Full Length Research Paper

The impact of greenery on the urban microclimate and environmental quality of Uyo metropolis, Akwa Ibom state, Nigeria

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Greenery in cities has important effects on people's lives and holds immense benefits to its inhabitants. These benefits are derived from the inherent ability of greenery to purify air, control environmental degradation, provide a natural cooling effect from shading and visually enhance the environment among others. Buildings surrounded by trees have been found to be cooler than those without trees. This paper highlights the concept of urban greening, the benefits of urban greening, the growing need for greenery and the challenges facing greenery in Uyo city. It suggests how its usefulness can be incorporated as a planning tool to soften the so much massiveness of inorganic components of the urban structure with its undesirable consequences.

Key words: Greenery, Microclimate, Humidity, Solar Radiation, Foliage.

INTRODUCTION

Studies on urban greening have received considerable attention in recent times. Increased rate of urbanization and the resultant deplorable state of urban centres have been steering up interest in the green option towards achieving healthier and more aesthetically pleasing urban environments. Environmental variables that are important for human thermal comfort include solar radiation, temperatures of surrounding surfaces, air temperature, humidity and wind speed. Urban greenery can ameliorate these environmental variables by preventing solar radiation from heating the surrounding buildings and surfaces, cooling the air by evapotranspiration, and reducing wind speed (Akbari, 2001). Greenery functions, therefore, as natural ‘air conditioners’, at least, with regards to the microclimate of the city.

The microclimate created within greenery has been the subject of several research programmes. Measurements that were carried out in the suburbs of Sacramento in areas where greenery are found, showed that the air temperature under the tree foliage was 1.7 - 3.3 °C lower compared with areas where there are no trees (Taha, 1998). In Miami, Florida, the average air temperature reduction during summer was 3.6 °C in the shade of large trees (Darker, 1989). Similar research that was carried out in Sacramento and Phoenix showed that a 25% increase in the number of trees can reduce the temperature during the summer by 3.3 – 5.6 °C (Akbari, 1992). In Bloomington, Indiana, Souch and Souch (1993) it was found out that midday temperature within the green areas of the city were 0.7 – 1.3 °C lower compared with non-green areas.

Urban greenery can also alter the solar radiation rates. Thayer and Maeda (1985) showed that certain deciduous plants help in the reduction of solar radiation rates from 25% to 50%, with an average reduction of 35%. Heisler (1982, 1984) showed that, during winter, certain species (such as platanus accerifolia and Quercus palustris) reduce solar radiation rates in the centre of their shade by 54% and 37%, respectively.

Greenery found in the urban environment prevent solar radiation from heating buildings, cool the area through their evapotranspiration, reduce wind speed and the need to use air-conditioning systems (Dimoudi and Nikolopoulou, 2003). However, due to the reduction of
vegetation in urban areas, the problem of the thermal island is continuously increasing. The cool climate conditions that occur in small areas depends on how shaded these areas are (Dafis, 2001). According to Ferrante and Mihalakakou (2001), plants have large effects on the microclimate. Green areas help to cool cities and to save energy. The evapotranspiration that results from vegetation foliage reduces the temperature in urban areas. An important change in temperature (heat tolerance) occurs as a result of the trees’ foliage, in combination with the direct solar radiation (Shashua-Bar and Hoffman, 2003).

**Urban Greening**

Urban greenery is the vegetated area in a city. Urban greening is a term which is fast gaining ground in growing recognition of the need for presence of vegetation in the daily lives of urban dwellers. According to Miller (1988), urban greening is an integrated, citywide approach to the planting, care and management of all vegetation in a city to secure multiple environmental and social benefits for urban dwellers. The benefit of urban greening also came to fore in the Green Cities Declaration of the World Environment Day, 2005, with a clarion call for urban environments to embrace urban nature.

The declaration categorically states in actions 10, 11, and 12, the need for every urban environment to “Ensure that there is an assessable public park or recreational space within half-a-kilometer of every city resident by 2015”, “Conduct an inventory of existing canopy coverage in the city; and then establish a goal based on ecological and community considerations to plant and maintain canopy coverage in not less than fifty percent of all available sidewalk planting site” and “pass legislation that protects critical habitat corridors and other key habitat characteristics (e.g. water features, food - bearing plants, shelter for wild life and use of native spieces) from unsustainable development ". Although urban greenery has been traditionally designed for recreation, and aesthetic value, their usefulness far exceeds their functions.

**Functions of Greenery**

According to Westphal (2003), there are numerous benefits available to individuals, organizations, and communities from a green environment. At the level of the individual, views of green space can have dramatic impacts on people in the following areas: improved worker productivity, reduce domestic violence, shorter healing times, reduced stress, improve healing, reduce driving frustration and aggression, greater sense of well-being and neighbourhood and satisfaction, support of children’s development of skills and cognitive abilities.

