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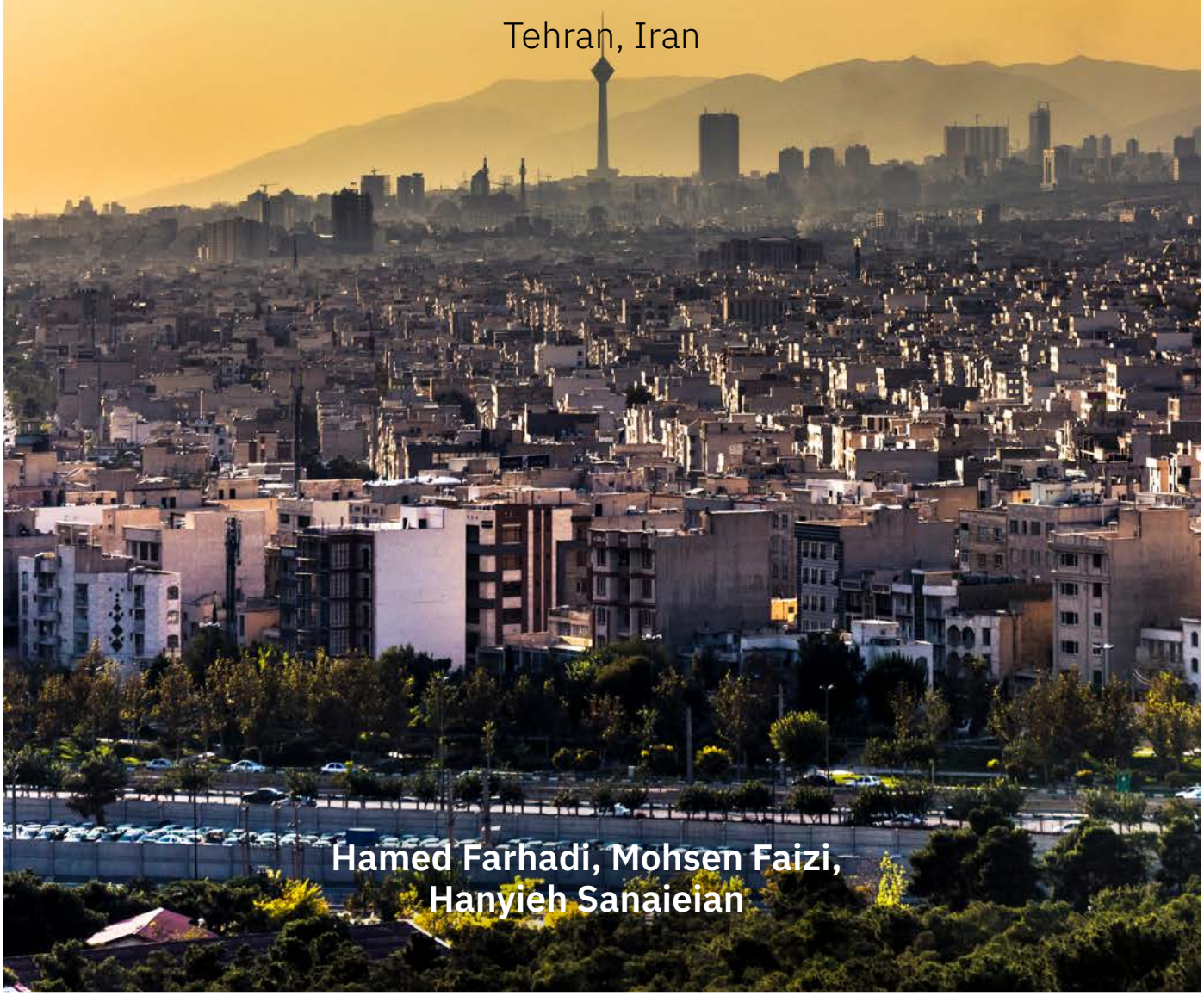
Urban Vegetation and Cool Materials: Mitigating heat stress in Tehran

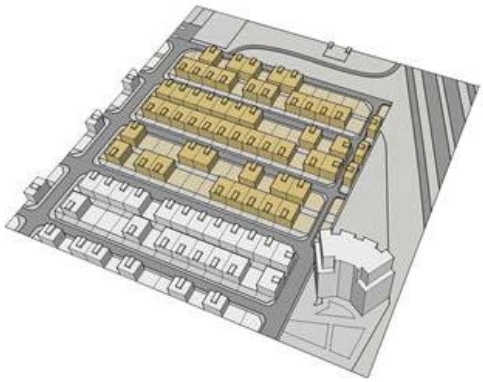
Tehran, Iran



Hamed Farhadi, Mohsen Faizi, Hanyieh Sanaieian

Urban Vegetation and Cool Materials: Mitigating heat stress in Tehran.

