ENVI
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Walkable outdoor spaces in Abu Dhabi

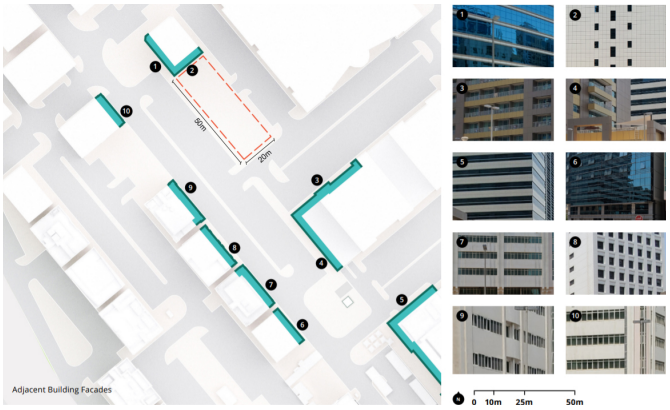
Ahmed Hamdani

Improving oudoor therm comfort

In Abu Dhabi, the microclimatic conditions that have been impaired by the morphology of the built environment, reduced pedestrian comfort between buildings.

The present thesis aimed to encourage what it calls usability – the ability of a place to welcome people to walk or to use– for longer periods every year. It focused on improving pedestrians' overall thermal comfort and extending the distance and the time that they could travel and use along their daily utilitarian journeys. Microclimatic analysis method was applied to investigate the physical urban environment in one district. This was conducted at different periods of the year and times of the day and were meant to identify the thermal comfort limits at such periods.

ENVI-met microclimatic simulations were run to analyze the urban district and identify the hot spots likely to inhibit comfort. The thesis proposes that allocating adequate shade and wind at frequent areas along the site provides a psychological satisfaction and physical heat stress relief, which improves the overall comfort and encourages usability. Proposed scenarios for the area were modelled and tested using ENVI-met to show the improvements of the microclimate and comfort conditions that can be achieved at different times of the day and year. The results of the simulation studies revealed the prospect for extending the distances and time that pedestrians tolerate being outdoors, through improving their thermal sensation and comfort at certain areas along the journey described as the recovery conditions.



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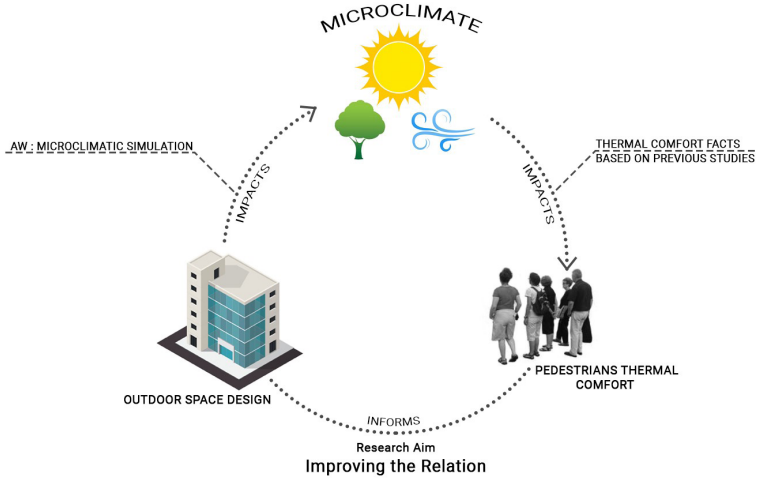
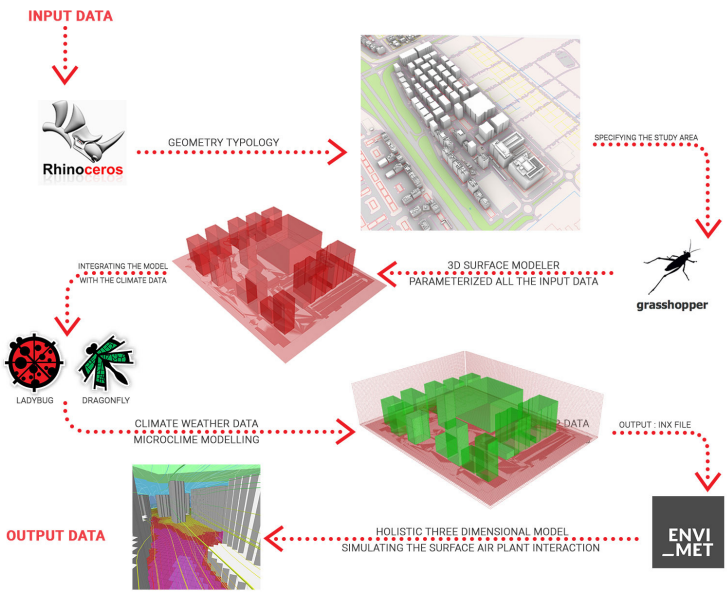
Methodology

Microclimatic simulations were run using ENVI-met 4.4.5 for a specific area in Abu Dhabi urban area to comprehend the influence of the morphological and built environment characteristics at the space along pedestrian's routes of on a larger scale.

Methodology: The microclimatic parameters air temperature, relative humidity, mean radiant temperature, Co_2 and wind speed were extracted from the simulations at different months throughout the year.
The parametric workflow in the Figure illustrates the approach of the analyses by continuous steps.