At the level of organization according to her, workers report greater productivity when they have a view of green space from their place of work, and their supervisors also feel that these workers are more productive. Business district with trees are considered more desirable and are thought to have more desirable goods and services. At the community level, she explained that greener space can increase perceptions of safety. Public housing neighborhoods also tend to be safer, with fewer incivilities and reported crimes. Environmental benefits of urban greening offer improvement in air, water, and land resources by absorbing air pollutant, increasing water catchment and flood plain surfaces, and stabilizing soils. Urban forests act as temperature buffers providing shade in the summer, and wind breaks in the winter in addition to reducing noise pollution and carbon dioxide (CO₂) levels, and providing a habitat for wildlife.

**Climate Control**

Research studies have provided empirical data on the role of greenery and its expanding relevance in the urban environment in the area of climate control. One of the primary objectives in site planning is to mitigate climate extremes in spaces occupied by humans. The focus here is on the internal climate of buildings, which is achieved through air conditioning, light control, etc. In landscape planning, the primary concern is with outdoor space areas and climate modification is achieved by using plant material and other elements of design.

Plants are used because of their influence on ground surface climate. A plant cover significantly displaces the lower boundary of the atmosphere upward from the ground onto the foliage. A microclimate of some depth is thus created between the foliage and the ground where solar radiation, surface temperatures and wind are lower than those over non – vegetated surface.

**Solar Radiation and Air Temperature**

Generally, our primary source of light and heat are from solar radiation, much of which is reflected back into space from clouds, with 20 % reaching the earth’s surface. A portion is diffused by particles in atmosphere, some absorbed by oxides, water vapour and ozone. The portion reaching the earth’s surface is reflected by glare, especially from light- coloured paving surface, which then radiates heat in the form of long – wave radiation.

Vegetation is thus one of the most natural controls of solar radiation. Under tree cover, for instance, incoming and outgoing radiation is greatly reduced by blocking or filtering the sunlight. Air temperatures are much lower and cooler under tree canopies by natural air-conditioning. This cooling system operates with plant
material absorbing carbon dioxide, heat and water, and transpiring cool air in the form of water vapour. Mature trees can transpire as much as 500 litres of water per day. Researchers at the University of Indiana, USA, have found that with an air temperature of 15°C, the surface temperature of a concrete rose to 22°C, but where shaded trees were planted, surface temperature dropped by 4°C (Bernatzky, 1969). It is now evident that more comfort is provided in shaded areas because of long-wave radiation and lack of glare. In European and American cities, trees line many streets to provide canopies for shaded areas where pedestrians walk.

Conversely, a general lack of street trees is evident in many Nigerian cities, including Uyo, (see Plate I), thus making walking along the streets very tiring. A more desirable condition would be possible by planting trees along our urban streets to provide comfort and shade from the enervating hot afternoon sun, (see Plate II).

Wind Breaks

Furthermore, urban winds are produced by convection currents and by constriction. Convection currents are created from air heated by buildings, streets and cars, which then rise. Large buildings add greater heat, causing air to rise faster from the street toward the buildings. Convection currents do not usually bother pedestrians. Constriction of air as it travels down the streets flanked by buildings is attributed to the Venturi Principle. Air speeds up as space becomes constricted and the speed is affected by building height, street width and street length. Street trees can buffer winds in urban areas caused by constriction and the Venturi effect. Trees planted in residential areas and open spaces provide protection against the wind. In Nigeria, street planting does not provide the needed protection against the wind because,
in many instances, it is only a collection of trees, which lack the size to make any impact on the wind. Planting along urban streets should be tied to planting in residential, industrial or recreational areas. Care, however, is needed in the selection of tree types and sizes.

**Bioengineering**

Greenery has played a significant role in environmental engineering in four key areas namely:

**Air Pollution and Purification**

Air pollution is one of the major pressing problems in Nigerian cities today. It is caused by the presence of hydrocarbons, carbon dioxide, photochemical oxides, thermal matter and particle matter in the air. Sulphur dioxide is also emitted from exhausts, burnt oils and automobiles. Automobile exhausts account for much of the carbon dioxide in the cities.

Plants absorb carbon dioxide in the process of photosynthesis and give out oxygen to purify the air. Experiments indicate that plants also trap on their surfaces gaseous pollutants such as sulphur dioxide (Bernatzki, 1969). They also help with ozone before it reacts as a reagent with sulphur oxide, and filter out up to 70% of particle pollutants, such as smoke, dust pollen, odours and fumes (Bassuk, 1995).

