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SOFT LANDSCAPE ELEMENTS: IMPORTANCE AND IMPLICATIONS ON THERMAL CONTROL IN TROPICAL BUILDINGS

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ABSTRACT

Thermal control in buildings is highly essential in the tropics where high solar radiation is received throughout the year. Its importance cannot be overemphasized in the face of climate change which is rapidly changing our world and exposing it to higher risk of environmental disasters. Climate change has been attributed to increased energy use from various human activities which cause a release of carbon dioxide and other green house gases into the atmosphere. Thermal control in buildings is one of the gate ways to minimizing the energy used for cooling. This is achieved by a reduction in the surface temperature using the soft landscape elements such as trees and shrubs to prevent heat gain. This study evaluates the presence of soft landscape elements in some selected areas of Akure metropolis. The study adopted the review of relevant literature in combination with the quantitative method of data collection and used structured questionnaires to collect the necessary data. Data was analyzed using the Statistical Packages for Social Sciences (SPSSx) and results were expressed in simple percentages and frequency. The study reveals that most areas understudied are without soft landscape elements that can help reduce heat gains into the buildings interiors. Consequently, consciously planned soft landscape should be part of the building design and be enforced by the government in order to have reduced energy use in buildings for cooling.

INTRODUCTION

The tropical environment is faced with the problem of keeping heat out of the building, and for greater part of the year, the building serves to keep the occupant cool rather than warm as a result of high temperatures witnessed throughout the year. The tropical climate is made up of three major climatic zones. These are; the warm- humid climates which are found near the Equator, extending to about 15^0 north and south; hot-dry desert or semi- desert climates, found between approximately latitude 15^0 and 30^0 north and south of the equator and composite or monsoon climate which occur near the tropics of Cancer and Capricorn (Koenigsberger, Ingersoll, Mayhew and Szokolay, 1978). Figure 1 shows the area covered by the tropical zone and other climatic regions of the world. Solar heat gain in building is one of the challenges in tropical environment. Nyuk and Yu (2009) asserts that very high solar radiation is received in the tropics and the proportion of diffuse radiation is also very high due to high humidity and cloud cover in the region; this affects the thermal conditions within the buildings. In an attempt to achieve thermal comfort in the tropical buildings, a large amount of energy is utilized for cooling; it therefore becomes important to control heat gains in and around the building environment. There are many ways by which thermal control can be achieved in buildings. These includes protection from heat gains through landscaping, building form, layout and external finishing, thermal insulation and control of internal gains; modulation of heat gains through the use of thermal capacity of the buildings; heat dissipation through rejection of the excess heat to an environmental heat sink (Pavlou and Santamouris, 2007). Landscaping is an effective means of protecting the building from unwanted solar gains and redirecting wind flow to enter the house for natural ventilation. A well planned landscape and strategically planted trees around the building can provide shade and reduce the temperature of the air surrounding the house. Modification of the surrounding climate and irradiance reduction achieved by plants is an efficient means of lowering energy usage for space cooling and it has been shown that about 25-80% savings on air conditioning can be achieved with proper landscaping (Nyuk and Yu, 2009). Large trees can provide shading for walls which can reduce outside wall temperatures and also provide shading for windows as shown in Figure 2.

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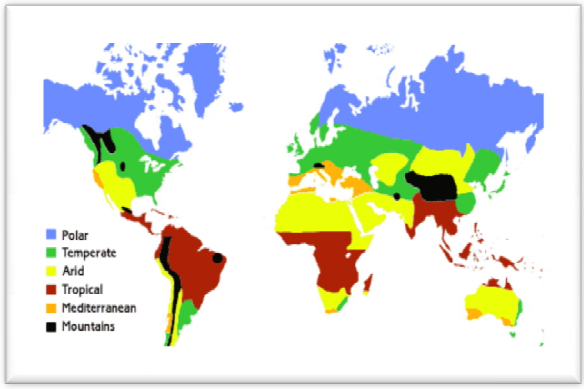

Figure 1: World Climatic zones. Source

Figure 2: The use of climbers and trees to reduce solar heat penetration.
Source: Ogunsote, Prucnal-Ogunsote and Adegbie, (2010).