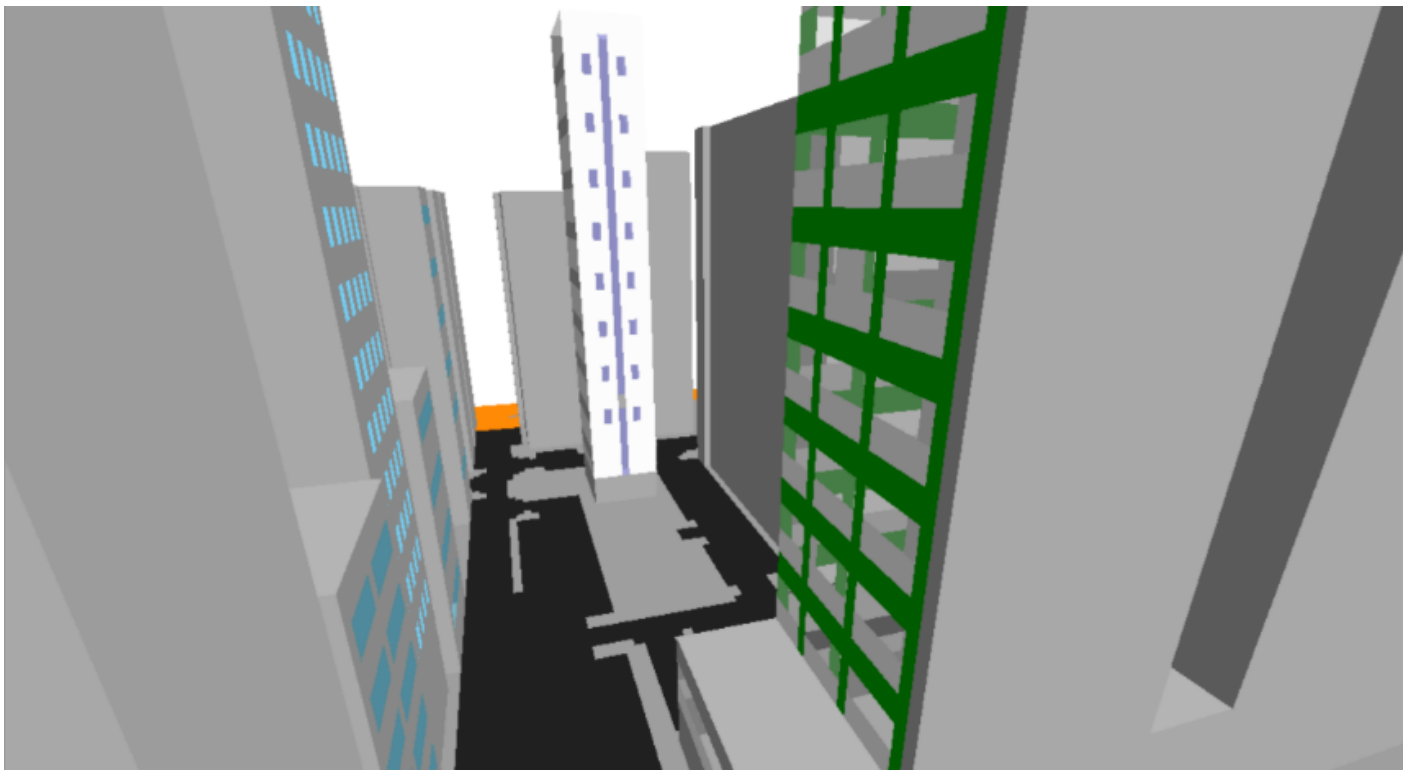
Firstly, a parametric workflow has been developed to combine the modelling characteristics and environmental analysis mechanisms and secondly, discuss local climate conditions to optimize the use of urban surfaces and the usage of natural elements.



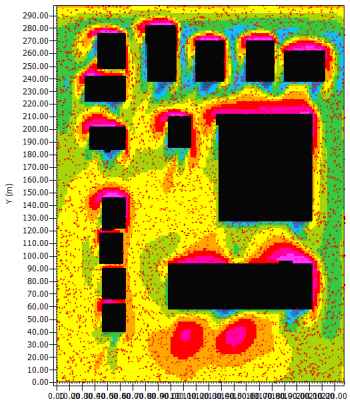


A Actual Scenario

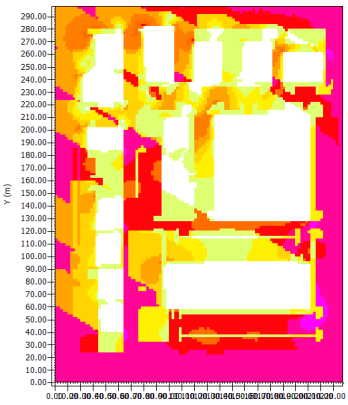
The block is mainly composed by different office building and retail buildings. In this context, areal images, and a geographic information system (GIS data) were used to verify the building, plant, and ground surfaces characteristics. Considering the photographic view references, the facade materials of the buildings were selected from default the ENVI-met database. Environmental factors simulated are: air temperature, relative humidity, and local wind speed. Another factor has been investigated since it has a direct impact on the microclimate condition of the site which is the Surface temperature. The environmental factors of the weather data on 21st of May is considered as the average days of the warm period of the year. The simulation time is between 9:00-18:00, on 21st of May.



