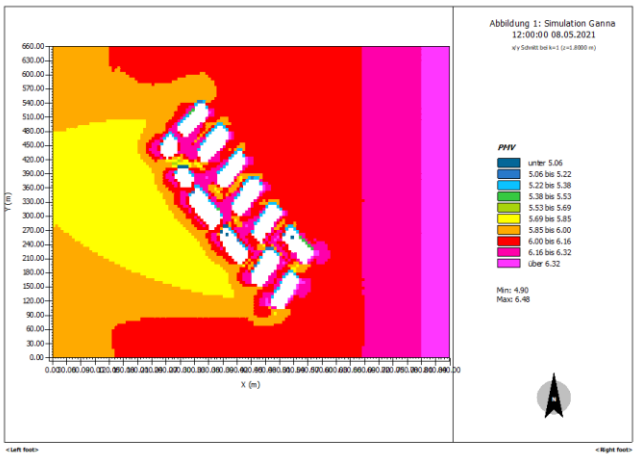

Figure7: thermal comfort PMV simulation at 12:00 PM, author

G. *Simulation results analysis*

1. *Air temperature*

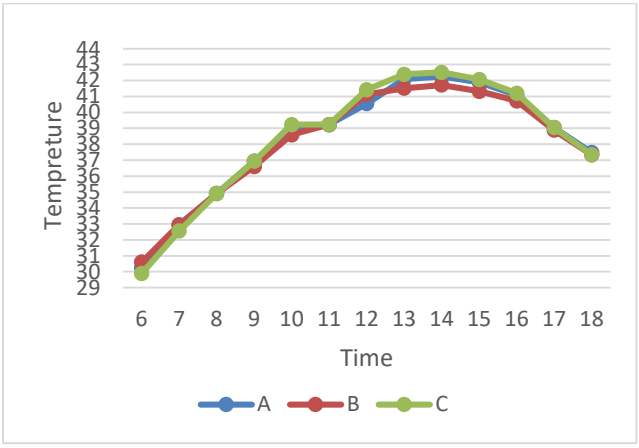

Figure 8: air temperature average for points A,B,C, author

The temperatures inside the compound ranged throughout the study day between 29,89 and 42.51, and their peak reached between 1:00 and 3:00 o'clock PM, but the temperature remained at its highest values with a value of half a degree than the highest temperature per day outside the compound.

2. *Relative humidity*

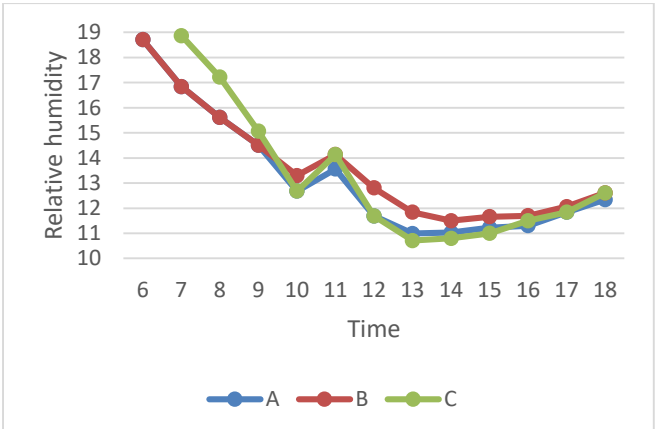

Figure 9: relative humidity average for points A,B,C, author

The relative humidity inside the compound ranged throughout the study day between 10.71 and 21.13 and its lowest values reached between 1:00 and 4:00 in the evening and the low relative humidity on this day related to that the winds were loaded with dust, but the value of the relative humidity was higher between 0.71: 11.13 than the relative humidity of the day outside the compound.

3. *Wind speed*

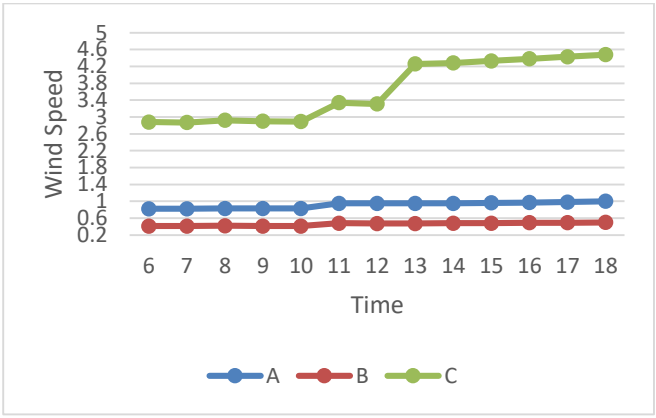

Figure10: wind speed average for points A,B,C, author

The wind speed inside the compound ranged throughout the study day between 0.41 and 4.48 m/s and it was noted that its value was fixed at the point that was chosen next to the building and the point that was chosen in the garden space while it was changing at the point that was chosen at the open urban space and its speed ranged at This point is between 2.87: 4.48.