The main objective of this study is to find out whether soft landscape elements are part of the building and environmental design in such a city like Akure , Nigeria, which is one of the typical cities in the tropics which receives high solar radiation throughout the year. This paper reports the status of the availability of soft landscape elements such as trees, shrubs, grasses, climbers, etc. in Akure, Nigeria, that can assist in reducing solar heat gains and contribute immensely to reduction in cooling loads for thermal comfort in buildings. This, combined with other passive strategies to combat high solar heat gains in tropical buildings will go a long way to achieve a sustainable buildings and environment.

Thermal Comfort in Tropical Buildings

Thermal comfort is one of the basic physical/biological needs of man. The deep-body temperature must stay around 37°C for survival. It is therefore imperative to keep thermal conditions in buildings within acceptable limits (Szokolay, 2008). Thermal comfort was defined by the British Standard BS EN ISO 7730 (ISO 7730, 1994) as that condition of mind which expresses satisfaction with the thermal environment. The thermal comfort zone is the region Stipulated by American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), in the psychometric chart where all the condition can satisfy 80% of the occupants. Thermal balance between human bodies and the environment is very essential for optimal and efficient performance of all human activities.
According to Koenigsberger, Ingersoll, Mayhew and Szokolay (1978), human response to heat and thermal environment does not depend on air temperature alone, but also on humidity, radiation and air movement. All these must be considered simultaneously in order to predict human responses. As noted by Baker and Steemers (2005), thermal comfort is related to the thermal balance between heat gains due to the metabolism of the body and heat losses from the body to the environment; furthermore, the breakdown of the heat-loss mechanism is 20% by evaporation, 35% by convection and 45% by radiation.

The parameters that influence the conditions of thermal comfort include environmental variables such as air temperature, air movement, humidity, radiation; personal factors such as metabolic rate, clothing, state of health and acclimatization; contributing factors such as food and drink, body shape, subcutaneous fat, age and gender (Szokolay, 2008). Air temperature is the dominant environmental factor as it determines convective heat dissipation. In addition, air movement accelerates convection, it also changes the skin and clothing surface heat transfer coefficient as well as increase evaporation from the skin surface thereby producing physiological cooling gender (Szokolay, 2008). The environmental variables are those that are influenced by soft landscape elements such as trees to achieve a conducieve indoor condition. Trees, shrubs, flowers, grasses and climbers can greatly affect the microclimate of an area and thereby assist to achieve thermal comfort. Table 1 shows the climatic data for Akure, from 1983-2004. The average monthly maximum and the minimum temperature is 31.0 and 20.5 respectively, while the average mean monthly maximum and minimum relative humidity is 77.6 and 53.6 respectively. The hour of sunshine is not less than seven hours on the average. This information shows that Akure is a hot city and achieving thermal comfort within the building interior is a problem.

Relevance of Landscape Elements in Building

Landscape depicts a view of scenery and includes features as can be seen in a single view (Ayeni, 2012) and made up of soft and hard landscape elements. Soft landscape elements includes plants i.e. trees, shrubs, flowers, grass, water and earth modelling (Adedeji and Fadamiro, 2011; Ayeni, 2012; Supplementary Planning Guidance, 2013). These help control the microclimate, thereby reducing the amount of heat gain in the house by acting as thermal insulation (Parker, 1981). In the same vein, Shah, Kal and Patki (2002) argues that soft landscape elements deals with types of trees, shrubs, hedges, climbers, ground cover, planning of garden and their maintenance. However, both hard and soft landscape elements are integral part of the building surrounding which help to improve the external spaces. Furthermore, apart from the integration of development into an area, it contributes significantly to the scenery. As noted by Adedeji and Fadamiro (2011) and Ayeni (2012), soft landscape elements are important components in the built environment as they offer amongst others, privacy, break in monotony of views, provide habitat for animals, provide security, seasonal colours and splendour, creates shades as well as environmental aesthetics; and serves the function of absorbing hash winds and absorbs heat from the sun which leads to reduction in heat gains inside buildings (Ayeni, 2012). Furthermore, shading from trees and vegetation is a very effective method of cooling hot air and at the same time helps in protecting the building from solar radiation (Ossen, Majid and Ahmad, 2008).