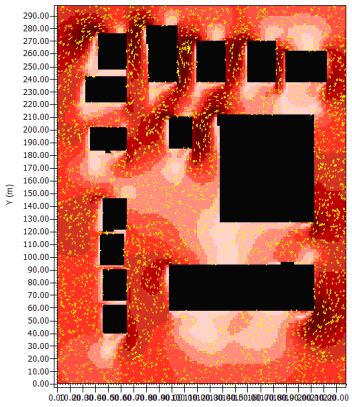
Air Temperature



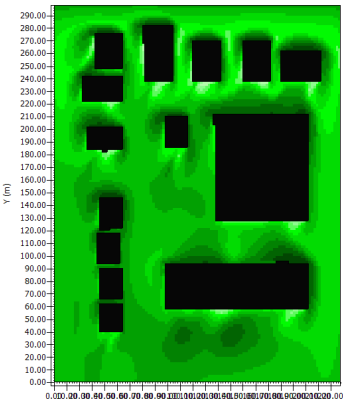
Surface Temperature



Wind Speed



Relative Humidity

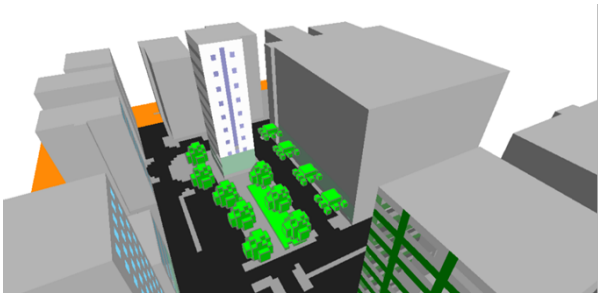


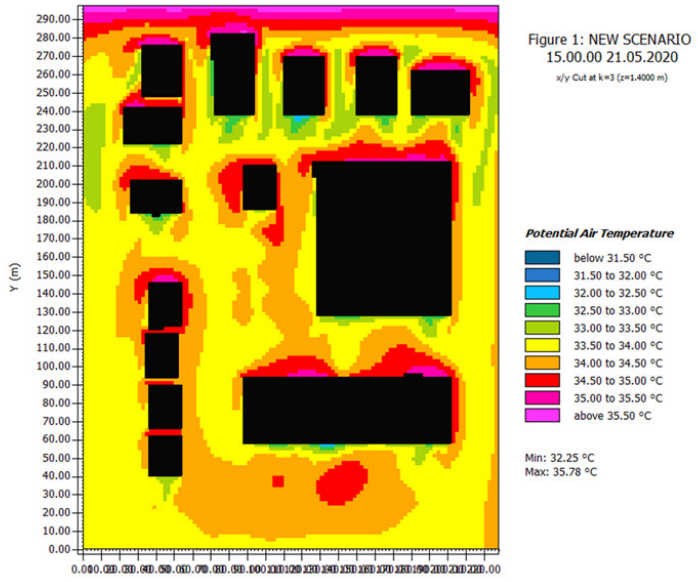
B Scenario 1 Configuration:

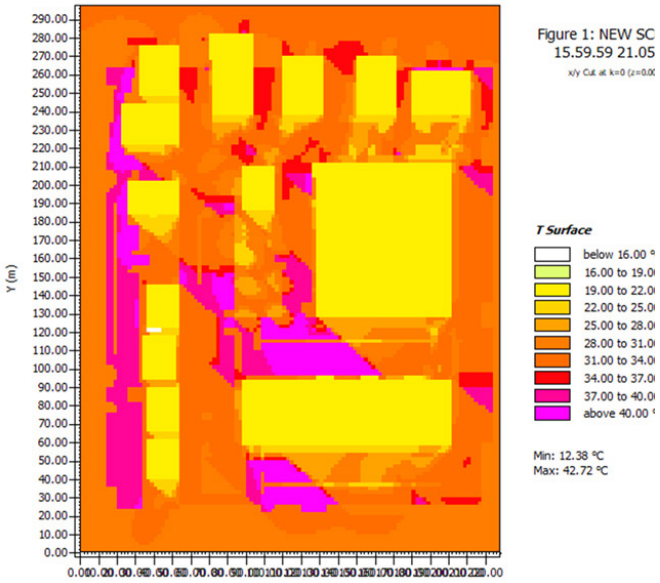
1. Detailed facades
2. Granite pavement (single layer)
3. Palm trees on one of the adjacent sidewalks (12m)
4. Covering half of the site with 50 cm grass
5. Shading trees inside the site (acer trees)
6. Asphalt road finishing

