The Effects of Green Space Expansion on the Patterns of Urban Heat Island (Case Study: Velayat Urban Park)

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Received: 1 January 2015 Accepted: 20 June 2015

Extended Abstract

Introduction

The megalopolis of Tehran is the most populated city of Iran with an irregular and unplanned pattern of urbanism. The situation of green spaces is far less than the standards and the distribution of green spaces in the urban area is unequal and heterogeneous. As a result, Tehran has a highly intensified and multi-core heat island located above the various industrially and residentially active regions. The heat island, by the definition, is the increase in temperature of urban area in comparison with that of the suburbs and rural regions. This phenomenon was first measured and defined by Luke Howard. It is nominated due to its spatial appearance. If temperature contours of a city are drawn, it will look like an island surrounded by water. Due to former studies, the heat island appears more in minimum temperatures.

In Tehran, because of numerous factories located in west part of the city and the effects of heat island in the country, the existence of heat island could transfer the pollutants into the urban area and henceforth, this phenomenon is of high importance in health related issues. The intensity of heat island imitates the synoptic weather patterns very much, but its spatial pattern is mainly affected by local conditions and land cover. According to the studies the intensity of Tehran's heat island is a function of synoptic conditions but never reaches zero. Also, many other researches confirm the connection of the land use, especially from natural land use to urban cover, to the heat island. Therefore, one of the best methods to reduce the heat island intensity is to increase the green spaces. However, it may be evident that increase in the green spaces will reduce the heat island intensity, but the rate of the effects may be different. This research was carried out to model and measure the effects of green space expansion on the heat island pattern in Velayat urban park.

Methodology

To measure the green space expansion in the Velayat Park, in the first step, the images for year 2006 and 2013 were obtained using Universal Map Downloader. The images were obtained to extract the pre and post conditions of the green space. Then, the images of the Thematic Mapper sensor (TM), landsat 5, and Operational Land Imager (OLI) and Thermal Infrared Sensor

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(TIRS), Landsat 8, were obtained and each image was processed using ENVI 4.7. The images were divided into four specific land use classes (Asphalt, Soil, Vegetation, and Concrete-representing buildings).The field observation was also inspected for four times to increase the precision. The outputs of this step were entered the Envi-met, a Microscale non-hydrostatic simulation model, with spatial resolution of 20 meters for an area of 3.4 kilometers long and 2.6 kilometers wide.

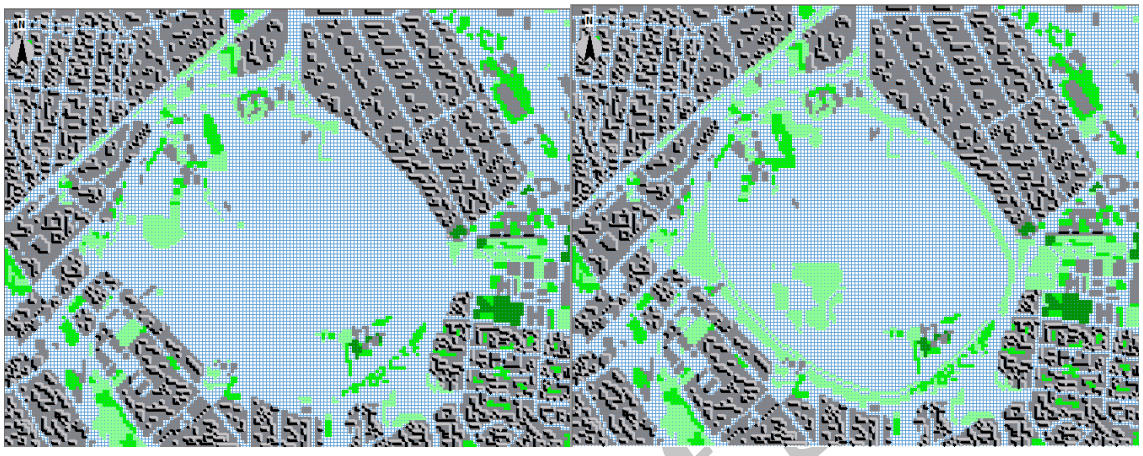
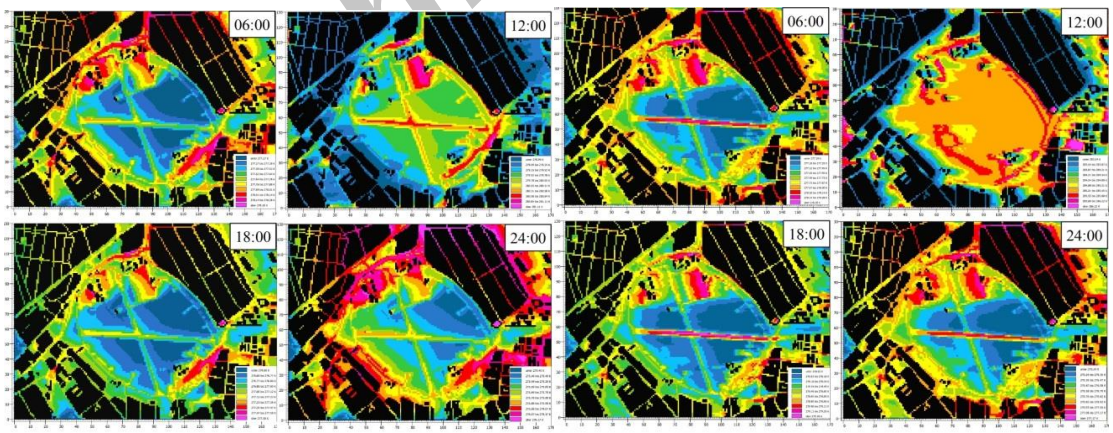