Analyzing the current situation



Author: Hamed Farhadi
Iran University of Science and Technology, Tehran, Iran
Supervisors: Dr. Mohsen Faizi, Dr. Hanyieh Sanaieian
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Urban Heat Island (phenomenon describes a situation in which urban areas experience the higher air and surface temperatures compared to the rural surroundings. Cities and climate change are both considered as reasons for creating UHI, however even if global warming stops, cities are still faced with UHI effect. Climate change seems to exacerbate this phenomenon through more intense heat waves, especially in hot months, which reveals the need to adapt to it more than ever before beyond climate change, urban features play a significant part in creating UHI effect cities cause heat islands for these reasons Urban surfaces are darker than surroundings, there are fewer trees and vegetation in urban areas, and buildings and surfaces in cities have high heat capacities

However, there are some heat mitigation strategies

- Urban vegetation: The cooling of the urban environment is done by plants through evapotranspiration, reflecting the direct sun radiations because of the high albedo, and shading. Application of greenery in an urban environments can be in various ways: Urban forests and parks, scattered vegetation such as street trees and green facades including green roofs and green walls).

- Cool materials: Materials are discussed with their albedo. The application of materials with high albedo to building envelopes results in the heat absorption reduction. In studies, Materials with high albedo in buildings have been especially evaluated in roofs. In addition, cool materials in paving are also evaluated in many cases.

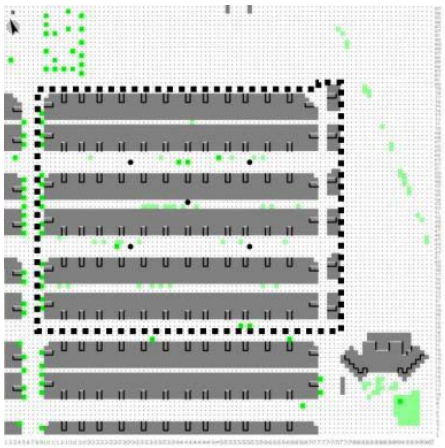
- Built Form: Geometry can be so effective in urban areas going through rapid modifications as a result of the urban expansion and development projects or significant change in current buildings and streets.

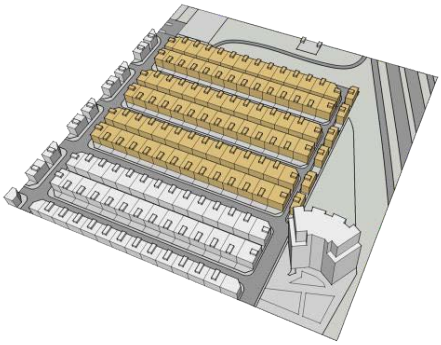
ENVI-met (4.3.0) is used to simulate the environmental conditions.

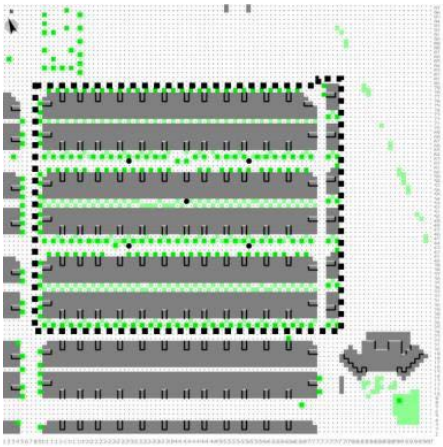
In order to analyze the effects of various mitigation strategies, six models were simulated and compared:

1. Base model (B)

Represents the current situation of the area (with buildings in vacant spaces for future possibilities).