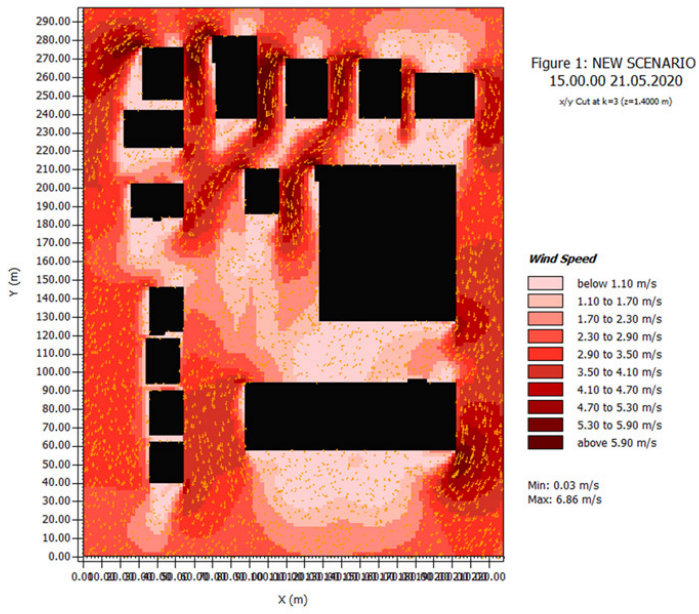
Day : 21ST of May 2020

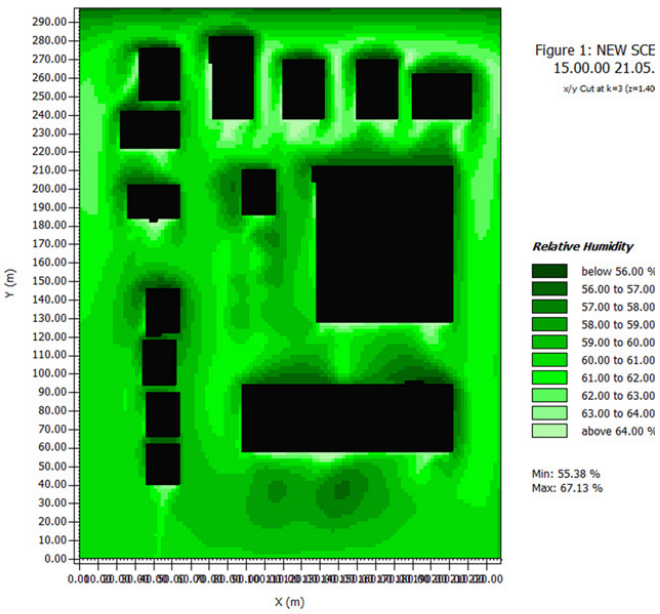
Time: 03:00 PM









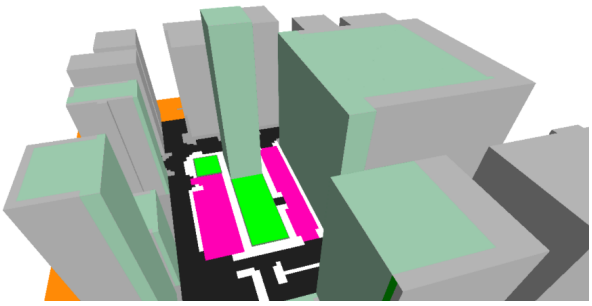


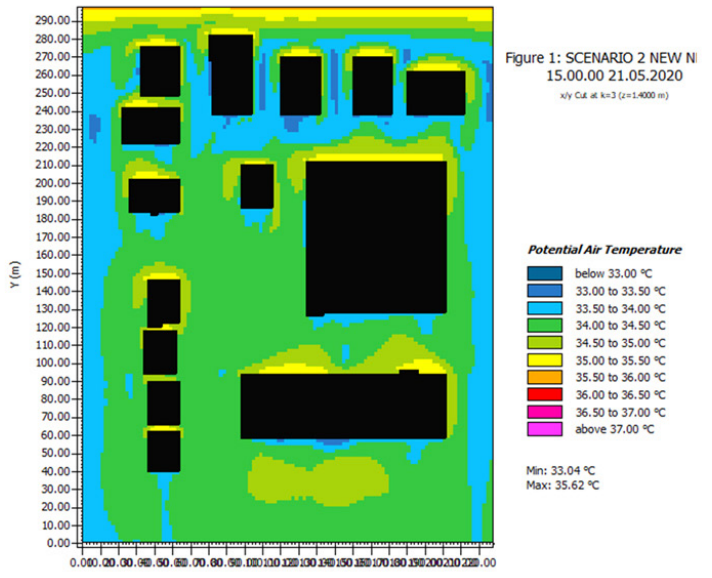
C Scenario 2 Configuration:

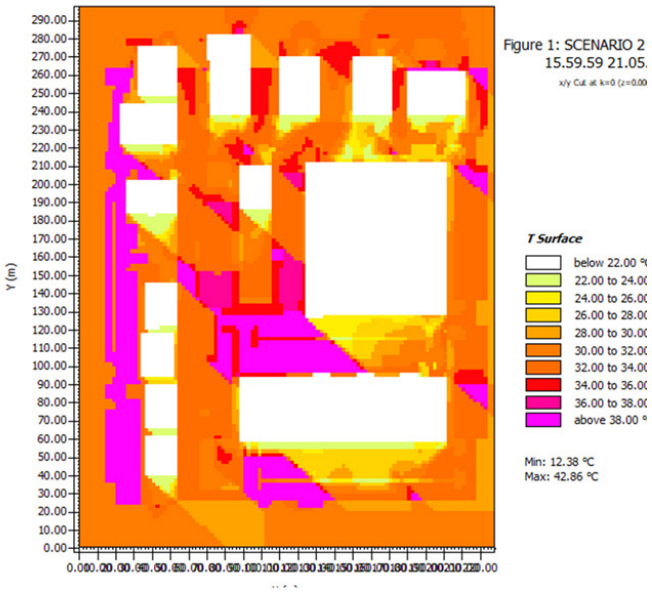
1. Green facades with mixed substrate for all the surrounding buildings
2. Concrete pavement (gray)
3. Total green roofs for the adjacent building
4. Grass covering for the whole site (25cm)
5. Asphalt road finishing with red coating

