EFFECTS OF GREENERY ON CITY COMFORT IN DIFFERENT MICRO CLIMATIC CONDITIONS

R U Halwatura,
Department of civil Engineering
University of Moratuwa
Telephone: +94777704826
E-mail: rangikauh@gmail.com

N M Nishad,
Skills Academy
Telephone: +94777771382
E-mail: acnmnishad@yahoo.com

Abstract

Due to the rapid urbanization of the world, more people leave villages and migrate to cities. The rapid growth of population and development in cities create uncomfortable living environment to human beings. These cities are significantly warmer than its suburbs/outskirts/peripheries. The main cause for this unfavourable condition is the modification of natural greenery by urban development and the changes of the thermal properties.

This study discusses the effects of temperature and relative humidity on buildings with surrounding environment. This was carried out in Colombo, Kandy and Nuwera-Eliya, which belongs to three different micro climatic conditions. Temperature and humidity measurements were taken with the presence of two different green cover and were compared with each other. The temperature readings illustrated a clear difference between greenery and low greenery environment. Nuwara-Eliya showed a significant difference with the increase of altitude than the other two cities. Temperature effects of trees were very high in Colombo when compared with other two cities as the traffic congestion and heat island effects are very high there. In greenery, relative humidity variation in Colombo is identical with low altitude and cities having high heat island effect than other two cities. With the observations made, the effect of trees in law altitude areas are comparatively high than other cases with respect to thermal comfort of the cities.

Key words: Micro climatic condition, Heat island effect, Traffic congestion, Low altitude, Greenery

1.0 INTRODUCTION

The rapid urbanization in many developing countries over the past half century seems to have been accompanied by excessively high levels of concentration of the urban population in very large cities. More than 70 million of residencies are added to the urban cities each year. These manmade structures and the changes which take place cause extensively negative effects on nature. . This will create an artificial environment and destroy the greenery of the earth planet. Unbalanced climate changes will affect the water cycle, increase temperature and cause uncomfortable humidity which may ultimately create Urban Heat Island (UHI) in the planet earth [1].

The world is categorized into different zones according to its climatic conditions. One such identified climatic condition is the tropical climate condition. The countries which are closer to the equator are mostly falling into this category. The tropical wet climatic conditions have the characteristics of high daily temperatures ranging between 20°C to 30°C, has uniform precipitation all year round, and the total rainfall over 2000 millimeters or greater. The humidity levels in these regions vary from 60% to 95%. In some months of the year the temperature is relatively high. In these months the heat island effect becomes prominent. Urban Heat Island effect is defined as the rise in temperature of any man-made area, resulting in a well-defined, distinct "warm island" among the "cool sea" represented by the lower temperature of the nearby natural landscape of the area. This phenomenon is unavoidable in the cities of countries where the daily mean temperature is high [2].

More than half of the world population lives in urban areas. Nevertheless, not all regions of the world have reached this level of urbanization. According to the World Urbanization Prospects report, it is expected that half of the population of Asia will live in urban areas by 2020, while Africa is likely to reach a 50 per cent urbanization rate only in 2035. Between 2011 and 2050, the world population is expected to increase by 2.3 billion, passing from 7.0 billion to 9.3 billion [3].

Urbanization is the physical growth of urban areas as a result of global change. The rapid urbanization of the world’s population over the twenty-first century is described in the 2011 Revision of the UN World Urbanization Prospects report. The world is undergoing the largest wave of urban growth in history. In 2008, for the first time in history, more than half of the world’s population was living in towns and cities. By 2050 this number will swell to almost 6.3 billion, with urban growth concentrated in Africa and Asia. While mega-cities have captured much public attention, most of the new growth will occur in smaller towns and cities, which have fewer resources to respond to the magnitude of the change [3].

The urbanization process refers to much more than a simple population growth; it involves changes in the economic, social and political structures of a region. Rapid urban growth is responsible for many environmental and social changes in the urban environment and its effects are strongly related to global change issues. The rapid growth of cities strains their capacity to provide services such as energy, education, health care, transportation, sanitation and physical security.