However, this purification process is known to be limited to the air immediately around the leaf area and thus, has only minuscule effects on these pollutants on the larger urban atmosphere (Marsh, 1997). Overall, vegetation appears to be most effective in trapping large particles in air moving laterally within several meters of the ground. In areas of heavy air pollution, a more pressing problem may be that of impact of pollution on the health and survival of vegetation.

The growing environmental planning approach to the problem of air pollution in cities is the concept of greenbelt to buffer urban areas and to provide vegetation belts to and aid air purification process. Most masterplans of Nigerian cities have designated areas for green corridors for this purpose, but such schemes are seldom implemented.

**Noise Abatement**

Noise is a problem, particularly in the cities where poorly serviced heavy vehicles and indiscreet vehicles horns, and ubiquitous presence of generating plants abound. Noise can be absorbed, reflected or deflected, and plants can absorb sound waves through their leaves, branches and twinge, with those having thick fleshy leaves and thin petioles being the best for this. The approach to noise reduction can also be tied to greenbelt concept as part of green buffer along transportation corridors.

**Glare and Reflection**

Direct sun ray produces primary glare while reflected light becomes secondary glare. Natural reflective surfaces are water, sand and rock. Man – made reflective surfaces are materials such as glass, metals, chrome, concrete and painted surfaces. Atmospheric particles that cause light to scatter also produce reflection.

Plants can minimize and screen glare from reflective surfaces. This can be accomplished by shading reflective surfaces such as cars or water. Plants are effectively used in outdoor space areas of residential, office or institutional buildings to filter or block glare. The effectiveness depends on the appropriate sizes, shape and foliage density. In Nigeria, most outdoor space areas of buildings lack plant materials to provide relief from these climatic elements. Screen planting in large areas becomes a necessity.

**Erosion Control**

The natural regeneration propensity of plant materials has been successfully applied to prevent erosion on steep slopes or loose soils from storm water runoff, and to control erosion during construction. Ground cover or other plant materials with dense root systems are especially valuable because their roots hold the soil in place. In Nigeria, several efforts have been made in recent times on afforestation programmes particularly in steep - sloped areas where gully erosion has been very spectacular.

**Aesthetic Uses**

Vegetation is one of the sources of providing aesthetic pleasure in the urban environment. It brings contrast to the inorganic structure of the city, softening the hard-edged city development. Two main aspects of this role can be identified.

**Landscape Design**

Greenery is one of the most important design elements in landscape architecture. Visual principles of colour, texture, scale, and rhythm are applied in plant materials selection to create aesthetically pleasing human environment. Vegetation can be used by itself or in association with other elements to create outdoor rooms; to screen out objectionable views or provide filtered views of buildings or spaces; to frame a view, maximizing its effect; to provide shade; to control land - use activities and features; to provide colour and texture on the base plane and so on. While other landscape elements can equally be used for similar purposes, it is evident that few
are as versatile and inexpensive as vegetation.

In the creation of outdoor rooms with plant materials, it is best to use trees first because their size and mass are important in establishing the overall framework of the spatial composition. Trees have the quality to visual walls and act like the columns in a building, subtly separating one room from another while their foliage mass defines the upper limits of outdoor spaces. After the trees have been arranged in the design, smaller plant materials, can then be located to complement the spatial organization created by the trees.

Plants also accent architecture providing reinforcement to the architectural style of the house. They can also articulate spaces, setting up sequences where appropriate, such as providing backdrops for other elements like sculptures and water fountains. In urban areas, plants relate buildings to human scale and introduce nature into the urban environment. In Uyo, more emphasis is placed on buildings at the expense of the loose outdoor space areas, making the city to appear lackluster. A sense of barren bleakness can often be felt in the city as a city beauty is dependent upon its visual form, aesthetic experience and the quality of its landscape components (Falade, 1998).

Study Area

Uyo lies between latitudes 4° 59’- 5° 05’ N and longitude 7° 54’- 8° 00’E. It covers a land area of 155,856 square kilometers in the south – south geo-political zone of Nigeria. It has a special radial road system which terminates at what is known as “Ibom Plaza”. The major roads, from this system spread through the main heart of the city giving rise to minor roads, streets and paths.

The city is also characterized by low relief being within the coastal plain of Nigeria. The most prominent feature of physical landscape of Uyo is the ravine, which lies in the north eastern part of the town. The ravine contains small perennial streams. These are tributaries of Ikpa River which is the main water course in the vicinity of the town.