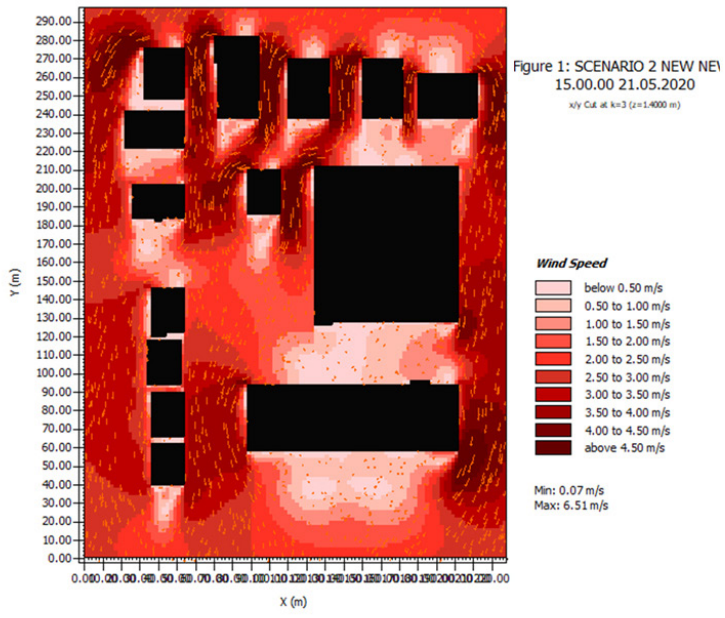
Day : 21ST of May 2020

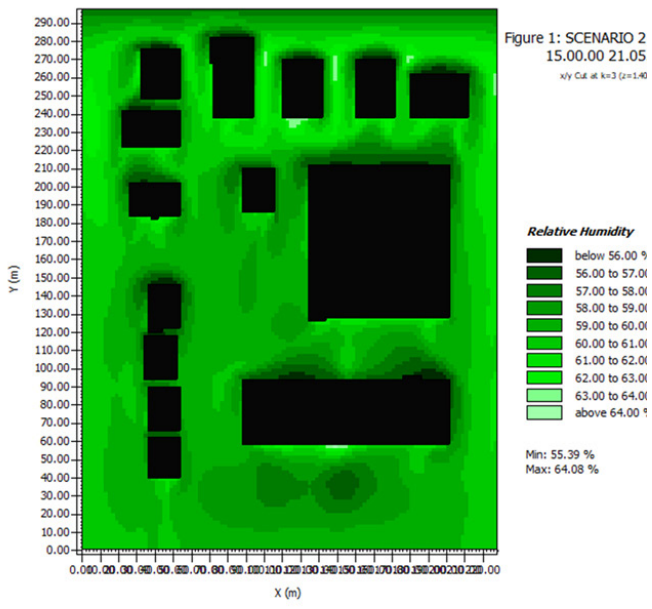
Time: 03:00 PM









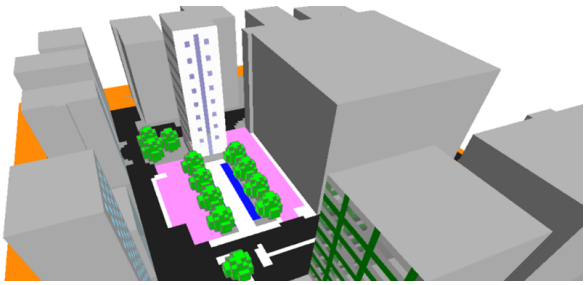


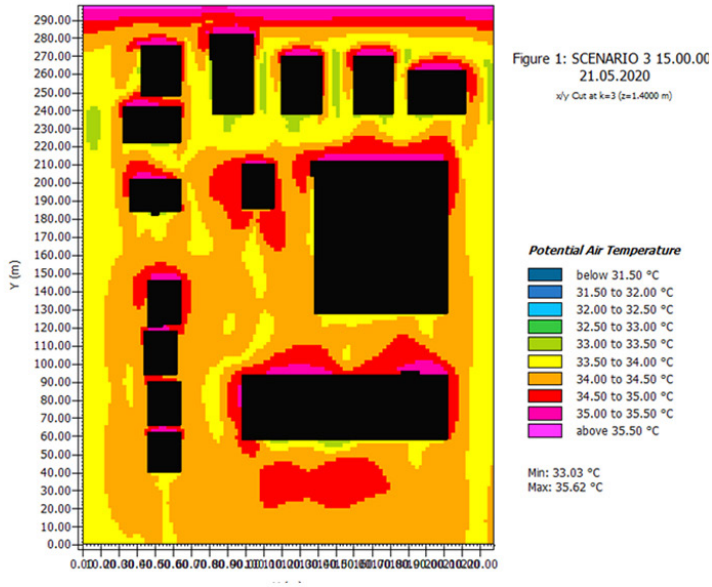
D Scenario 3 Configuration:

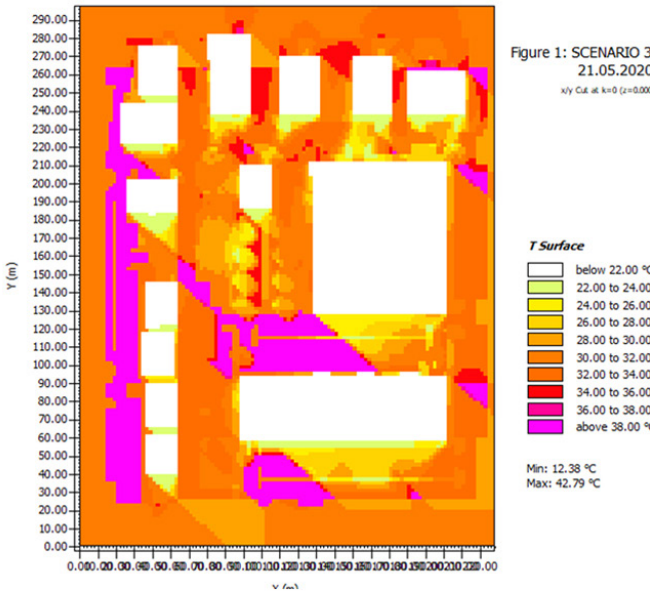
1. Basalt brick road
2. Concrete pavement (light)
3. Two water bodies inside the site on the side
4. Detailed facades for the surrounding buildings
5. Significant use of shading trees inside the site