Sri Lanka is a country which is located in the Indian Ocean at the latitude of 5°-10°N and longitude of 79°-82°E. Climatic condition in Sri Lanka is tropical wet. Country is divided into nine provinces with 25 districts. The major district, Colombo which is in the Western Province is a highly populated urban city in Sri Lanka and is sited below the 30 meter mean sea level and some areas in the east of Colombo are even below the sea level. It has a very low altitude than other two cities considered for the study and an average temperature at day is 30°C. The city of Kandy lies at an altitude of 488.6 meters above sea level in the center of the island and is surrounded by ranges of mountains. Mean temperature level in city 28°C. Nuwara Eliya is situated at an elevation of about 1745 m above mean sea level and is surrounded by a significantly large green environment and mountains. Mean temperature level in the city is 15°C [4]

The population in Sri Lanka is still predominantly rural, with only a quarter of the population living in urban areas-broadly defined as the areas designated as Municipal, Urban and Town councils. The rate of urban growth in Sri Lanka has been relatively low. The urban population increased by 2.2million from 1946 to 1981, while the total population increased by 8.1 million. But the population living in the urban areas is aggregated to small areas leaving 3000 persons per square km meter in 1996 while nine districts have a population density in the excess of 400 persons per sq km meter. The Colombo urban area and the adjoining suburbs accommodate nearly 60 per cent of the urban population, 80 per cent of the manufacturing industries, and over 60 percent of the vehicles in Sri Lanka. Excessive concentration of industry in the Colombo and Gampaha districts has resulted in problems such as scarcity of labour, road congestion and problems of air, water and noise pollution [5].

The buildings, concrete, asphalt, and the human and industrial activity of urban areas have caused cities to maintain higher temperatures than their surrounding countryside. This increased heat is known as an urban heat island. The air in an urban heat island can be as much as 20°F (11°C) higher than rural areas surrounding the city [6].

Climate is defined as the condition of the atmosphere at a particular location over a long period of time (from one month to many millions of years, but generally 30 years). Climate is the sum of

atmospheric elements (and their variations), solar radiation, temperature, humidity, clouds and precipitation (type, frequency, and amount), atmospheric pressure, and wind (speed and direction). Due to the location of Sri Lanka, within the tropics between 5o 55' to 9o 51' North latitude and between 79o 42' to 81o 53' East longitude, the climate of the island could be characterized as tropical [7].

The central part of the southern half of the island is mountainous with heights more then 2.5 Km. The core regions of the central highlands contain many complex topographical features such as ridges, peaks, plateaus, basins, valleys and escarpments. The remainder of the island is practically flat except for several small hills that rise abruptly in the lowlands. These topographical features strongly affect the spatial patterns of winds, seasonal rainfall, temperature, relative humidity and other climatic elements, particularly during the monsoon season [8].

Strategic planting on valuable free space, such as roofs and walls in our cities, is set to transform the urban environments of the future. Burnley leads the way in researching the application of vegetation techniques for climate change adaptation, and our experts consult with councils and developers to initiate green roof installation in cities. There are several methods are available to design green environment to the urban cities [9].

2.0 OBJECTIVES AND THE METHODOLOGY

The main aim of this research is to identify the change of temperature and humidity inside the dwellings according to the surrounded environments. In this task the research provides a thermal comfort level of greenery and non-greenery environment in Sri Lankan cities.

Measure the temperature and humidity changes within a 08.00hrs to 18.00hrs time period in 15 minutes intervals in three cities in Srilanka, Colombo, Kandy and Nuwara Eliya.

- Find the temperature and humidity changes in greenery environment building in each city.
- Find the temperature and humidity changes in low greenery environment building in each city.
- Plot and analyze the data of temperature and humidity changes reading by computer simulation.

3.0 DATA ANALYSIS AND FINDINGS

The analyses of plotted data illustrate the temperature and relative humidity variations in Colombo, Kandy and Nuwara Eliya according to their altitude increases and climatic conditions with greenery and low greenery environments. Colombo is a highly populated urban city in Srilanka and is sited below the 30 meter mean sea level and some areas in the east of Colombo are even below the sea level, this site has very low altitude than other two cities. The two locations in the Colombo area are shown in Figure 1. The University of Colombo premises which is surrounded by lot of big trees where high traffic congestions can be sighted in morning and midday hours. Area near Dematagoda railway station was identified as a low greenery area.