4. *Thermal comfort PMV*

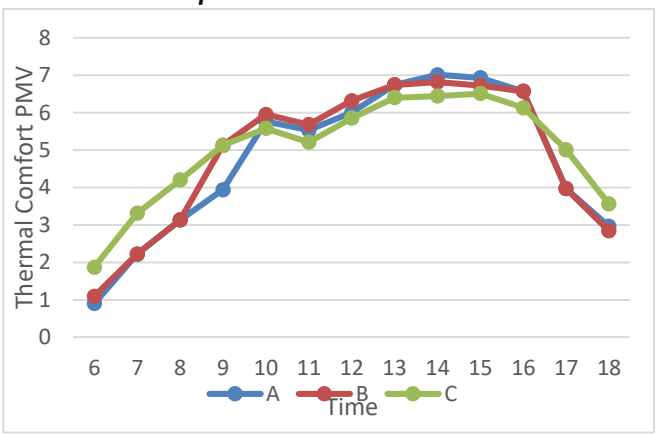

Figure11: wind thermal comfort PMV for points A,B,C, author

Not a good indicator of thermal comfort appears in most of the simulation hours, with values ranging between 0.9 and 7.01, we notice a good indicator of thermal comfort from 6 O'clock to 8 O'clock in the morning only and its values ranged between 0.9 and 4.2, and its values improved also only at six in the evening.

IX. SECOND CASE

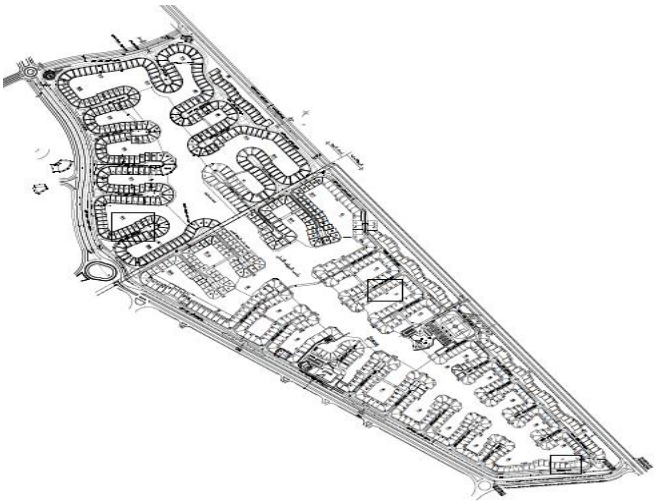

Figure 12: Rabwa compound, Source Sheikh Zayed City Authority

The Rabwa compound is located in the centre of Sheikh Zayed City, and about 6th of October 6 km before the first Cairo -Alexandria Desert Road is 850 meters and the Rabwa compound rises from the sea level by 140 meters and the Rabwa compound extends over the area of 505 acres of the vast majority of that area designed Special for areas of services and Landscapes as it is characterized by the presence of a large golf course and in the middle contains a lake of 80 meters and 30 meters wide, only 7% of the total area of residential buildings has been allocated in the form of villas consisting of two floors, and it also contains a course for cycling and Running amid green spaces.

A. *Simulation area*

Three points taken
Point A beside building
Point B in garden between buildings
Point C in the centre of 0pen space without any shad

B. *Simulation results at 12:00 PM*

This hour was chosen as an example, as it represents the highest temperature over the evaluation day

Firure13: simulation area, google maps

C. *Air temperature*

Notice the decrease in the air temperature inside the compound area between 3:4 ° C than air temperatures for that day.

