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Review Article

Climate-Responsive Architecture and Sustainable Housing in Nigeria

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ABSTRACT

Climate is the prevailing meteorological condition in a given region. It is a measure of the average pattern of variation in elements such as temperature, humidity, solar radiation and wind over long periods of time. The design of pleasant buildings that ensure physiological comfort of users is achieved through an understanding of the climate and the human responsive systems. One of the greatest challenges facing human society in the 21st century is climate change. This refers to any significant change in measures of climate lasting for an extended period. Tackling climate change requires reducing carbon dioxide emissions by changing the ways in which buildings are designed, constructed, managed and used. This paper examines sustainable architecture and housing in Nigeria. It asserts the need for energy-efficient housing design strategies to achieve sustainability in housing and towards attaining of a humane and responsive environment.

Keywords: Architecture, Climate, Carbon dioxide, Housing, Sustainability.

INTRODUCTION

Climate is the average weather condition of meteorological variables such as temperature, humidity, atmospheric pressure, wind, precipitation in a place over long periods of time, the standard average period being 30 years. The climate of a region is determined by the climate system consisting of five components namely: atmosphere, hydrosphere, cryosphere, lithosphere, and biosphere. The climate of a location is affected by its latitude, terrain, altitude and water bodies[1-4].

The design of pleasant buildings that ensure physiological comfort of users is achieved only through an understanding of the climate and environment (the adjacent system) and the human responsive systems[5]. For instance in the northern part of Nigeria the climate is characterized by a long dry season associated with cold and dry harmattan wind, high temperature range and intense sunlight. The climate calls for design solutions that can vitiate the cold and biting winds while providing a cool respite from the intense heat of the mid-day sun. The impact of solar heat is enormous and has to be contended with in achieving comfortable interiors. Southern Nigeria on the other hand lies within the equatorial and sub-equatorial rain forests and has the warm-humid climate of the tropics. The climate is characterized by heavy rainfall and high temperature. In warm-humid conditions two main requirements are necessary for the physiological comfort of users: these are thermal insulation and cross ventilation[6].

There have been changes in the climate of the earth during the planet's history, with events ranging from ice ages to long periods of warmth. These have largely been due to natural factors such as volcanic eruptions, changes in the earth's orbit, and the amount of energy released from the sun. Human activities have also changed the composition of the atmosphere and therefore are influencing the earth's climate. The burning of fossil fuels such as coal and oil has caused the concentrations of heat-trapping greenhouse gases to increase significantly in the atmosphere. The gases prevent heat from escaping to space and thus have precipitated global warming.

This paper examines the development of sustainable architecture and housing in Nigeria. It asserts the need for energy-efficient housing design strategies to achieve sustainability in housing and towards attaining of a humane and responsive environment. Sustainability in the built environment involves minimizing negative impacts on the environment and is achieved through minimizing climate change, reducing pollution and improving air quality and health, and thus creating sustainable settlements. These actions would encompass minimization of energy consumption in buildings, rational use of natural resources and stricter control of Green House Gas emissions[7].

Climate change and global warming

Climate change refers to any significant change in measures of climate (such as temperature, precipitation, or wind) lasting for an extended period (decades or longer). Climate change may result from human activities (through burning fossil fuels, deforestation, reforestation, urbanisation) and natural factors (changes in the sun's intensity) and processes internal to the earth (changes in ocean circulation, volcanic eruptions, desertification)[8,9].

Global warming is an average increase in the temperature of the atmosphere near the earth's surface which can contribute to changes in global climate patterns. Global warming can occur from a variety of causes, both natural and human-induced. In common usage, global warming often refers to the warming that can occur as a result of increased emissions of greenhouse gases from human activities. It is thus used for human causation while climate variability is used for non-human caused variations i.e. natural internal processes within the climate system and variations in natural or anthropogenic external forcing[10,11].

The building industry and environmental problems

The first UN Conference on the Human Environment (UNCHE) took place in 1972 and it brought environmental issues into international agenda. In 1987 the Brundtland Commission Report defined sustainability as "development that meets the needs of the present without compromising the ability of the future generations to meet their own needs"[12] The Rio Earth Summit in 1992 identified the requirements of achieving sustainable development. Further world summits including Johannesburg in 2002 and Bali in December 2007 have tried to arrive at agreements to safeguard the environment and to formulate polices for sustainable planning and development. The summits have identified the building industry as a major contributor to environmental problems. The industry consumes 40% of the materials entering the global economy, and is responsible for almost half of the global greenhouse gases[13]. Buildings account for 30 - 40% of the worldwide energy use[14,15]. Sustainable buildings are prerequisite to the creation of sustainable communities in which people will be happy to live; their needs and aspirations are met without damaging their environment or causing problems for other communities or future generations[16,17].

