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Research Article

Building Orientation; Enhancing Nature with Nature

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A b s t r a c t

With the increase in energy efficient measures in residential buildings, Architects in the tropics are continually exploring bioclimatic approaches that enhance the efficient passive performance of buildings. A north-south orientation is recommended for buildings in the tropics as this ensures the building takes advantage of windward breeze that aids cooling and shuts out excessive sunlight that causes overheating. Where site constraint makes it difficult to achieve a north-south orientation, extra measures have to be employed to ensure that the building is not over heated. The aim of a building design is to provide comfort for occupants to do their activity at home by considering the macro and microclimate. In this paper, emphasis is laid on vegetation a natural and passive design feature to improve the microclimate. A three (3) bedroom bungalow sited on a piece of land with some constraint, not oriented in the recommended north-south orientation for building in the tropics is studied. In this light, trees, shrubs and vegetal cover were used to improve the microclimate and a comfortable exterior and interior were achieved passively, while the aesthetic appeal of the ambience was enhanced. Buildings can take advantage of the macroclimate of their locations, and the microclimate can be improved upon with vegetation (passively) to achieve comfortable living conditions while attaining naturally, aesthetically pleasing scenery. Nature can be used to enhance nature.

1. Introduction

The orientation of a building is important to its overall energy efficiency. A properly oriented building can save a lot of money by cutting down heating and cooling costs. (EcoWho, 2017) Building orientation has strong correlation with wind direction and sun radiation (Prianto et al., 2000). Every region in the world has a specific climatic behaviour, some places might be too hot or too cold and some other in between. Prior to every construction, there is an important decision to be taken in determining the building location; the

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orientation. This will turn the building to its most important side so occupants (users) will have the best living conditions even when the weather outside is not too conducive (Akande, 2010). Tropical countries are countries located between 15o north and south of the equator. The basic climatic condition in the tropics is generally wet and dry season with high humidity and almost equal in day and night hours. Problems frequently noticed in this climate are: high temperature in the building (over heating), low air quality for internal spaces and glare. This contributes to high energy usage for cooling in buildings as users try to get the right comfort zone (Sahabuddin, 2012). A building oriented for solar design takes advantage of passive and active solar strategies. Passive solar strategies use energy from the sun to heat and illuminate buildings. Building orientation facilitate temperature moderation and natural daylighting (Green Building Manual, 2011). Nigeria; a country in west Africa is located in the tropics and is faced with these problems in most of her cities. Developers in most cities ignore these problems as they are primarily concerned with the value of the properties and/or the amount these properties can generate as rent. Cooling cost is often ignored and neglected as the use of air-conditioners is some form of status symbol in most cities in Nigeria. In the tropics, buildings should maximally avoid direct sun and try to make a barrier between it and living space.

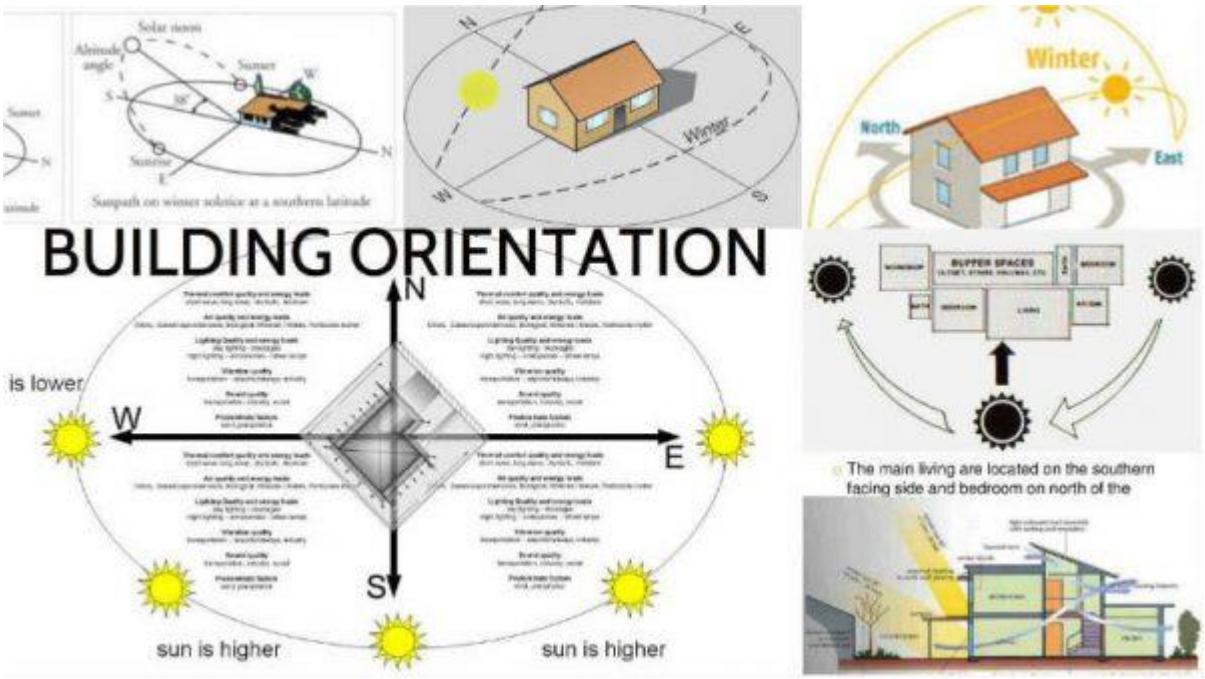

Figure 1: building orientation Source: The Constructor: Civil Engineering Home (2017)