Figure 1: Greenery and Low greenery area of Colombo.

The city of Kandy lies at an altitude of 488.6 meters above sea level in the center of the island and surrounded by ranges of mountains. Readings were taken from Katugasthota, Ugurassapitiya which are shown in figure 2. Ugurassapitiya is the greenery area shown in figure 2 (C) and Low greenery area is Katugastota, near Kandy Indra Traders shown in figure 2 (D).

Figure 2: Greenery and Low greenery area of Kandy

Readings from Nuwara Eliya which is located at an elevation of about 1745 m above mean sea level and is surrounded a green environment and mountains was taken near Craigbank hotel Nuwara Eliya as shown in figure 3 (F). It is surrounded with lot of vegetation and the reading of the low vegetation area was taken from Hill Road junction at Nuwara Eliya which is shown in the same figure (E).

Figure 3: Greenery and Low greenery area of Nuwara Eliya

3.1 EFFECT OF TEMPERATURE AND RELATIVE HUMIDITY IN COLOMBO

Figure 4 shows the temperature change curves from 8.00 hrs to 18.00hrs in green and low greenery environments in Colombo. In the morning hours low greenery environment curve shows nearly 2^{o}C increases than greenery atmosphere. Following the increases in heavy traffic congestion and industrial activities in midday, the city temperatures rise gradually and maintain less than 0.5 ^{o}C intervals between both environments. Subsequently the temperature of the greenery area goes down while the temperature of the low greenery environment increases up to the15th hour as shown in the graph. At the end of the day temperature of both the environments comes down to almost the same level. This decrease of temperature in the greenery area of the urban city provides a more comfortable residential atmosphere than the low greenery environment.

Relative humidity (RH) variation in Colombo green and low green environment is also shown in figure 4. RH value in low greenery area is higher than greenery area in the morning hours. In the midday RH of greenery area is higher than of the low greenery area from the effect of traffic congestions and high evaporation in the city. The highest was 77% in the greenery and 71% in the low greenery areas during the midday hours. After the 17.00 hour, curves change same in the morning hours.

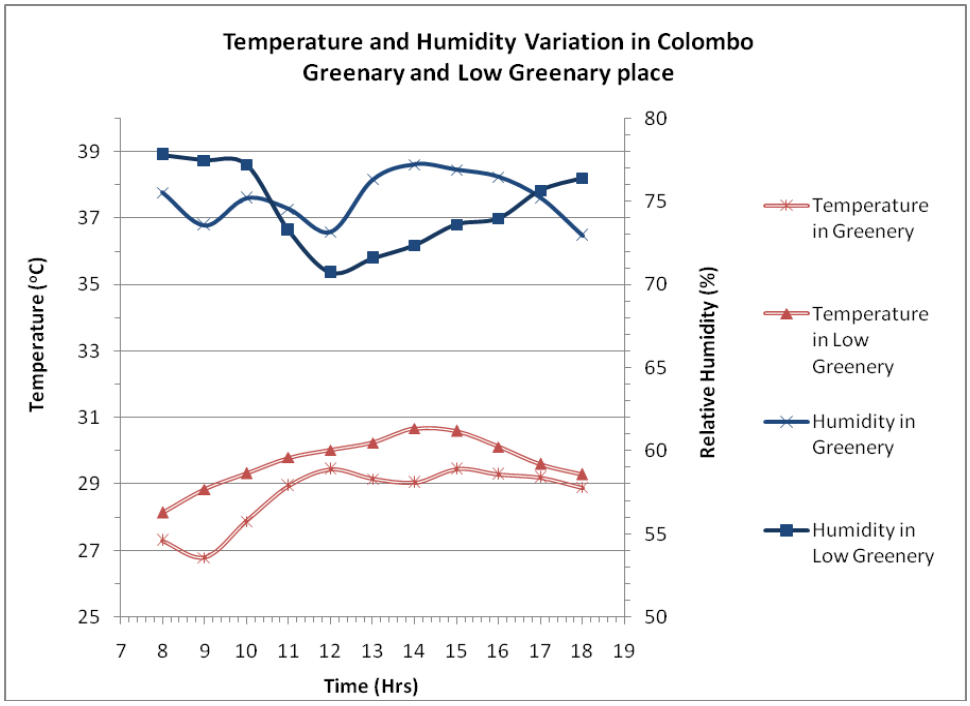

Figure 4: Temperature and humidity variation in Colombo in greenery and low greenery environment