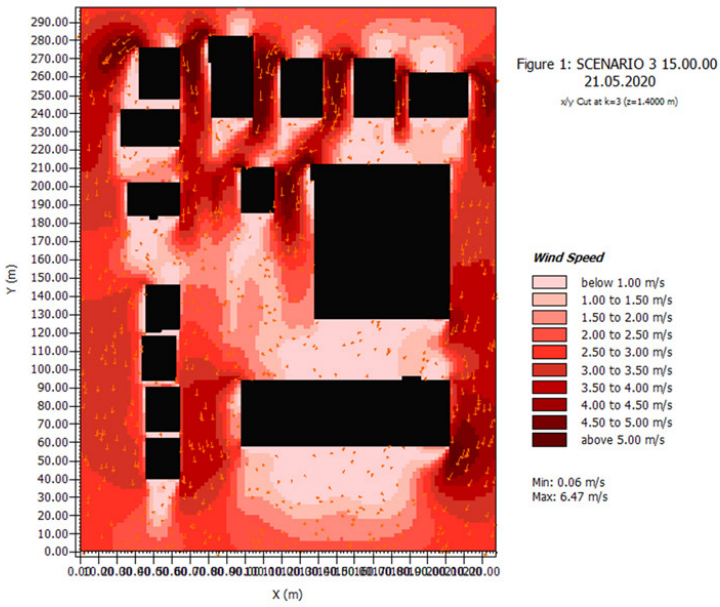
Day : 21ST of May 2020

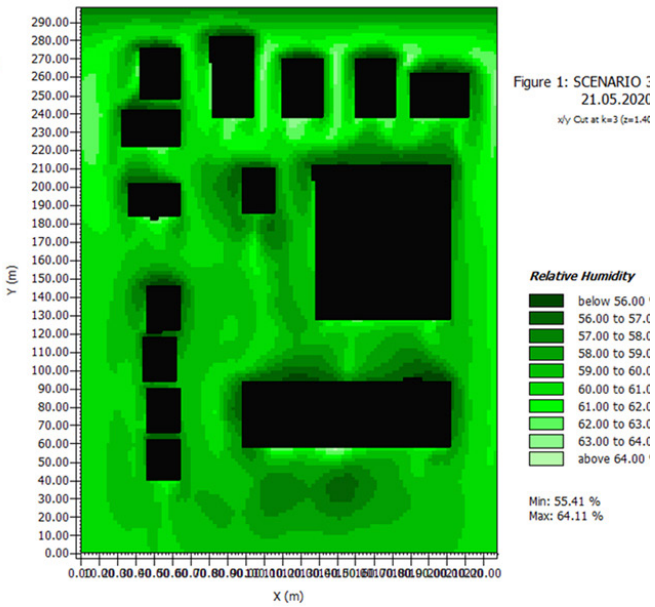
Time: 03:00 PM









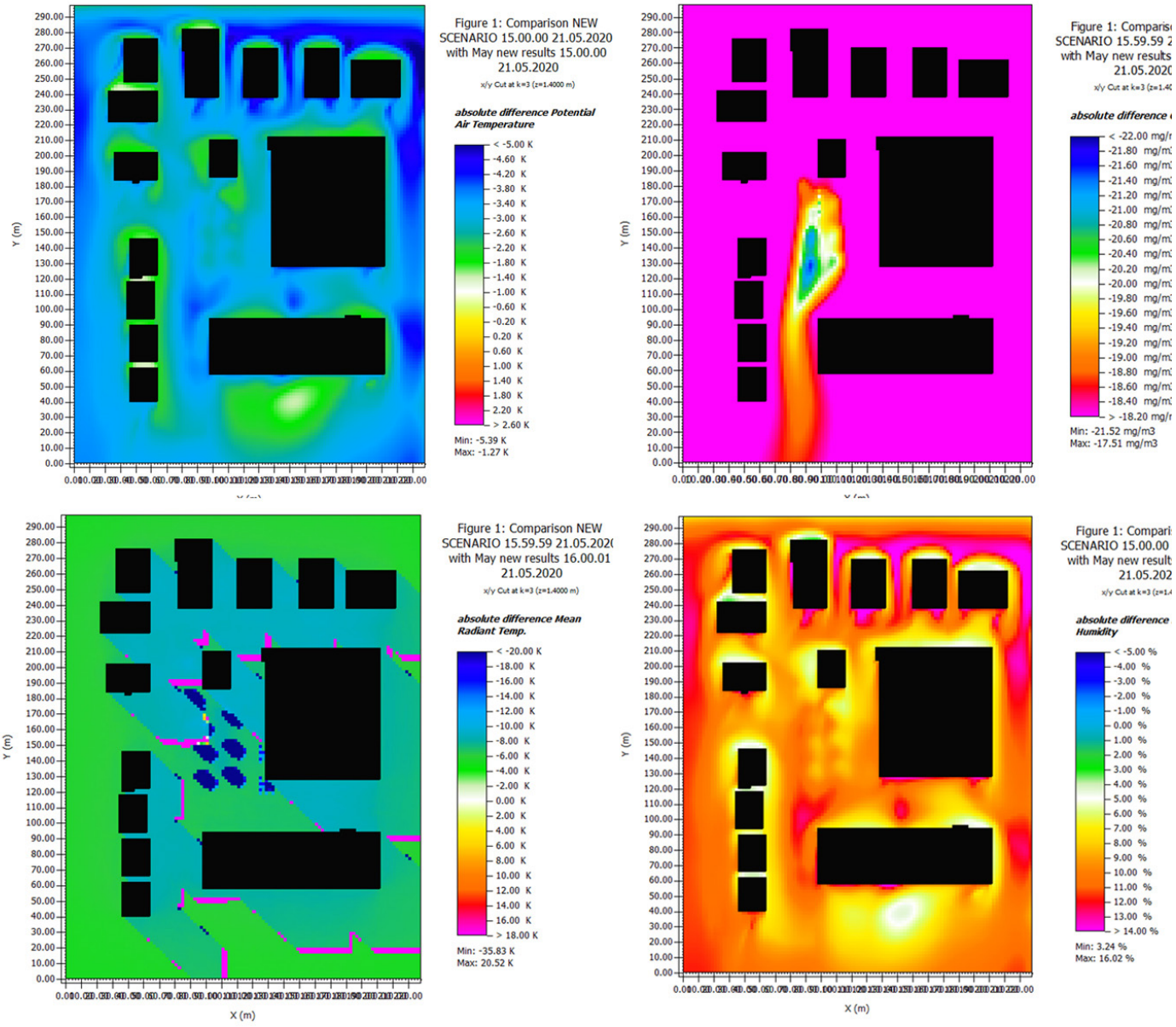


E Absolute difference between Actual Scenario and the experimented three Scenarios:

Potential Air Temperature, Relative Humidity, Mean radiant Temperature and CO_2
Day : 21st May 2020 : 3:00 PM

Actual Scenario vs. Scenario 1

Comparison:
Air Temperature ↓ 2 – 4 k
Relative humidity ↑ 7 – 10%
MRT ↓ 20 k
CO_2 ↓ 20 mg/m^3



Actual Scenario vs. Scenario 2

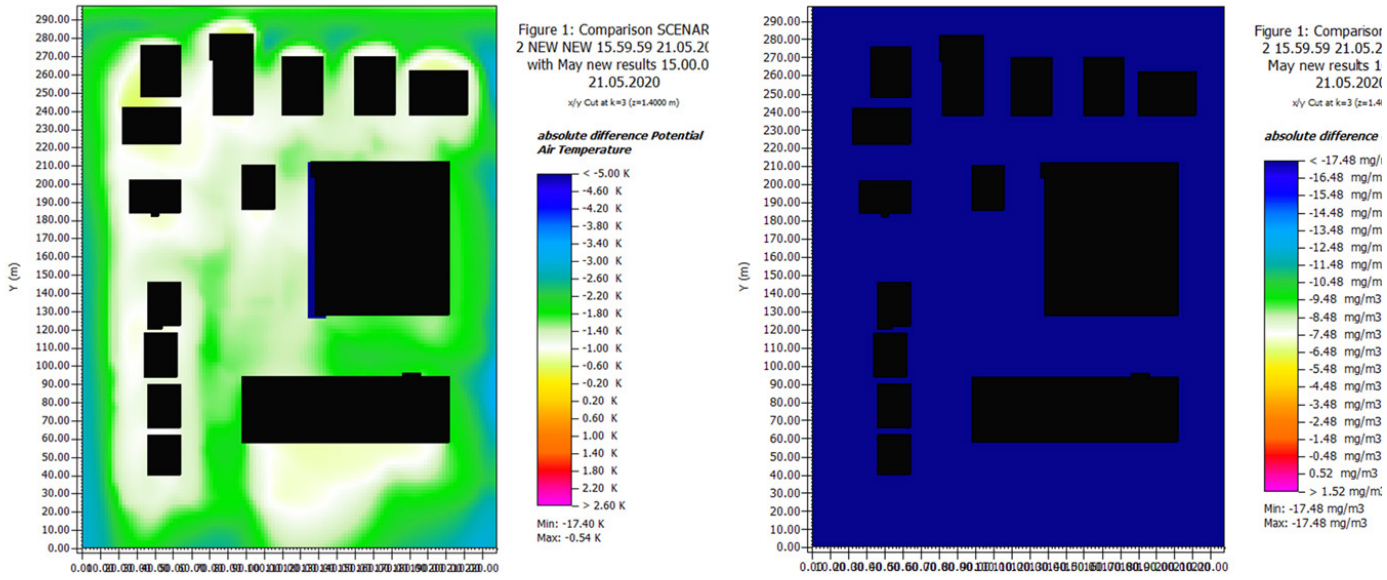
Comparison:

Air Temperature ↓ 1 – 2 k

Relative humidity ↑7 – 9%

MRT ↓ 6–10 k

CO_2 ↓ 17 mg/m³



Actual Scenario vs. Scenario 3

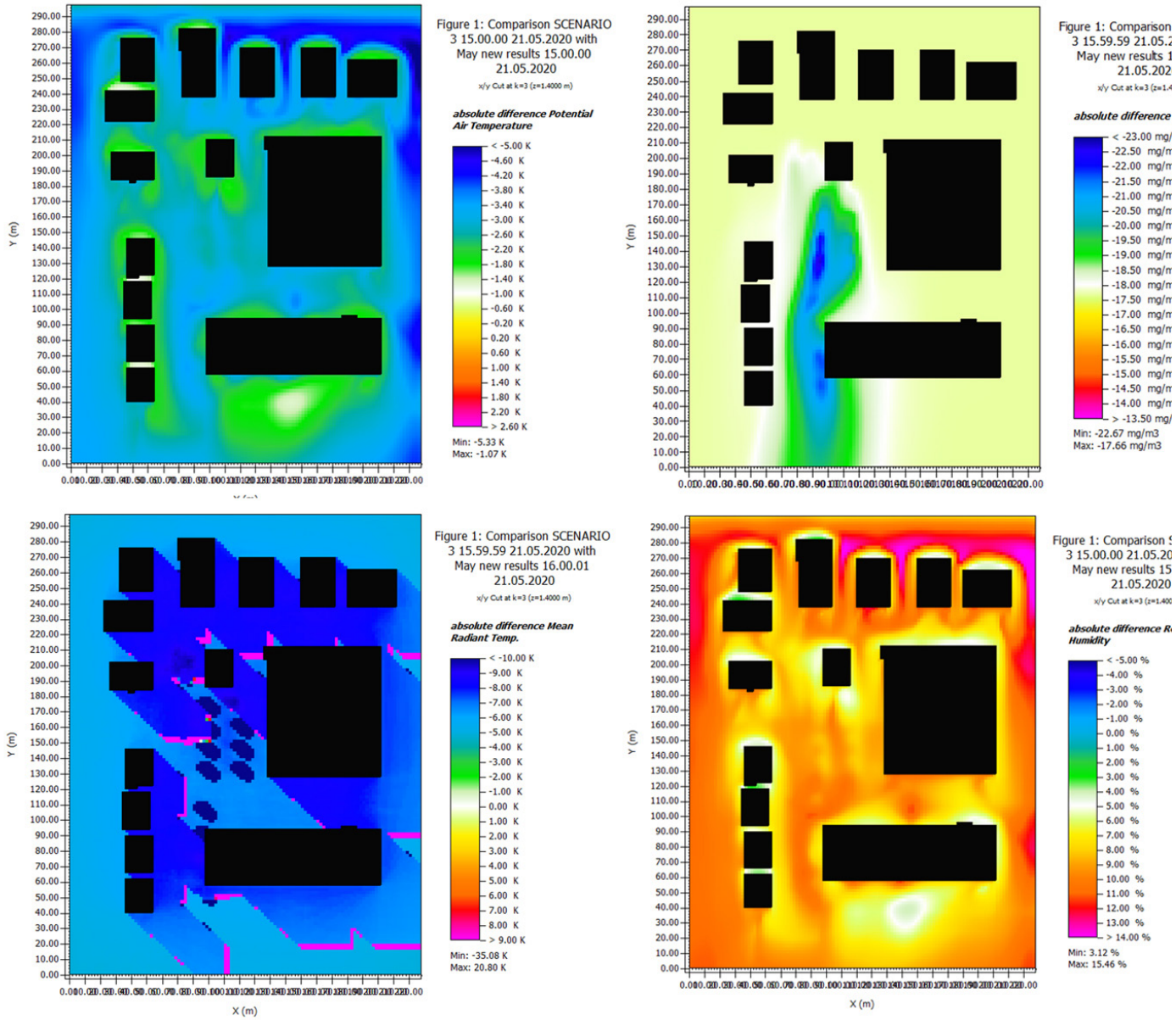
Comparison:

Air Temperature ↓ 2 – 4 k

Relative humidity ↑ 7 – 12%

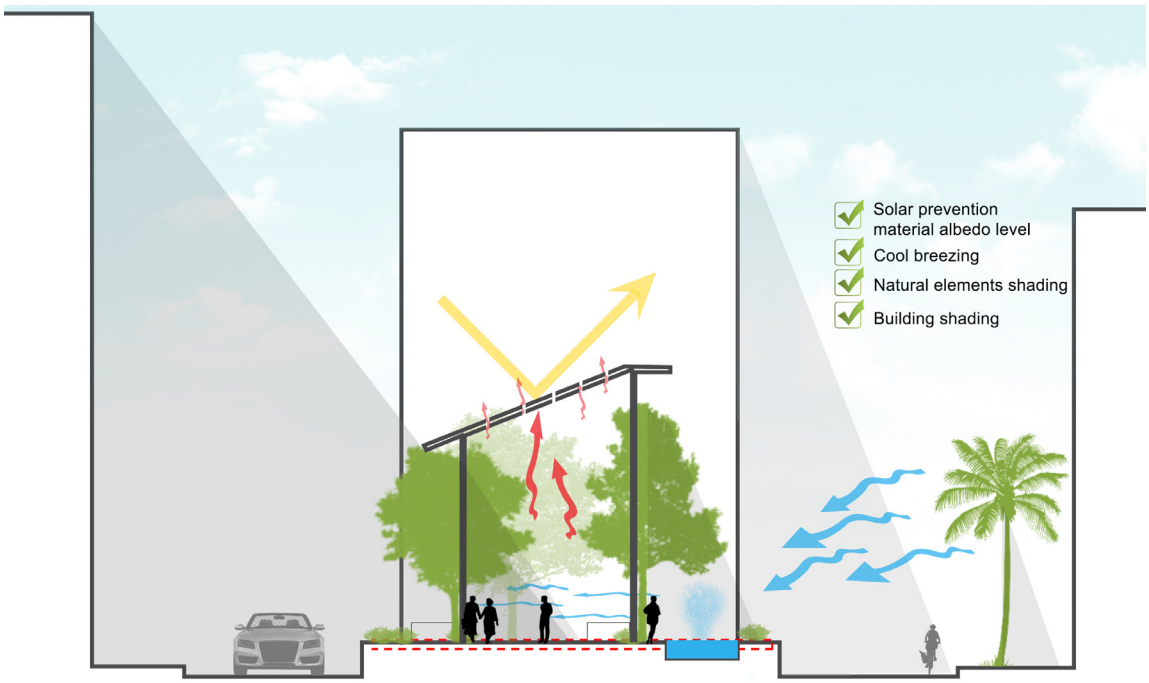
MRT ↓ 10 k

CO_2 ↓ 21 mg/m³



Conclusion

The solution experimented was to try different alternative materials for site and the surrounding surfaces, besides using natural elements such trees and water bodies that conditioned the microclimate through their efficient ways of shading and influencing wind movement.



This study was undertaken in an effort to find critical justification for the short span of walkability in urban communities in Abu Dhabi. It aimed to provide one or more solutions that would extend the period that pedestrians were prepared to venture outdoors. It was postulated that improving pedestrians' thermal comfort on their daily journeys would encourage them to walk and use public spaces for longer distances and over longer periods of the year.

The site was analyzed with different characteristics, which were selected mainly to examine the cooling potential of shade provided from trees, canopies, or buildings, compared to the lack of shade. The findings favored the space shaded by buildings, because they have few horizontal surfaces that obstruct the release of heat. However, such spaces should not be designed for use at midday due to the lack of shade; at this point, space shaded by trees is the coolest. One of the main findings revealed was the importance of the space orientation in promoting ventilation. Spaces that are continuously shaded during the day may still exacerbate the thermal conditions in stagnant areas; consider the state of the space that was shaded by a canopy. Therefore, in an urban area wind penetration should also be encouraged on a larger scale and this was uncovered by the ENVI-met simulations. This microclimatic analysis tool revealed that wind penetration is extremely favorable in this climate, but warm breezes, blowing air that has been heated by passing through hot spots – should be avoided. Based on the investigation done, the warm period, with nonextreme conditions, is the time of year with the highest potential for microclimatic improvements through both shade and wind.