Figure 1 above shows the orientation of a building with the longer sides facing the north and south. The best orientation for buildings in the tropics is the north-south orientation as they are better for daylighting and visual comfort; the east and west facades facing the sun. These facades are recommended to be of solid wall or have minimal openings (Autodesk, 2017). To take advantage of the sun's light and warmth, larger

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expanse of windows is recommended on the south façade than on the north. In climates of prolonged excessive heat, an expanse of northern windows is recommended to benefit from indirect sunlight (Beal, 2010). Due to site constraint, these requirements might not be met, and then extra design measures have to be employed to ensure that the building is not over heated. A natural solution will be to improve the micro-climate around the building. This helps to reduce overheating and cooling cost, maximize outdoor comfort, improve durability of building materials by reducing rain penetration and provide better visual environment around the building (Rehan, 2016). The factors affecting micro climate can be classified as those outside the architect's control and those within the architect's control.

Table 1: Factors affecting Micro Climate

Outside Architect's control	**Within Architect's control**
Area and local climate	Spacing and orientation of building
Site surrounding	Location of open spaces
Site shape	Form and height of buildings
Topographic features	Fenestration
Surrounding buildings	Tree cover
	Wind breaks
	Surrounding surfaces

Source: ESRU, (2012).

Table 1 above shows the factors affecting the micro climate. For this paper, emphasis was on the factors within the architect's control where orientation is not optimally achieved because of site constraint.

1.1 Enhancing Nature with Nature

Vegetation: this is the overall plant cover (trees, shrubs, grasses) within an area. Vegetation is one naturally occurring phenomena. It is rich and provides an excellent means of improving microclimate. Its surfaces do not heat up and they provide efficient shading at almost no cost (ESRU, 2012). It can be redirected, redesigned and improved upon to enhance the micro climate, hence, the phrase "enhancing nature with nature". Trees can be planted to redirect and break winds, ground cover (grasses) can be planted to reduce and in some cases curb the effect of erosion. They can also reduce the external temperature of a building surrounding through evapotranspiration; compound word used to define evaporation and transpiration (Burleson, 2011; Ismail et al., 2011). Hard surfaces are almost inevitable around buildings, but they should be minimal to reduce the outdoor temperature. When hard surfaces are heated and these surfaces are surrounded by shrubs, instead of a significant increase in the ambient temperature, the ambient temperature remains cooler as a result of shading provided by plant foliage and moisture that they retain in the soil. A

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vegetal cover of the ground keeps pavement comparatively cool and contributes much to a cooler outdoor microclimate (Faust, 2000). Vegetation (trees, shrubs and grasses/groundcover) serves the following functions:

- Protection against solar radiant heat
- Cooling of ventilated space after pavements and green cover
- Reduction of dust by filtering the air
- Regulating effects of humidity.

2. Methodology

Relevant literature on building orientation in the tropics and on improving microclimate was reviewed. For this paper, emphasis was laid on vegetation as it is natural, effective and an affordable means of improving microclimate. A simple three (3) bedroom bungalow sited on a site with some restraints was considered. The building orientation was not the recommended north-south orientation for building in the tropics, but trees, shrubs and ground cover were used to improve the microclimate. Hence, a comfortable exterior and interior was achieved using affordable soft landscape elements.

3. Discussion

The site was irregularly shaped, though predominantly a triangle. This was the major constraint as the shape of the site predetermined the shape and orientation of the building. The longer axis of the building had to be on the longer axis of the site. The site had a north-east, south-west orientation, hence, the orientation of the building.