Table 1: Average Climatic Conditions in Akure (1983-2004)

Akure (1983-2004)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average / Total
Mean Monthly Maximum Temperature (°C)	32.1	33.5	33.4	32.3	31.6	29.0	29.0	28.2	29.1	30.4	32.2	31.4	31.0
Mean Monthly Minimum Temperature (°C)	17.9	20.0	21.7	22.0	21.1	20.8	20.2	20.1	20.2	20.6	21.2	19.8	20.5
Mean Daily Maximum Relative Humidity (%)	66.3	65.1	75.9	78.4	79.6	83.2	86.6	85.8	84.6	79.2	75.2	70.7	77.6
Mean Daily Minimum Relative Humidity (%)	43.6	40.0	48.2	54.0	56.5	59.1	62.8	64.1	61.4	60.3	50.0	43.2	53.6
Precipitation (mm)	10.9	33.5	65.6	79.1	154.4	169.5	209.9	245.7	178.8	180.3	49.0	34.1	1410
Hours of Sunshine	7.9	8.1	7.4	8.4	8.1	7.5	6.9	6.3	7.6	7.6	8.0	7.6	7.6
Mean Wind Velocity (m/s)	0.9	1.1	1.2	1.1	1.1	1.1	1.2	1.1	1.2	1.1	1.1	1.1	1.1

Source : Ogunsote, Prucnal-Ogunsote and Adegbie(2010).

Chen *et al* (2009) acknowledged that landscaping have a large impact on microclimates and are efficient mechanism for cooling communities and neighbor hoods with more trees cooler than those with fewer trees. As such the use of artificial means of cooling can be reduced within the neighbor hoods. To achieve a healthy and comfortable environment, there are three components which need to be considered as argued by Ogunsote and Prucnal-Ogunsote (2002); these include the use of landscaping, building fabric as well as passive technologies. They basically help to moderate the micro climate, maintain the interior and also provide ventilation and lighting.

In the same vein, Mamoud (2011) stated that comfortable and healthy microclimate conditions are necessary for any type of environments and emphasized that the use of green (trees) serves as strategy to improve the microclimate as well as aesthetics. Brown and Gillespie (1995) define microclimate condition as the solar and terrestrial radiation, wind, air temperature, humidity and precipitation in a small outdoor space. And these adversely strongly influence the thermal comfort of people within a landscape. Yunos and Saring (2012) noted that outdoor thermal comfort problems occur due to decrease of green areas and green buffer within area. However, this can be overcome by strategic planting of trees, shrubs and other landscape elements in order to reduce air temperature, glare and heat from the sun. Furthermore, Sandifer (2007) summarizes the effect of planting around buildings to include reduction in direct solar heat gain through shading, reduced radiation, reduced heat gain and improved microclimate.

STUDY AREA AND METHODOLOGY

The study was carried out within two residential areas; the Orita-Obele Residential Area and Apatapiti Residential Layout in Akure, the Ondo State Capital in Nigeria. Akure, became the Ondo State Capital in 1979 and is situated in the South-Western part of Nigeria, and lies on latitude 7^{o} 15' North of the Equator and longitude 5^{o} 05' East of the Greenwich Meridian. 1979 (Fakere and Ayeni, 2013; Ayeni and Ebohon, 2012; Ayeni, 2012; Akinbamijo, 2006; Olujimi and Bello, 2009). The study adopted the review of relevant literature in combination with the quantitative method of data collection and used structured questionnaires to collect the necessary data in order to gauge the views of residents within the two randomly selected residential areas on the importance of landscape elements on thermal comfort in the tropics. The quantitative method used in the study measured the data in numerical terms, while the review of relevant literature allowed in-depth knowledge underpinning the relevance of land scape elements and thermal comfort in the tropics in order to give credible and valid results through the use of various publications. A total sample size of one hundred and thirty nine was estimated for the study with a sample size of sixty nine and seventy respectively per area and administered randomly by 400 Level students of the department of Architecture, at the Federal University of Technology, Akure who acted as research assistants after having been thoroughly trained for the survey; this was neither too small nor too large in order to achieve the objective. At the end of the survey, all the questionnaires (100%) were retrieved and the data obtained from them were collated. Data was analyzed using `the Statistical Packages for Social Sciences (SPSSx) and descriptive statistics used and results expressed in simple percentages and frequency.

