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MICROCLIMATE OF HOUSE GARDENS AT TAY LOC WARD, HUE CITY

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ABSTRACT

The subject of this research is the effect of house gardenonmicroclimate, especially in the hot season with southwest foehn wind . The research is carried out by examining the vegetation structure oftraditional house gardens as well as new ones and their effects on microclimate. Monitoring results on some hot waves in 2017 shows that in the traditional house garden, there are many vegetation layers, high LAI, etc, as a result, it lowered the temperature by up to 3 - 5 ^{0}C, the humidity is 6 - 14% higher as compared to the data of the Hue station; as for the new house garden, the survey data is not much different from Hue station. When it comes to the comfort temperature of hot season ranging from 29 to 29.5 ^{0}C, the temperature in the traditional house gardens has little difference than that of the new house gardens.

Keywords: ability, microclimate, traditional house garden, Tay Loc ward.

TÓM TẮT

Vi khí hậu vườn nhà tại phường Tây Lộc, thành phố Huế

Bài báo này nghiên cứu hiệu ứng của vườn nhà ở phường Tây Lộc đối với vi khí hậu, đặc biệt vào mùa nắng nóng có gió foehn Tây Nam hoạt động bằng cách khảo sát cấu trúc của lớp phủ thực vật ở vườn nhà truyền thống và vườn nhà kiểu mới, ảnh hưởng của chúng đối với vi khí hậu. Kết quả quan trắc vào một số đợt nắng nóng năm 2017 cho thấy, ở vườn nhà truyền thống do có tầng tán thực vật nhiều, chỉ số LAI lớn… nên khi so sánh với trị số quan trắc của trạm Huế thì ở đây có nhiệt độ thấp hơn từ 3 - 5^{0}C, độ ẩm cao hơn 6 - 12%; còn ở vườn nhà kiểu mới các giá trị này không chênh lệch nhiều và đối chiếu với ngưỡng tiện nghi nhiệt vào mùa nóng là 29 - 29,5^{0}C thì nền nhiệt của vườn nhà truyền thống cũng chênh lệch ít hơn, còn vườn nhà kiểu mới chênh lệch nhiều hơn

Từ khóa: khả năng, vi khí hậu, vườn nhà truyền thống, phường Tây Lộc.

1. Introduction

Hue city has a high density of trees and itis famous for the house gardens system. Compared with the previous time, the number of house gardens at Tay Loc ward, Hue city has decreased considerably. However, there are more than 30 traditional house gardens and dozens of new house gardens, that do not follow the rules of traditional house gardens at Tay Loc ward. There are significant differences between the two types of gardens such as

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level of cover, number of vegetation layers, type of vegetation, purpose of garden construction... Air temperature, relative humidity, wind speed and shade of the trees in the two types house gardens are measured to assess the correlation between parameters that affect the microclimate of two house gardens during the hot season. The results will provide additional data to confirm the great role of house gardens in the amelioration of microclimate. This will be a database for the project to restore the house gardens in Hue city.

2. Methodology

The investigation and survey on the number, the structure of home gardens as well as the growing features of plants in these house gardens are carried out with the help of common tools such as bamboo pole, tape measure and glass clamp.

Previously (before 1975), about 2/3 of Tay Loc ward is the traditional house gardens, hundreds of gardens with an area of over 1,000 m^2. Each of the house gardens has the area of construction is smaller than the area used many times.

In recent times, the garden system of Hue city in general and Tay Loc ward in particular have tended to change less actively. Many traditional gardens have been demolished, subdivided, with the area built up in the garden increased. Preliminary survey showed that there are only about 18 gardens with an area of 1000 m^2, 25 gardens from 500 m^2- 1000 m^2 in the area. The number of traditional gardens with many layers of vegetation, high coverage, diversity of plant species is rare. New types of gardens have grown with many ornamental plants of less variety and less vegetation than traditional house gardens.

Identifying the "LAI" index of several popular types of trees in the house gardens:

Table 1. *Names, leaf area indices, canopy thickness of the 10 species of trees common in house gardens at Tay Loc ward*

Scientific name	Common name	Leaf area index (LAIz)
Scheffera octophylla	Dwarf Umbrella Tree	1.5 - 2.2
*Tamarindus Indi*a	* Tamarind tree	3.1 - 3.6
Dracaena Fragrans	Chinese money tree	1.0 - 1.8
Ficus benjamina L	Weeping Fig Tree (bonsai)	0.3 - 1.0
Melia azedarach L	* white cedar	2.4 - 3.5
Nephelium longana	* Logan tree	4.5 - 7.5
Artocarpus heterophyllus	* Jackfruit tree	4.7 - 6.2
Chrysophyllum cainnino L	* *Star Apple*	5.1 - 6.7
Mangifera Indica L	* Mango	5.5 - 8.2
Adenium obesum bonsai	Desert Rose (bonsai)	0.2 - 0.3

(*) The trees common in traditional house gardens at Tay Loc ward. [Souces: Authors]

Air temperature, humidity, wind speed in the traditional house gardens and in the new house gardensare carried out by multifunctional environmental measuring device PCE-EM882. All measurements were made in the hot season (June, July and August) and in the early hours of the afternoon, from 13.00 to 14.00. Air temperature, humidity and wind speed were measured at a height of 1.5 m from the ground in the shade of trees, avoiding the sun.