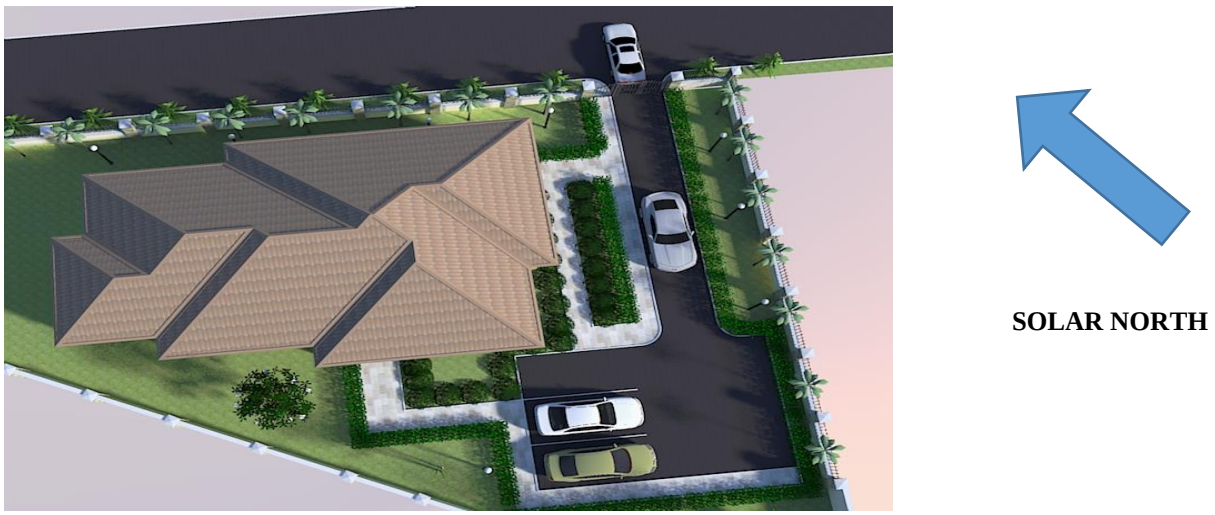

Figure 2: Showing 3-dimensional architectural site plan

Figure 2 above is a 3-dimensional architectural site plan of the 3-bedroom bungalow used as the case study for this paper. It can be seen from the figure that the longer façade of the building is facing north-east and south-west, hence, the building has a north-east, south-west orientation. The shape of the site was a constraint in achieving the recommended north-south orientation. Even though modifications were made in the landscaping at the construction stage to enhance the microclimate, the building orientation remained unchanged. As the building had a north-east, south-west orientation, trees were planted on the north east façade to filter the dry and dusty north-east trade winds, thereby reducing and to an extent eliminating the effect of the wind. A duplex was also built about fifteen metres (15m) away on the north-east façade of the bungalow in study thereby further reducing the effects of the dusty north-east trade winds.

Figure 3: Trees on the north-east façade

Figure 4: Porch on the south-east façade

The smaller facades of the building were facing the south-east and the north-west. The south-east façade had the tendency to be overheated as it receives most of the sunshine since the sun rises in the east and travels to the west through the south. To curb or reduce overheating, a veranda (porch) was designed on this façade and a window located in the porch, thereby, protecting it from direct sunlight. To achieve cross ventilation in one of the rooms, a window had to be located on this façade and was exposed to direct sunlight. Vegetation was used to curb and/or reduce the effect of overheating as a golden palm tree was sited just in front of this window and Bahamas grass planted as ground cover.

Figure 5: Golden (areca) palm in front of Window

Figure 6: Play area

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The north-west end of the site was designed as the play area and further away was an orchard. Trees were also planted at the perimeter wall to curb the effect of glare from the sun-set in the west. The site had a predominant south-east and the north-west slope. Ground cover (buffalo grass) was planted to curb erosion. This ground cover had such an aesthetic appeal that it improved the aesthetic value of the site. The south-west façade which was the other longer façade of the building was staggered to reduce the effect of driving rain. A veranda (kitchen porch) was also designed on this façade. Trees were also planted on this façade to reduce rain penetration. The pavements (hard surfaces) were minimal and restricted to carparks and walkways. These surfaces were surrounded with hedges and vegetal cover thereby, keeping the ambient temperature cool as a result of shading provided by shrub foliage and moisture retained in the soil.

Figure 7: Staggered south-west façade

Figure 8: Hedges and Bahama grass surrounding pavement

The gazebo, located close to the car park suffers no effect of overheating by means of reflection from the pavement. This is because most of its sides are open; hence, heat is not trapped. Furthermore, it is surrounded by vegetal ground cover (buffalo grass). Summarily, the building is allowed to grow with and become part of the environment while taking advantages of the macroclimate and improving the microclimate to its advantage.

4. Conclusion

Even though a north-south orientation is the best for buildings in the tropics, where this is not achievable due to site constraint, vegetation can be used to improve the microclimate. This helps to attain a comfortable outdoor and indoor ambient temperature while improving the aesthetic appeal of the site. As architects, site constraint and imperfect scenarios should rather spur us on to bring out the best in our creative abilities rather than aid us have excuses for the limitations of nature. The problems frequently noticed in the tropics: high temperature in the building (over heated), low air quality for internal spaces and glare can be curbed through proper planning, planting of trees and vegetal cover. Buildings can take advantage of the macroclimate of their locations, and the microclimate improved upon with vegetation to achieve comfort conditions and naturally aesthetic ambience. Nature can be used to enhance nature.

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