RESULTS AND DISCUSSION OF FINDINGS

Respondents' Characteristics

Characteristics of respondents from the two areas studied, that is, Orita-obele Estate and Apatapiti Layout are summarised in Table 1 and Table 2 with 69 and 70 respondents respectively making a total of 139 respondents that participated in the survey. These were analysed using the SPSSx. Analysis of respondents in Table 1 showed that males predominate in the sample, representing 56.5 per cent while female respondents were 43.5 per cent. Also Table 2 also showed that 40 male and 30 female participated, a total of 57.1 and 42.9 percent respectively. This confirms the Nigerian culture having male taking important decisions as concerns households. Most respondents that took part in the survey were married which made up about 71 percent in the Orita obele area and single were about 24.6 percent while the widowed were 4.3 percent as further revealed in Table 1. While at the Apatapiti layout, the singles dominated with 61.4 percent as shown in Table 2. Also, the education backgrounds of respondents showed that majority were educated in both areas surveyed and so are able to understand and respond appropriately. From these, about 49.3 per cent have tertiary education, 42.0 per cent having secondary education.

Also, 7.2 percent had primary education while only one person representing 1.4 percent did not have any form of education as revealed in Table 1. However, Table 2 showed all had one form of education or the other, made up of primary, secondary and tertiary with 1.4, 27.1 and 71.4 percent respectively. Furthermore, many of the participants were gainfully employed with about 49.3 per cent being self employed and 23.2 per cent were made up of government employees. 8.7

Table 1: Respondents Characteristics at Orita Obele Estate

Characteristics	Frequency	Percentage	Valid Percentage	Cumulative Percentage
Respondents Gender				
Male	39	56.5	56.5	56.5
Female	30	43.5	43.5	100.0
Total	69	100	100	
Marital Status				
Single	17	24.6	24.6	24.6
Married	49	71.0	71.0	95.7
Widowed	3	4.3	4.3	100
Total	69	100.0	100.0	
Level of Education				
Primary	5	7.2	7.2	7.2
Secondary	29	42.0	42.0	49.3
Tertiary	34	49.3	49.3	98.6
None	1	1.4	1.4	100
Total	69	100.0	100.0	
Occupational Status				
unemployed	13	18.8	18.8	18.8
Self employed	34	49.3	49.3	68.1
Government Employee	16	23.2	23.2	91.3
Private sector Employee	6	8.7	8.7	100.0
Total	69	100.0	100.0	
Personal Monthly Income				
<N100.000.00K	34	49.3	49.3	49.3
N101000.00K- N250.999.00K	4	5.8	10.0	59.3
N251,000.00K – N350.999.00K	1	1.4	2.5	61.8
N351.000.00K - above	1	1.4	2.5	100.0
No Response	29	42.0		
	69	100.0	100.0	

Source: Researchers' Field Survey 2013

Table 2: Respondents Characteristics at Apatapiti layout, Akure

Characteristics	Frequency	Percentage	Valid Percentage	Cumulative Percentage
Respondents Gender				
Male	40	57.1	57.1	57.1
Female	30	42.9	42.9	100.0
Total	70	100	100	
Marital Status				
Single	43	61.4	61.4	61.4
Married	25	35.7	35.7	97.1
Widowed	2	2.9	2.9	100
Total	70	100.0	100.0	
Level of Education				
Primary	1	1.4	1.4	1.4
Secondary	19	27.1	27.1	28.6
Tertiary	50	71.4	71.4	100
Total	70	100.0	100.0	
Occupational Status				
unemployed	9	12.9	12.9	12.9
Self employed	23	32.9	32.9	45.7
Government Employee	28	40.0	40.0	85.7
Private sector Employee	8	11.4	11.4	97.1
Retired	2	2.9	2.9	100
Total	70	100.0	100.0	
Personal Monthly Income				
<N100.000.00K	34	48.6	48.6	48.6
N101000.00K- N250.999.00K	20	28.6	28.6	77.1
N251,000.00K – N350.999.00K	5	7.1	7.1	84.3
N351.000.00K - above	5	7.1	7.1	91.4
Retired	6	8.6	8.6	100
	70	100.0	100.0	

Source: Researchers' Field Survey 2013

percent were privately employed and about 18.8 per cent were unemployed as shown in Table 1. Although, Table 2 revealed that 2 retirees took part in the survey making a total of 2.9 percent of the respondents. Also, the unemployed, self employed, government employee and the private sector employees in this area were 12.9, 32.9.40.0 and 11.4 percent respectively. As such many of the respondents are able to either afford or rent a property and falls under different occupancy basis. The monthly income of respondents showed that those who receive less than N100.000.00k were majority from both areas as revealed from both Tables 1 and 2. Followed by Between N101.000.00k- N250.999.00k. while N251.000.00k – N350.000.999k were 1.4 percent and another 1.4 percent and 7.1 in both cases in Table 2 receive between N350.000.00k and above. And in the case of Table 2, the retirees do not receive any income. From the characteristics of respondents, the tables revealed that all groups were well represented in the sample. Both areas have different levels of income, education, marital status as well as occupation; which can only enhance the validity and credibility of results.