Uyo lies within the tropics and so enjoys a humid tropical type of climate and heavy rainfall, high temperature and high humidity. The area is characterized by two main seasons – the wet or rainy season, which usually beings in March and lasts till early November. The dry season lasts from late November to February. The mean annual rainfall is about 215mm. The trend is for the monthly rainfall to run to a peak in July, a decrease in August (August break) and another peak in September, before it finally decreases to its lowest in December. Temperatures are uniformly high throughout the year. The mean annual temperature is 26°C. Relative Humidity, except for the short period of the dry season remains at an average of 70 to 80% throughout the year (Ekpenyong and Okoji, 1998). The city’s climate favours the growth of trees.

Challenges of Greenery in Uyo Metropolis

The rate of decline of greenery in Nigerian cities and Uyo in particular, is alarming. In places where traces of greenery still exist, they are often left untended and regarded as ‘wasted space’. Such spaces end up attracting the activities of the urban informal sector, who convert them to illegal business premises. The resultant effect is an illegible road corridor made up of unsightly fragments and general squalor. Such spaces are also prime targets for land speculators and are often susceptible to conversion as refuse dumps.

Non- Incorporation of Greenery as Part of Urban Planning Tool

Apart from Ibom plaza where there was a conscious effort to bring greenery into the Uyo urban renewal between 1999 and 2007, no other part of Uyo (including the major streets) have received such attention. Before embarking on this scheme, Ibom plaza, the centre of Uyo metropolis, was known for its traffic congestion, dilapidated buildings, and general chaos. The use of this plaza is further enhanced through tree planting and other landscaping features. The flowers and the water fountains bring nature in the otherwise hard surfaces of red brick walls and paving stones.

Non- Appreciation of Greenery Visual Quality

The urban built environment in Nigeria and Uyo, in particular, faces many challenges that range from structural, economic, ecological, psychological, social, and behavioural, among others (Akinsola, 2006). From Akinsola’s definition of environmental psychology, there exists a relationship between the emerging patterns of development in Nigerian cities and the psychological and behavioral patterns of its inhabitants. She defines environmental psychology as the study of inter-relationships between the physical environment and human behavior. The inter-relationship is such that behaviour is influenced by the environment in which it occurs, while the environment is altered by behaviours that occur in it. Using the act of waste disposal as an illustration, a blighted and squalor ridden environment is likely to serve as a stimulus for the behaviour of dumping waste on the sidewalk and planter zones of a street corridor, in drainages and designated open spaces and green areas.

RECOMMENDATIONS

The natural environment has metamorphosed into man-
made environment due to numerous activities carried out by man in his quest for shelter, food and other industrial needs (Sada, Aliyu, and Daroda, 2004). The dynamism and diversity of problems in urban areas become serious threats to urban environment quality vis-à-vis the sustainability of urban environment. This paper recommends that:

1. In designing new or restructuring existing urban roadways, provision should be made for road medians, which will also double as planting strips. The sidewalk should be designed to incorporate a planter zone where street trees and hedges could be planted.
2. In the past, corporate offices and multinational corporations landscaped and beautified only their immediate surroundings. Here, it is recommended that government should make it mandatory for them to undertake beautification and street improvement projects for the entire streets on which they are located.
3. The long-forgotten culture of designating spaces as parks, open spaces and recreational gardens should be resuscitated, considering their role in mental refreshment and urban aesthetics. Town Planning authorities should enforce planning laws against any developer who builds on such designated open spaces. Budgetary allocations should also be provided for the maintenance and upkeep of these parks.
4. Finally, an appreciation of the aesthetic value of greenery needs to be imbied in our cultural norms and values. To achieve this, it is recommended that the knowledge of greenery, the benefits accruable from it and the role it can play in regenerating the decayed urban fabric should be incorporated into the educational curricular right from elementary through to the tertiary level of education in Nigeria.

CONCLUSION

Greenery as an important component of urban environment cannot be overemphasized. It is evident that where so much massiveness of inorganic components of urban structure tends to stifle the sense of naturalness, a sense of claustrophobia takes over. It is no wonder that under such condition, the subconscious human instinct for self-expression finds vent in violence and illogical vandalism. This may explain the rising urban violence we are witnessing today in the country.

Planning for civilized and ordered life for urban living should borrow a leaf from the diversification planned by nature with incredible and unmatched ingenuity. Integrating greenery in Nigerian cities can provide this order not only by mitigating climate extremes but also by supplying the emotional nourishment in terms of therapeutic and calming effects on the city dwellers. In its potential to remind us of our connection with the natural world, cycles of birth and death, and the inevitability of change, access to vegetation within the city provides a positive contribution in the midst of so much urban cluster and frantic activity in our urban environment.

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