3.2 EFFECT OF TEMPERATURE AND RELATIVE HUMIDITY IN KANDY

Temperature variations in Kandy, with and without vegetation are shown in figure 5. At the beginning of the day, temperature of both the places gets similar values. Along the time axis, the temperature difference of both cases reaches more than 2^{o}C. At the end of the time axis temperature goes down in both environment and shows a similar pattern.

Relative humidity levels in Kandy are different than the Colombo city. In the morning hours RH in the greenery area is higher than the low greenery area. Since the temperature decreases in the green area during the midday, RH readings at the greenery area get decreased than of the low greenery area and it shows 57% and 65% respectively.

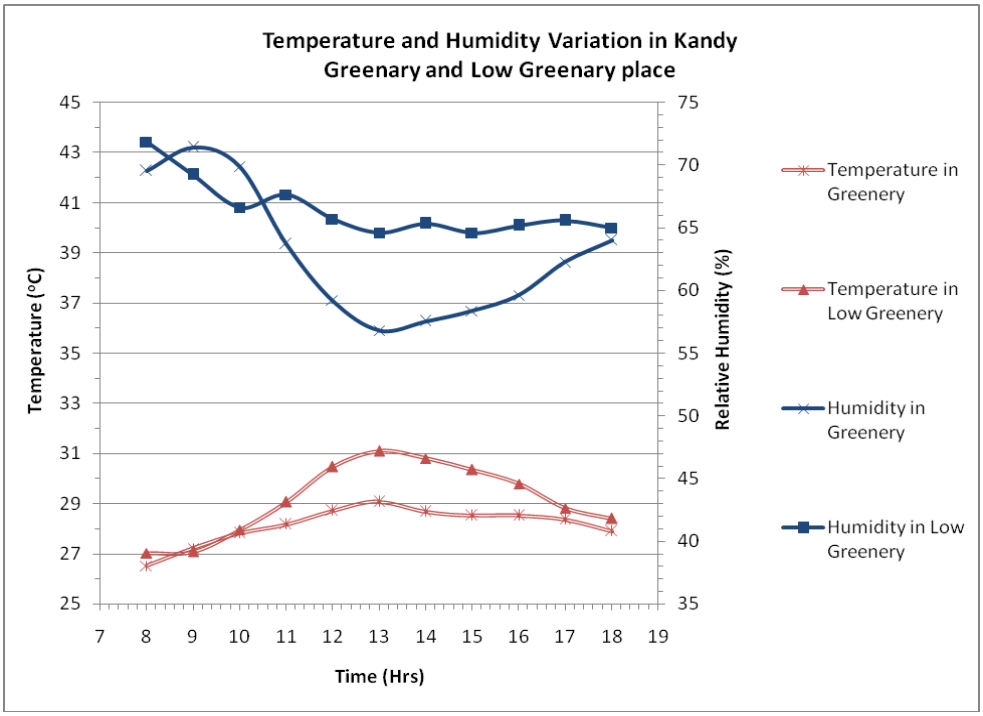

Figure 5: Temperature and humidity variation in Kandy in greenery and low greenery environment

3.3 EFFECT OF TEMPERATURE AND RELATIVE HUMIDITY IN NUWARAELIYA

Temperature curves on figure 6 shows little different between green and low greenery environment in Nuwara Eliya. Till 12.00 hour, it takes up to 23^{o}C degrees. Afterwards greenery area temperature goes down and the temperature of the low greenery area slightly increases in the midday. Maximum values shown in greenery and low greenery environments are 23^{o}C and 25^{o}C respectively. This causes to enlarge the temperature difference of both the environments nearly by 2^{o}C.

The relative humidity in Nuwara Eliya is most of the time higher in low greenery area than the greenery area. Only at 10.00 hour it gets higher in greenery area. In midday, RH at greenery and low greenery area shows the lowest value of 52% and 55% respectively and at 13.00 hour the maximum temperature of 24^{o}C and 25^{o}C is shown respectively. At the end of the time axis RH curve gradually decreases in both the environments as the temperature decreases.