Building Data of respondents

Respondents were asked in the quest to know if those who occupy the different type of building in these areas willingly carry out landscaping within their surrounding without having to take permission from the building owners and or if they own the building; in addition, whether they are comfortable with the ventilation in the buildings they occupy. In comparison, majority of respondents in both areas surveyed showed dominance in bungalow occupancy; this was followed by the block of flats and the row housing while very few occupy the duplex. Combining both results, about 75 percent of the respondents fall under the group of those that occupies the bungalow. Furthermore, many of the buildings were owner occupied, while some were rented and others government owned. Also, majority of respondents have 4 numbers of rooms in their houses with household size of between 4-6 and buildings well ventilated. This shows that the respondents can willingly carry out landscaping within their surroundings.

Building Materials and Appliances Used

To ascertain and corroborate the literature whether the building materials and appliances used have any effect on their thermal comfort as in the case of the tropics. Respondents were asked the type of building materials their building is made of. Majority have their buildings made from block wall and only three buildings were made from mud, two from bricks and one from wood within the areas surveyed. The use of block wall by the majority may be due to the fact that it absorbs heat from the hot environment during the day, however, the absorbed heat is released when the sun goes down and consequently makes the interior warmer, thereby calling for the use of one form of cooling device or the other. Furthermore, many of the respondents used aluminium roof covering and corrugated iron sheet while three from thatch. Also, majority used an affordable means of cooling device which is the electric fan, while a handful that are able to afford air conditioning used this for cooling device and about twenty five of the total respondents used the natural air. As in the case of block wall, aluminium and corrugated sheet roof covering also absorb heat from the sun during the day, and looses the heat as soon as the sun goes down. This perhaps suggests why the majority of the respondents depend largely on one form of cooling device or the other for comfort.

Soft Landscape Features

From the literature, it was revealed that to achieve a healthy and comfortable environment, soft landscape elements are components that need to be integrated within the surrounding. This will not only moderate the micro climate by reducing the heat gain in buildings, but will at the same time add to the general aesthetics of the surrounding. However, in order to confirm if the absence or presence of soft landscape elements actually does not add to the comfort of the respondents and has therefore called for the use of artificial cooling device by the majority; respondents were asked to indicate the availability and/ or inadequacy of soft landscape elements such as tree, shrubs, flowers, grasses within their surroundings. An over whelming majority of about 95 per cent acknowledged that soft landscape elements are not available and where available are not adequate. Corroborating this with the use of artificial cooling device revealed previously show that the non availability and inadequacy have called for the use of various forms of cooling devices and this has also corroborated that the few who use natural air are those who have some form of soft landscape features around their homes. As such do not need any form of artificial cooling devices. The results therefore corroborates the literature that landscape elements are needed within the building surroundings to help in the cooling of hot air as well as radiation from the sun. Based on the results from the analysis therefore, the need for soft landscape elements within the building surrounding cannot be over emphasized. As revealed, the absence of landscape elements in residential areas studied resulted on use of artificial means of cooling devices in buildings. In addition it revealed that majority of the respondents are not aware of the need and importance of soft landscape elements around their buildings for aesthetics purpose as well as improving thermal comfort within building spaces. Furthermore, it also revealed that majority of the people are not enlightened on the importance of soft landscape elements in their immediate environment which further shows its absence and inadequacy within the residential areas studied.

Conclusion

The research findings have enabled the awareness of the importance of soft landscape elements in the design of buildings; especially residential buildings and has elaborated on the relationship between thermal comfort, thermal control and landscape elements. Based on the study, enlightenment campaign on the need and importance of landscape elements should be embarked upon in addition to architectural designs being made to include adequate soft landscape elements before such designs are approved. In addition, architects should be made to design with provision for natural ventilation within building spaces in mind as well as consider thermal comfort before making the choices of building materials.