The analysis of temperature, humidity, wind speed surveyed in 2 types of house garden in comparison with standard microclimate allowed in the workplace, living space, human activities issued by the Ministry of Health of Vietnam has drawn conclusions about the impact of garden types on microclimate.

Quick interviews with two people per household in two types of house gardens about their ability to adapt in the record hot days and the cost of cooling microclimate are conducted.

3. Research results

There is a big difference in temperature and humidity in hot season in two types of house gardens at Tay Loc ward.

Hue city has high density of trees, partly due to the dense presence of house gardens. Many studies suggest that the garden system in the city is considered to adapt to extreme weather condition. In the city of Hue, in the hot season, there are often hot and dry southwest foehn winds when the temperature can reach 39 - 40 ^{0}C, the humidity is very low, sometimes less than 50%. The cold season is also the rainy season, with the northeast monsoon, when the temperature drops, sometimes to 20 ^{0}C or lower.

Figure1. *The traditional house gardens at Tay Loc ward*

Figure2. *The new house gardens at Tay Loc ward*

Trees have apositive effect on good microclimate through three mechanisms [1], that is: Appropriately situated trees can prevent some solar radiation from striking buildings, thus reducing initial heating and heat storage (Simpson and McPherson, 1996); Trees can act as wind breakers to modify the ambient conditions around buildings. Scattered trees planted throughout a neighborhood were found to increase surface roughness, thereby reducing wind speeds (Heisher, 1990); Low wind speed can reduce the

penetration of outside air into the indoor space, which can be beneficial throughout the hot and cold seasons (Akbari, 2002). Trees can lower high levels of air temperature through evapotranspiration (Akbari, 2002).

Evaporation on hot days in an area with good urban forest cover can notably decrease air temperature and increase humidity (Akbari, 2002). The effect of trees shade on air temperature, surface temperature, relative humidity, solar radiation and solar transmission are also compared in relation to the leaf area index (LAI) [2], [3]. It is found that the air temperature under the canopy can be reduced between 0.67 ^{0}C to 2.55 ^{0}C, while the surface temperature can be reduced from 3.23 ^{0}C to 8.15 ^{0}C [2].

In the hot season, higher LAI species will give more cooling effect. The ever green trees provide shade throughout the year, while deciduous trees provide shade for the hot season and for the sun in the cold winter [2], [4]. The survey results of the research group in 18 traditional house gardens generally show similar results. That is: The trees with high LAI $\geq$ 5 air temperature in the canopy compared to the canopy outside reduced from 2 to 3^{0}C, while the trees with LAI from 7 to 8 reduce the heat from 4.5 ^{0}C to 6.2 ^{0}C

The data on temperature, humidity measured during the heat waves in June, July, August, 2017 in 18 traditional house gardens and modern house gardens show a clear difference in microclimate of the two types of gardens.

Below is the actual survey data in one of the hottest heat waves in Hue city. The survey data in other heat waves also showed similar results. Table 2 shows the difference in temperature, humidity between the two types of house gardens.

Table 2. *Differences in air temperature, humidity in two types of house gardens at Tay Loc ward and their differences as compared to the observation data recorded at the Hue station in the heat wave from 31/5 - 5/6/2017*

[Souces: Authors]

Day	The traditional house gardens				The new house gardens			
	Temperature (^{0}C)	**The arithmetical difference	Humidity (%)	**The arithmetical difference	Temperature (^{0}C)	**The arithmetical difference	Humidity (%)	**The arithmetical difference
1/6	32.2 - 33.6	(-) 5.0 - 5.5	60 - 75	(+) 11 - 12	35.8 - 37.0	(-) 0.7 - 1.4	55.0 - 64.5	(+) 0.5 - 3.0
2/6	32.2 - 34.5	(-) 4.3 - 4.8	60 - 72	(+) 8 - 12	36.0 - 37.1	(-) 1.7 - 2.0	52.0 - 64.5	(+) 0.5 - 3.0
3/6	32.0 - 35.0	(-) 3.5 - 5.0	60 - 69	(+) 10 - 14	36.8 - 38.0	(-) 0.2 - 0.5	50.0 - 57.0	(+) 2
4/6	33.6 - 35.0	(-) 4.0 - 4.7	62 - 71	(+) 6 - 12	36.5 - 37.5	(-) 1.5 - 1.8	51.0 - 62.0	(+) 3

Notes: (**) The arithmetical difference (as compared to the data collected at Hue station).
(-).decrease; (+) increase

Table 2 shows that the difference in temperature, humidity between the microclimate in traditional house gardens with Hue station is quite significant, the temperature is 3 - 5 ^{0}C lower, the humidity increases from 6 to 14%. Meanwhile, in the new house gardens, these figures are not much different.