The International Union of Architects (UIA) declared the theme of the 2007 World Day of Architecture as "Transmitting Zero Co_2 Emission Architecture". The UIA intended to demonstrate architects' ability to drastically reduce carbon dioxide emissions through ecological design, construction, and maintenance of buildings and cities.

Sustainable architecture and housing quality

Sustainable architecture is a general term that describes environmentally-conscious design techniques. It seeks to minimize the negative environmental impact of buildings by enhancing efficiency and moderation in the use of materials, energy, and development of space. Different terms are used for sustainable design including 'green architecture' 'climate-responsive architecture', 'high - performance architecture'. These have one key objective which is to apply sustainable principles through the entire life cycle of a building, from planning to disposal[18,19].

Studies have shown the deplorable conditions of urban housing in Nigeria. Housing quality is often evaluated in terms of the quality of design, building materials, standard of construction, and the provision and performance of public amenities. The use of poor quality materials such as concrete with excessive quantities of dust and clayey matter which inhibits the production of good quality concrete[20] is prevalent in the urban centres[21-27]. The satisfaction of the user population with the housing stock and its environment, which exude a general sense of well-being, is an important determinant of housing quality[28].

Environmental comfort and energy saving procedures constitute the indicators that can be applied in the conception, construction and use of buildings. Thus light, air, space, health and efficiency constitute structuring elements in the concept of sustainable construction[29]. Building functionality, architectural design, accessibility, ergonomics, along with the quality of materials and constructive features, contribute decisively to the sensitive comfort of people, influencing the population's quality of life, and the socio-cultural value of the interventions. The use and organization of space can also play an important role in environmental conditions.

The use of low carbon materials and low carbon construction techniques has been in practice in Nigeria for a long time. Building earth is the traditional material for construction and has been used for centuries[30]. Extensive research has been carried out in the country and has resulted in the use of stabilized bricks for walling which could offer low carbon solutions. Stabilized earth brick houses are appropriate for a variety of climates in Nigeria and are ideally suited for passive solar heating and cooling. They are warm in cold seasons and cool in hot seasons with little or no need for auxiliary or mechanical energy. Stabilized earth brick houses require substantially less fossil fuel-derived energy to build, than the conventional sandcrete buildings commonly found in many urban centres in Nigeria. Reduced energy consumption would provide a wide range of environmental benefits particularly reductions in greenhouse gas emissions.

Design is the first step in achieving sustainable architecture. Energy-efficient housing design strategies include the following: passive solar design, proper insulation, day lighting, natural ventilation, landscaping, material selection and use of solar power.

Whole life cycle analysis

Achieving sustainability requires seeking housing solutions relating to energy saving, emissions control, production and application of materials, and the use of renewable resources since carbon dioxide (CO_2) is emitted to the atmosphere in great quantity through the whole life-cycle of a building. Carbon dioxide (CO_2) is emitted into the atmosphere during the production of building materials, the construction, renovation, rehabilitation and demolition of a building[31].

In order to achieve a truly sustainable construction, all the environmental impacts of buildings need be considered[32]. The total environmental impact of a building is the result of environmental loads occurring during the life span of the building. These are; initial impact, annually repeating impact and deconstruction impact[33]. The initial impact occurs during the design and construction of the building including project management activities, material use, construction processes and waste. The annually repeating impact is the result of energy use for heating, lighting, ventilating and cooling and the repairs and refurbishments occurring during the usable life of a building. The final stage, the deconstruction, happens when the building is demolished.

The whole life carbon emissions of a building are made up of the sum of direct (construction, operation, maintenance and deconstruction) and indirect (embodied energy of materials) energy. The operational life of a building is an important factor considering the fact that a significant impact of a building may occur after its construction and installation. An efficient operational life could be ensured with high-performance envelopes, careful selection of materials and construction techniques, and good services design.

CONCLUSION

The design of pleasant buildings that ensure physiological comfort of users is achieved through an understanding of the climate and the human responsive systems. One of the greatest challenges facing human society in the 21st century is climate change. This refers to any significant change in measures of climate lasting for an extended period. Tackling climate change requires reducing carbon dioxide emissions by changing the ways in which buildings are designed, constructed, managed and used. This paper has shown that housing quality can be enhanced in Nigeria, and buildings can contribute to sustainable environment by ensuring that they are sustainably designed; that is they should be created with consideration for the wider, long-term environmental, social and economic aspects of sustainability.

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