REFERENCES

Adedeji, J.A and Fadamiro, J.A (2011) the Duo Building Setback and Landscape Quality: Lautech Nigeria) Neighbourhood examined. *Demensi Journal of Architecture and Built Environment. 38*(1) pp 23-30

Akinbamijo, O. B. (2006). Predicting Urban Health Status- An Empirical Modelling Approach from Cities in Southwest Nigeria. *The Social Sciences, 1*(2), 133-138.

Ayeni, D.A. (2012). EmphasizingLandscape Elements as Important Components of a Sustainable Built Environment in Nigeria. *Developing Countries Studies, 2*(8), 33-42

Ayeni, D.A & Ebohon, O.J. (2012). Exploring Sustainable Tourism in Nigeria for Developmental Growth. *European Scientific Journal, 8*(20), 126-140.

Baker, N., & Steemers, K. (2005). Energy and Environment in Architecture. London: Taylor & Francis Group.

Brown, R.D and Gillspies, T.J, (1995) Microclimatic Landscape Design: Creating Thermal Comfort And Energy Efficiency. NY: John Willey and Sons.

Chen, Z, Karti, M., Meng, Q and Zhao, L (2009) Sensitive Analysis Of Landscaping Effects On Outdoor Thermal Environment In Residential Community Of Hot Humid Areas In China. The Seventh International Conference on Urban Climate 29 June- 3 July 2009. Yokohama, Japan

Fakere, A and Ayeni, D.A (2013) Communal Facilities and Residential Neighbourhoods in Akure, Nigeria. *Civil and Environmental Research 3* (1) pp48-56

Olujimi, J.A.B. & Bello, M.O. (2009). Effects of Infrastructural Facilities on the Rental Values of Residential Properties. S*ocial Sciences, 5*(4) 332-341.

ISO 7730, 1994. Moderate thermal environments-Determination of the PMV and PPD indices and specification of the conditions for thermal comfort. International Organization for Standardization

Koenigsberger, O., Ingersoll, G., Mayhew, A and Szokolay, S. (1978) Manual of Tropical Housing and Building. Part One: Climatic Design. New York: Longman.

Mamoud, A.H.A (2011). Analysis of the Microclimatic and Human Comfort Conditions in an Urban Park in hot and Arid Regions. *Building and Environment, 46* (2011) 2641-2656

Ogunsote, O.O and Prucnal-Ogunsote, B (2002) Control of Tropical Microclimates through Landscape Design: Concepts and Methods. Working paper presented at the National Workshop on Landscape Design for the Federal Capital Development Authority, Abuja by the Department of Architecture, Ahmadu Bello University, Zaria. April 17 – May 10, 2002.

Ogunsote, O., Prucnal-Ogunsote, B and Adegbie, M (2010). Optimising Passive Cooling Systems in Residential Buildings: A case Study of Akure, Nigeria. *Proceedings of the 1st International SET Conference,* Federal University of Technology, Akure, October 25-27, 2010.

Ossen, D.R, Majid, R.B.A and Ahmad, M.H.B (2008) Tropical Building Design Principles For Comfortable Indoor Environment. Faculty of Built Environment Universiti Teknologi Malaysia

Parker, D. S. (1981). A comparative analysis of the role of various landscape elements in passive cooling in warm humid environments. *Proceedings of the International Passive and Hybrid Cooling Conference.* Miami Beach, 365-368.

Pavlou, K. And Santamouris M. (2007) Microclimate and Passive Thermal Control. Retrieved from Public.ises.org/ ...3/7_Pavlous_Microclimate_ThermalControl.pdf. Accessed on 20/2/13

Sandifer, S.A (2007) The Use Of Landscape Elements In Passive Cooling Strategies For Buildings. Phd Thesis in Architecture. University of California, Los Angeles.

Shah, M.G, Kal, M.C and Patki, S.Y (2002) Building Drawing with an Integrated Approach to Built Environment.

Supplementary Planning Guidance (2013) Landscape Design London Borough of Croydon. Available from www.croydon.gov.uk. Accessed on 26/2/13

Szokolay, S. (2008). Introduction to Architectural Sciences: The Basis of Sustainable Design. Oxford: Elsevier.

Yunos, M.Y and Saring, Z (2012) Perceptions of Urban Residential Landscapes; Role Of Plants In Enhancing Outdoor Thermal Comfort. Universiti Putra Malaysia. Alam Cipta 5(2) pp119-128

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