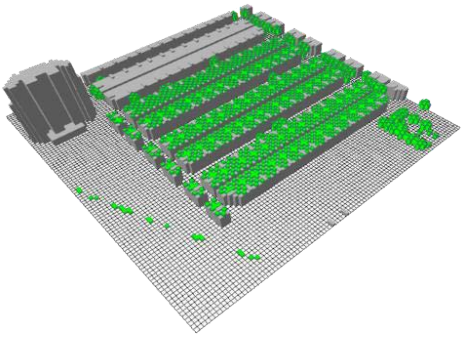


2. Green model (G)

Vegetation coverage increased by 10% of the selected area (showed in Fig. 3). After the increase, half of the greenery consists of trees and the other half includes grass.

3. Green roof model (GR)

50 % of roofs in the selected area were covered with vegetation.



4. Cool roof model (CR)

Roof albedo has increased from 0 3 up to 0 6 in the selected area.

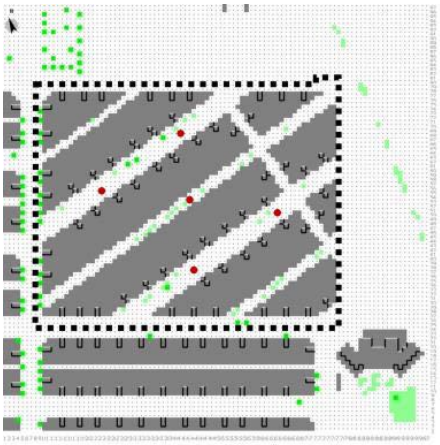
5. Cool pavement model (CP)

The base model has two types of paving Asphalt with albedo of 0 2 and concrete pavement with albedo of 0 4 An increase of 100 was made for a better roof and pavement comparison as the albedo of roofs has doubled too.

6. Rotation model (R)

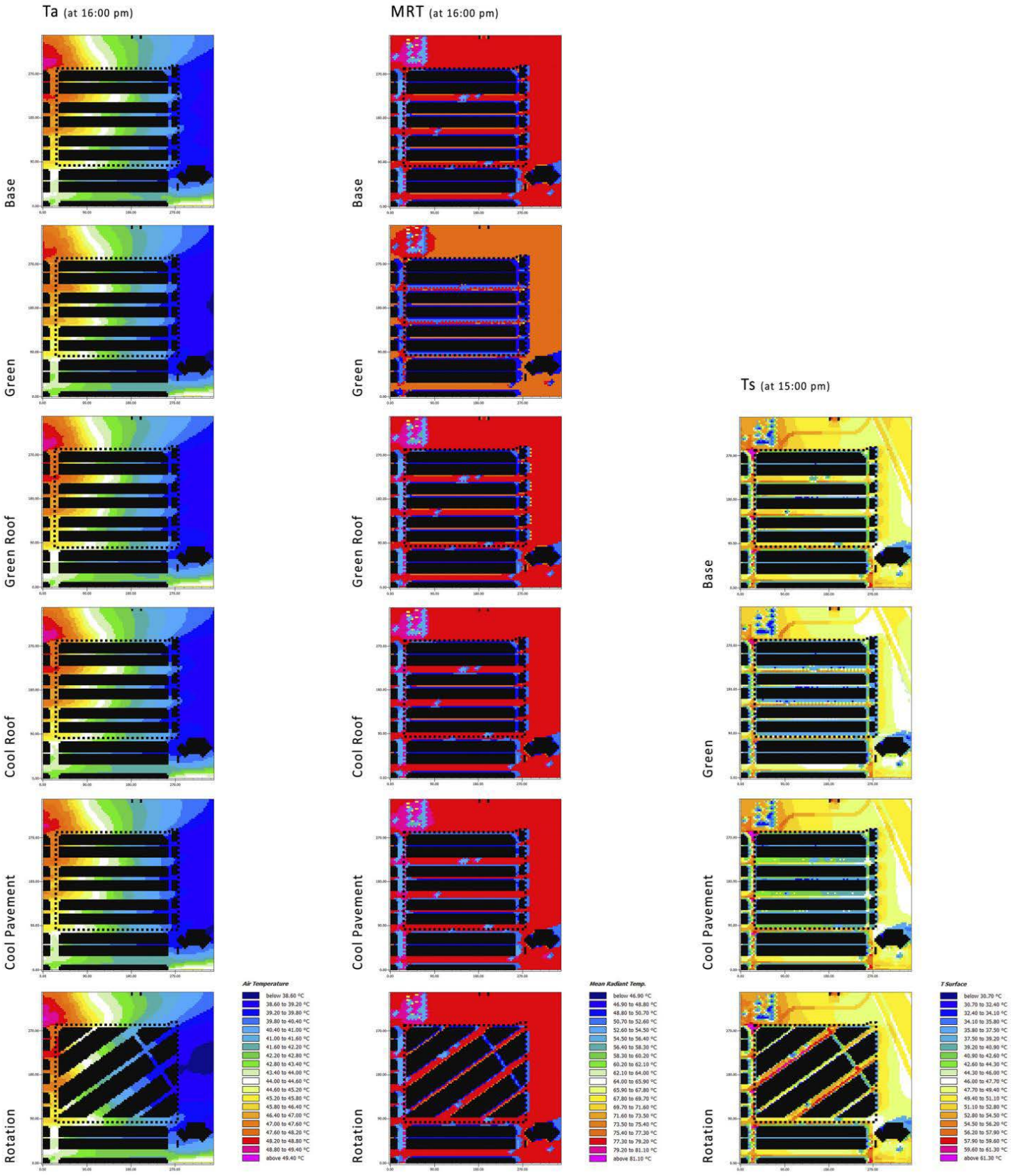
The best orientation for buildings in Tehran is from southeast to south, which is considered in architectural and urban space designs. If the orientation of the building is slightly tilted toward the west, the maximum radiation is received in the afternoon, when the air temperature is maximal, too.