Compared to the standard microclimate, the temperature, humidity in the traditional house garden does not differ too much and residents have more opportunities to adapt easily, without the support of cooling equipment, thus reducing the cost of energy. In contrast, in the new house gardens the temperature is much higher, the humidity is lower and the demand for cooling technology is huge, so the cost of electricity increases.

It can be said that this is the result of differences in the structural characteristics of trees in two types of garden. Field surveys show that in the traditional house garden there are many types of woody plants with high shade, which are important conditions for the formation of good microclimate in the hot season, specifically, in the home gardens of No. 12 Luong Ngoc Quyen, No. 1, No. 3 Tran Nhat Duat, No. 33 Tran Van Ky, etc, common evergreen species such as longan (*Dimocarpus longan* Lour), jackfruit (*Artocarpus heterophyllus Lam.*), peach (*Prunus persica* Stokes.), millet tree (*Chrysophyllum cainino*), mango (*Mangifera Indica L*), etc, with average height from 10 - 15 m, tree age from 20 to 50 years, large LAI (Table 1), so the canopy cover of the garden is very high from 0.4 to 0.5.

Therefore, in the most severe heat waves, the maximum temperature measured from 32.0 - 34.7 ^{0}C, humidity from 60 - 75%, the difference is not much compared to the comfort temperature this season from 29 to 29.5^{0}C. Gardens with 4 - 5 layers of vegetation, a large coverage of 45 - 55%, prevent the wind speed (low wind velocity, from 0.8 to 1.5 m/s) to reduce the penetration of hot dry air into the house.

Table 3. *Ability to form good microclimate of two typeshouse gardens at Tay Loc ward*

[Souces: Authors]

Evaluation criteria	**Ability to meet**		**Structural characteristics of the garden**	
	Traditional home garden	New home garden	Traditional housegarden	New house garden
Appropriately situated trees	****	****	4 - 5 vegetation layers; Diversity of plant species; Many types of trees are 10 -15 m high, big shade; high cover level; crop layout according to certain rules.	the number of vegetation layout is little, many kinds of ornamental plants, less diverse species, little or no species of tall trees, low coverage; crop layout is not according to certain rules.
Big LAI	****	**		
Many layers of plants	***	*		

Notes: Ability to meet: *** High; *** Pretty high; ** Medium; * Low.

Table 3 shows that the decline of trees in house gardens is one of the major causes of reduced good microclimate. Preliminary measurement data in the heat waves, initially showed that the ability to create good microclimate of two types of gardens at Tay Loc ward is very different. In general, new house gardens have the ability to form good microclimate at a low level while traditional house gardens are high level.

The difference in microclimate between the two types of home gardens is also analyzed by the feeling of the people living here about the weather during the heat waves.

The survey found that 85% of people living in traditional house gardens said that in the heat waves, in daily activities, they did not feel too tired from the heat because shade from the trees in the garden has cooled down the living space. Total time spent with cooling equipment in a day and night is from 3 to 4 hours,particularly the time from 23.00 to 6.00 the next day residents have no need to use the device.

In contrast, in new house gardens, the total time spent with cooling technology in a day and night is between 10 - 12 hours. 95% of respondents said that they often feel hot, tired during hot days. Most of them have plans to improve their thermal comfort in the future.

Therefore, the cost of electricity consumed in hot months increases. The average cost of electricity consumption of two types of house garden is very different. For traditional house gardens, there is a 5% - 10% increase while new house gardens increase from 45% to 68%.

4. Discussion and conclusion

Preliminary results show that, in the hot season traditional house gardens are capable of producing better microclimate at much higher levels than new house gardens. The values of humidity, temperature observed in the traditional house gardens do not change much compared to the microclimate standard, and the cost of cooling for microclimate is almost negligible. Large shade, large cover of green trees in the garden, many layers of vegetation are important factors to create that ability. To improve the quantification of research results and the reliability of scientific judgment, the data collected over many year and the use of modern equipment for monitoring temperature and humidity in the gardens need to be added.

Faced with the fact that the number of traditional house gardens in Tay Loc ward is decreasing, most of the trees in the gardens are old, the ability to improve microclimate will gradually decrease. Therefore, it is necessary to promote the protection program, renovation of traditional house gardens, the direction of microclimate improvement to reduce the severity of climate in the area. The priority issues that need to be done are the comprehensive statistics on the number and classification of houses gardens at Tay Loc ward, the analysis of the impact of the specific garden structure in the area on the microclimate. It is also necessary to propose a typical house garden for microclimate improvement and to encourage people to use their garden to adapt to climate change.

❖ ***Conflict of Interest:*** *Author have no conflict of interest to declare.*

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