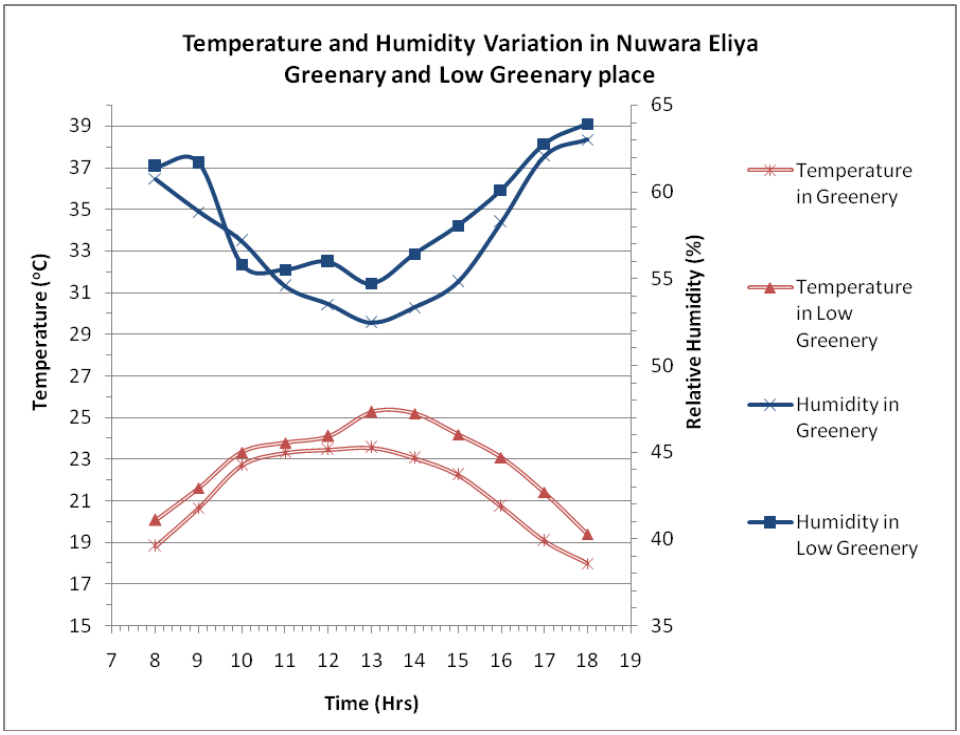

Figure 6: Temperature and humidity variation in Nuwara Eliya in greenery and low greenery environment

3.4 THERMAL EFFECT OF THREE CITIES

Temperature changes in the three cities are shown in figure 7. This illustrates the temperature variation of three cities according to the micro climatic change and altitudes increase. Temperature in Colombo and Kandy low greenery areas are almost the same in the midday at 13.00 hour and it takes nearly 30^{o}C, but in the morning and evening hours temperature is very high in Colombo city. When the greenery environments are compared, Colombo temperature gets close to the Kandy environment which is nearly 29^{o}C. When compared with Nuwara Eliya greenery environment, temperature takes 23^{o}C in midday and decreases by 6^{o}C degrees.