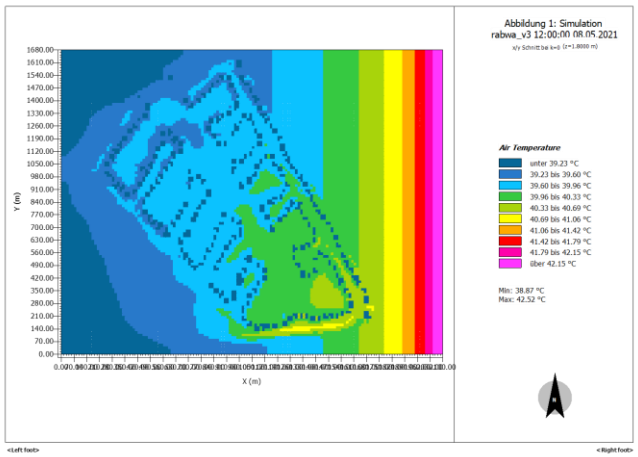

Figure 14: air temperature simulation at 12:00 PM, author

D. *relative humidity*

The percentage of relative humidity inside the study area in the compound ranges around the built block between 13.48 % and 14.33 %, while the actual relative humidity percentage outside the compound at that hour was 10 % or less and perhaps this is due to the size and area of green and water surfaces

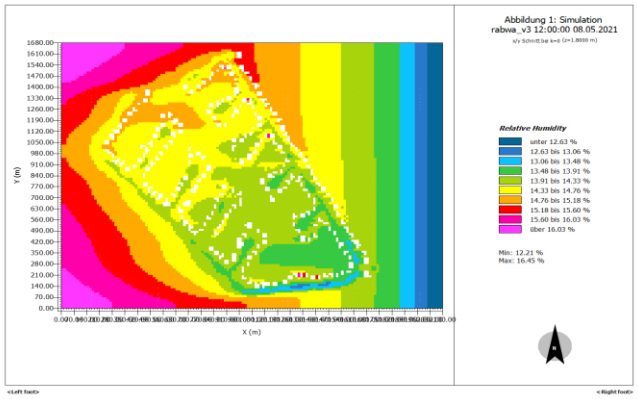

Figure 15: relative humidity simulation at 12:00 PM, author

E. *Wind speed*

You notice the decrease in the wind speed next to the buildings so that it reaches 0.48 m/s, while the wind speed in the spaces between the buildings range was about 2.39 :2.87 m/s then the wind speed begins to increase around the compound in the form of rings and its maximum is at a speed of 4.30 m/s

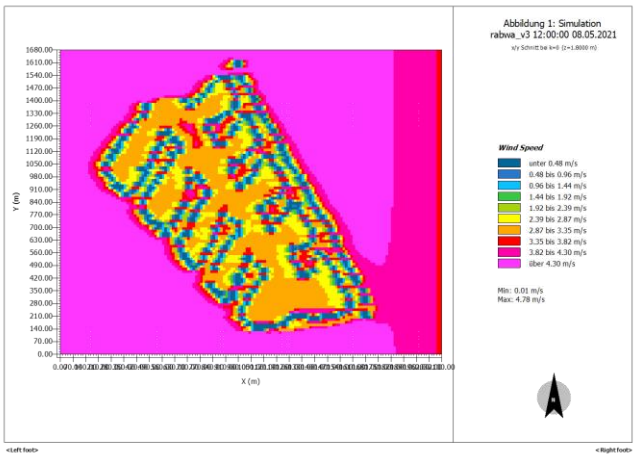

Figure 16: wind speed simulation at 12:00 PM , author

F. *Thermal comfort PMV*

You notice the thermal comfort index ranged in the interviews between the buildings between 5.13 : 5.22, which are close to the thermal comfort index, although this value was registered at the highest thermal value for the simulation day.