Fig.1. The land uses entered to the model (Envi-met) before and after the green space expansion (right and left, respectively). Green, grey, and blue represent vegetation, buildings, and asphalt and soil surfaces (bare surfaces), respectively

Results and Discussion

After the steps were taken, the simulations were carried out. The results were produced for a 24 hours pattern, but since the patterns were somehow alike and the descriptions would take a larger article to be shown, the results were limited to 6 hours intervals with maximum like-hood. The results are shown in Figure 2.



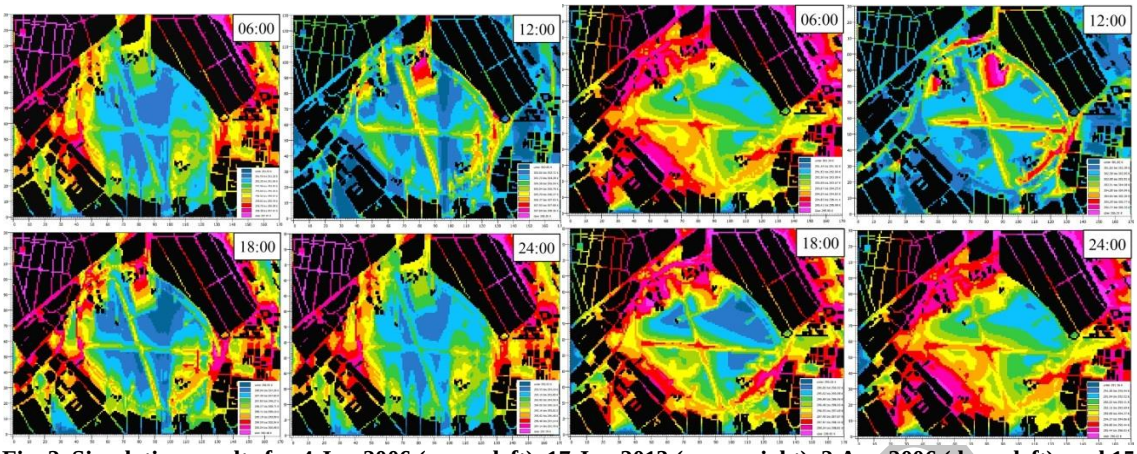


Fig. 2. Simulation results for 4 Jan 2006 (upper left), 17 Jan 2013 (upper right), 2 Aug 2006 (down left), and 15 Jul 2013 (down right) at hours 06:00, 12:00, 16:00, and 24:00 for each day

Conclusion

One of the methods used to study the heat island, nowadays, is modeling of the remotely sensed images. In this research, a microclimatic model (Envi-met) was employed to simulate the effects of green spaces expansion on the spatial pattern of the heat island in the Velayat Park. The results have indicated that the central area of the Velayat Park with soil cover makes a cool island core in most hours. This core is sometimes coherent and sometimes divided into parts. Anyway, the coldest part of the core is located in the northeastern quarter. The thermal gradient is the highest in the western part of the park. The effects of green spaces expansion in this part of the park have intensified this gradient. Furthermore, it seems that in some hours, the air temperature is increased in the edge of the expanded green space. For the heat transfer, since the park is surrounded by relatively tall buildings, the heat transfer is hardly possible. It is clearly evident that around the Bahman Farhangsara (which has almost no construction), the heat and cold tongues penetrate out of Velayat Park boundaries. Hence, it could be concluded that if the height of the buildings around the park is changed, the cooling effect of the park will expand more efficiently.

It was also discovered that the effects of green space expansion are most evident at 12:00 in winter when (after the expansion) temperature differences in the central zone of the park show a reduction in comparison with those of the pre-expansion pattern. It could also be seen that the effects of the asphalt road passing through the park is almost vanished at daytime while its effects could be easily witnessed before the expansions. In summer, two points should be notified: first, in August 2nd 2006 in which the wind is southward, all temperatures are moved southward unexceptionably. The second can be seen in all times when the effects of green space expansion appear with the increase in temperature differences. It is clearly evident that in summer when the sun shine is more, the more homogenous the surfaces are the less the temperature differences will be and vice versa. In warm seasons, the rate of cooling is also different due to the variant thermal characteristics of the surfaces. Hence, in summer pattern, in both diurnal and nocturnal hours, the expansion of green spaces is equivalent to increased temperature differences. Therefore, two different thermal patterns may be seen in warm and cold seasons.

Keywords: green space, thermal pattern, Velayat Urban Park, urban heat island.

References

1. Abdi.F, Azmon. I, 2011, Practical approach on the basic patterns of systematic thinking, Chalesh Press