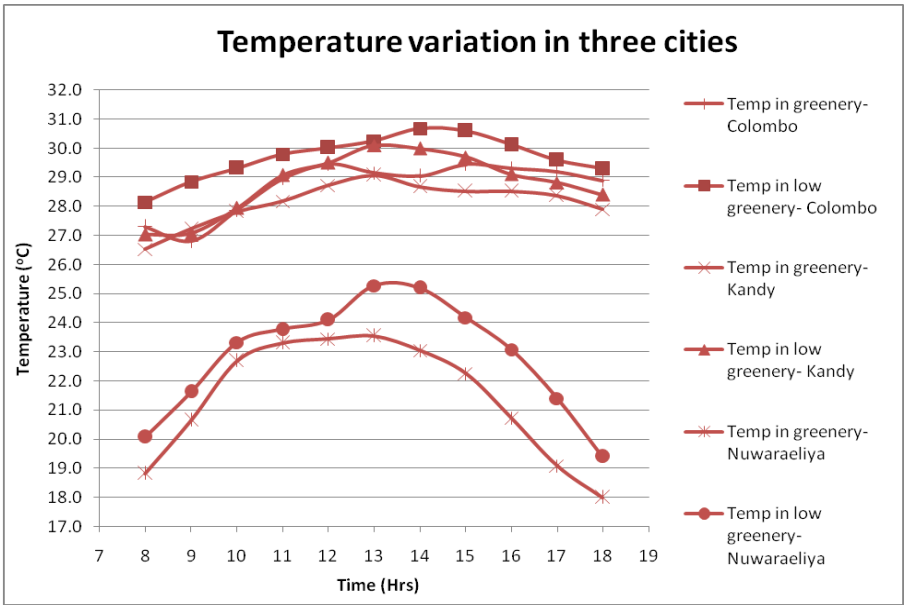

Figure 7: Temperature variation in the three cities

Relative humidity (RH) changes in the three cities are shown in figure 8. These curves illustrate the variation of RH in the three cities with their altitude increases. When comparing the midday hours, in the greenery areas of Kandy and Nuwara Eliya, RH values are very low in greenery than the low greenery areas, and it is 57% and 52% respectively, but in Colombo in greenery, RH was higher than the low greenery and it was around 77%. This huge variation has occurred due to high water vapour amount created in Colombo greenery area during the midday hours. At the end of the time axis RH values of Kandy and Nuwara Eliya get 64% in both cases and in Colombo is about 75%.

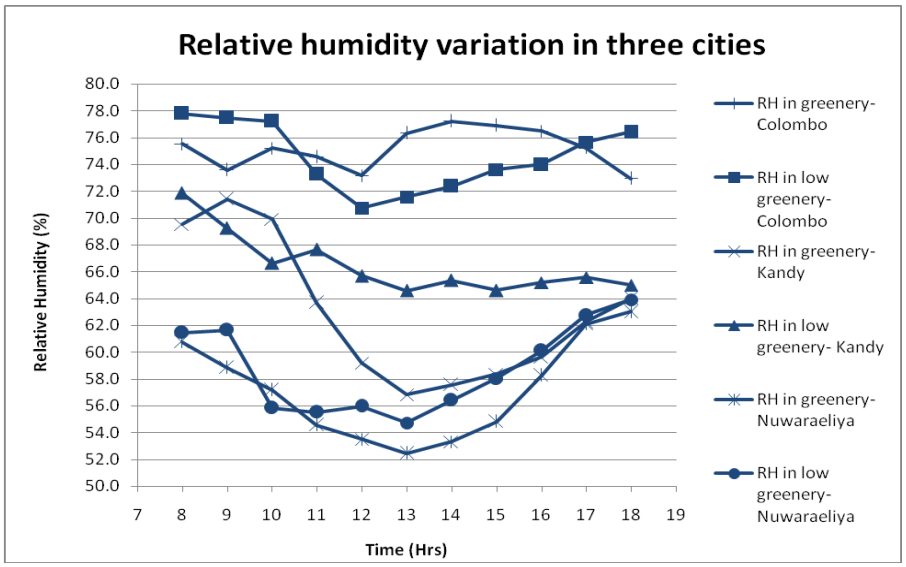

Figure 8: Relative humidity variation in the three cities

4.0 CONCLUSION

The temperature and relative humidity variation in cities with greenery and less greenery environments can be identified from the data analysis of this study. Increase of altitude has colossal effects on both the parameters measured. The humidity level of each city is within the comfortable limits. Temperature decreases by $1^{o}C$ in greenery area than the low greenery area in the urban city, Colombo. Moreover it was noted that the effect of greenery is much higher in low altitude areas than in the up country. Greenery plays an important role in building an environmentally friendly society. It brings many benefits to the environment and the people who have busy days. It is believed that urban cities in the world like Colombo in Sri Lanka can benefit from green surfaces, especially when both walls and roofs are covered with vegetation. Public awareness and building codes can help to encourage the adoption of green roofs and other greenery measures. It is important to help property owners and developers to look beyond the immediate financial burden to realize the long term benefits and the pressing need to achieve a sustainable urban environment.

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