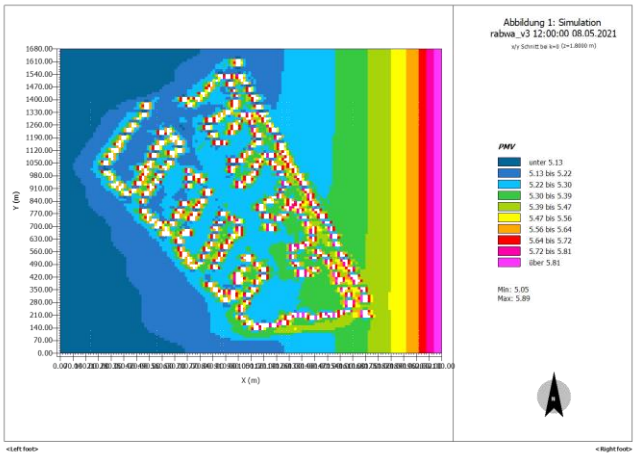

Figure 17: thermal comfort PMV simulation at 12:00 PM, author

G. *Simulation results analysis*

1. *Air temperature*

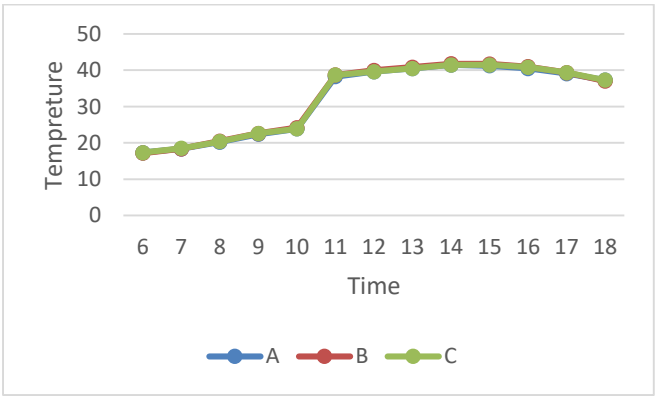

Figure18: air temperature average for points A,B,C, author

The temperatures inside the compound ranged throughout the study day between 17.19 and 40.83 and reached their peak between two and third o'clock in the afternoon, but the highest value of the temperature inside the compound was about three degrees less than the highest value of the temperature for the day of evaluation outside the compound as we notice almost a matching of the values of the measurement points Despite its different locations inside the compound.

2. *Relative humidity*

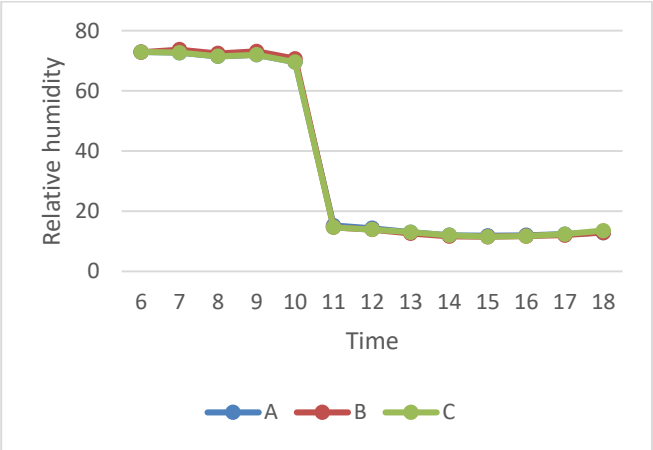

Figure19: relative humidity average for points A,B,C, author

The relative humidity inside the compound ranged throughout the study day between 11.53 and 72.95 and the high humidity inside the compound was observed over the periods of simulations from the relative humidity of the day outside the compound, but it was in the granular and influential range in the values of thermal comfort as we notice almost identical to the values of the measurement points despite the difference Its locations inside the compound.

3. *Wind speed*

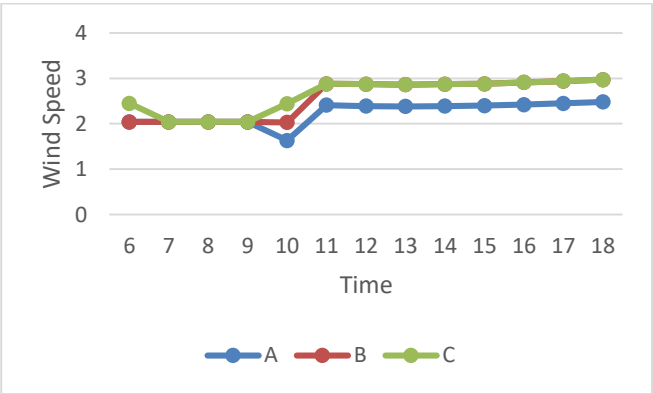

Figure20: wind speed average for points A,B,C, author

The wind speed inside the compound ranged throughout the simulation day between 1.63 and 2.97 m/s, and the closely values of the wind speed were observed during the simulation hours, especially between eleven in the morning and sixth in the evening, and we also notice almost a match for the values of the measurement points despite the different locations inside the compound.