So the air inside the buildings gets very hot in the afternoon. This problem is resolved when the orientation of the buildings is facing south east. This orientation is observed in many streets of Tehran, so its effect on open spaces should be studied in comparison with the southwest orientation (which is observed in many neighborhoods of district 22).

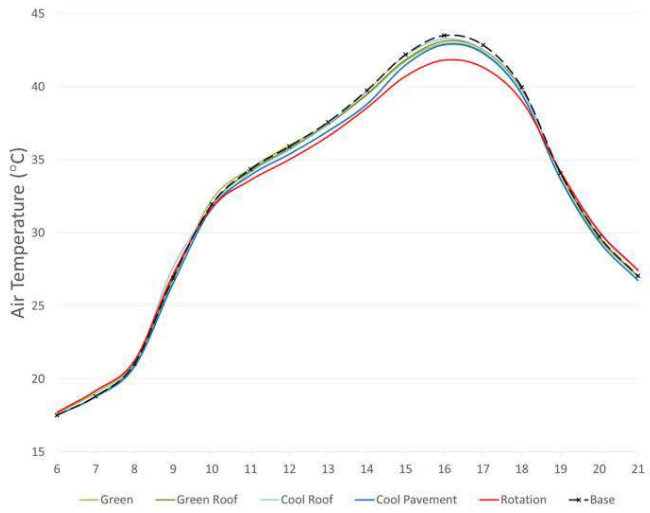


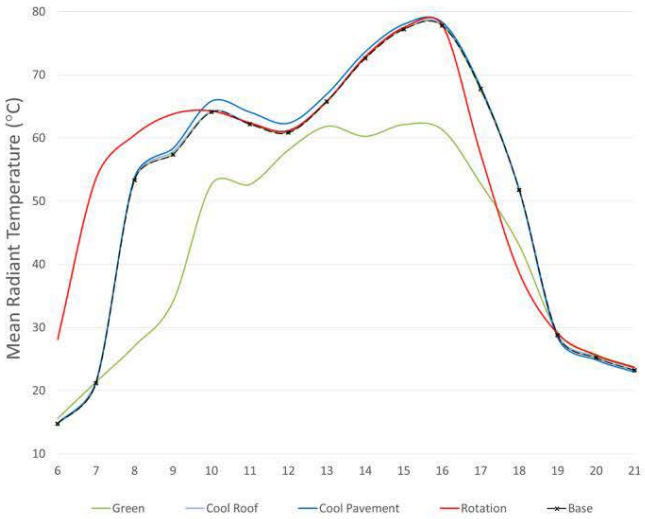
Results

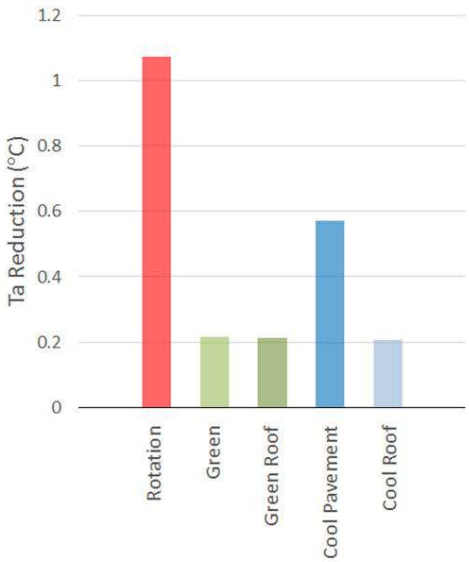
Ta and MRT maps at 16:00 h and Ts maps at 15:00 h

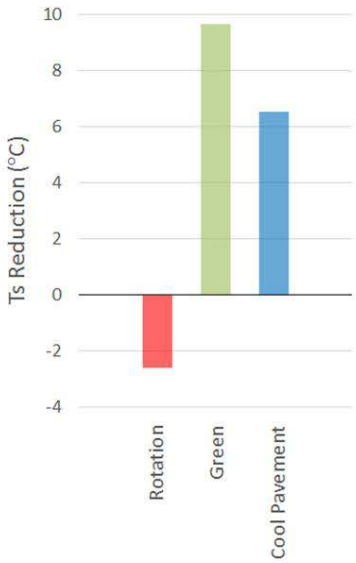


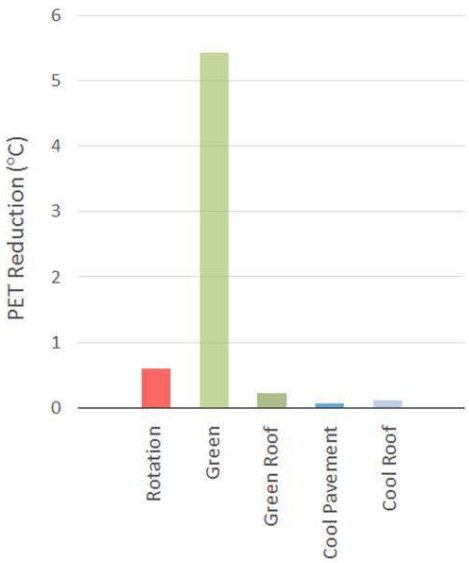
Major results





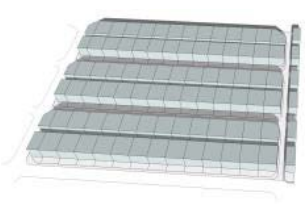


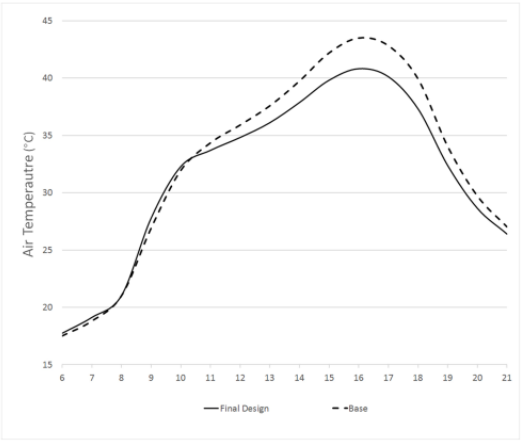




- Correct design of urban forms would significantly mitigate UHI specially for new sustainable construction.
- The best thermal comfort condition was achieved by increase in urban greenery cover.
- There is no significant relationship between UHI mitigation and thermal comfort improvement.
- The key challenge in increasing the number of trees is the reduction of wind speed.
- Application of green roofs does not significantly improve the thermal conditions.
- It can be expected that proper design of urban geometry and the presence of urban greenery and specially trees in sufficient numbers, would improve both UHI and thermal comfort conditions in Tehran

Presenting an alternative





Base Model

Final Design Model