4. Thermal comfort PMV

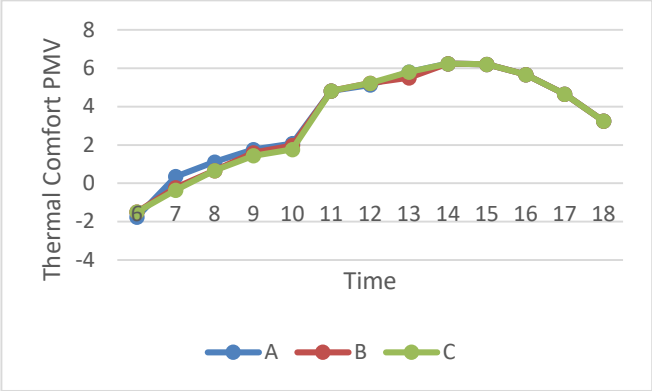

Figure 21: thermal comfort PMV average for points A,B,C, author

A good indicator of thermal comfort appears in most of the simulation hours, while the thermal comfort index increased during the period from one o'clock until four o'clock, but its highest value is still lower than the values registered for the first study.

Font Size	**Comparison between Ganna &Rabwa compounds**		
	Ganna copmpound	**Rabwa compound**	
Site planning	Regular network layout with longitudinal and cross streets and some small spaces as gardens	Planning in which urbanization is characterized by mutual relationships between internal urban spaces (urban gardens and private gardens) and outer urban spaces (golf courses, public gardens, public spaces and streets). Residential units have also been arranged in a traditional way so that they wrap in the form of ringing groups around the space (garden) as The housing is surrounded by a group of streets that meet in public spaces.	
Buildings heights	18m	9m	
water	Not exist	exist	
Air temperature	Air temperature inside the compound decreased between 0.5 : 1.5 ° C, than air temperatures for that day.	air temperature inside the compound decreased between 3:4 ° C than air temperatures for that day.	20: 27° C
Relative humidity	The relative humidity inside the compound ranged throughout the study day between 10.71 and 21.13 and its lowest values reached between 1:00 and 4:00 in the evening and the low relative humidity on this day related to that the winds were loaded with dust, but the value of the relative humidity was higher between 0.71: 11.13 than the relative humidity of the day outside the compound.	The relative humidity inside the compound ranged throughout the study day between 11.53 and 72.95 and the high humidity inside the compound was observed over the periods of simulations from the relative humidity of the day outside the compound, but it was in the granular and influential range in the values of thermal comfort as we notice almost identical to the values of the measurement points despite the difference Its locations inside the compound.	20: 80
Wind speed	The wind speed inside the compound ranged throughout the study day between 0.41 and 4.48 m/s and it was noted that its value was fixed at the point that was chosen next to the building and the point that was chosen in the garden	The wind speed inside the compound ranged throughout the simulation day between 1.63 and 2.97 m/s, and the closely values of the wind speed were observed during the simulation hours, especially between eleven in the morning and sixth in the evening, and we also notice almost a match for the values of the measurement	4:8 m/s

	space while it was changing at the point that was chosen at the open urban space and its speed ranged at This point is between 2.87: 4.48.	points despite the different locations inside the compound.	
Thermal comfort PMV	Not a good indicator of thermal comfort appears in most of the simulation hours, with values ranging between 0.9 and 7.01, we notice a good indicator of thermal comfort from 6 O'clock to 8 O'clock in the morning only and its values ranged between 0.9 and 4.2, and its values improved also only at six in the evening.	A good indicator of thermal comfort appears in most of the simulation hours, while the thermal comfort index increased during the period from one o'clock until four o'clock, but its highest value is still lower than the values registered for the first case study.	-4 : +4

CONCLUSIONS

The importance of having ways to apply environmental planning and sustainability elements as indicators of measuring these elements to urban communities.

1. The importance of the role of environmental simulation programs in urban planning as a tool for maximizing the role of information technology and overcoming obstacles to measuring environmental planning and sustainability elements in accordance with the sustainability indicators for each element.
2. The environment considers a system consisting of four main elements (heat-wind-relative humidity-radiation) and working on its environmental treatments to achieve thermal comfort for the human.
3. Creating a network of urban spaces within the one residential assembly leads to facilitating the process of thermal exchange between high and low temperatures between urban blocks.
4. The green element in its various forms is one of the elements affecting urban planning to reduce the temperature and achieve thermal comfort.
5. Adding the water element in urban spaces such as industrial lakes or fountains and others contributes to a major role in reducing temperature and thus achieving thermal comfort It is preferable to place it in the prevailing wind path, as it is bearing moisture before entering the building or to the external urban spaces. .

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