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ECO-FRIENDLY BUILDINGS: THE ARCHITECT'S PERSPECTIVES

Emmanuel Udomiaye, Ibok U. Okon, Odom Christopher Uzodimma and Ntaji Patrick

Department of Architectural technology, Akanu Ibiam Federal Polytechnic Unwana

ABSTRACT: *In today's Architectural practice, there is a struggle to find the ways to balance or harmonize environmental technology, protection of resources and aesthetic content. And the world has witnessed some level of significant industrial and technological revolution. The revolution, despite its acclaimed benefits to humanity has resulted to a worrisome level of interaction with our environment. . One point of a great concern, with regard to the eco-system, is that as the global greenhouse gas level continue to rise, the planet's temperature with corresponding rise, resulting in the melting of the ice caps and seriously altering global weather conditions. Current estimates calculate that the world built environment account for approximately one third of all global greenhouse gas (GHG) emissions whilst consuming 40% of the world's energy. However, the challenge facing environmental architecture is meting the increasing demand for revolutionary architectural solutions while mitigating its impact on the eco-system. The aim of this paper therefore, is to critically review current ecologic design concept/environmental technology using secondary and primary data. The effect of the built environment on the co-system which has resulted in consistent rise in global temperature in the past three decades was accessed. The paper recommends adopting more eco-friendly design approach, passive design methods and use of renewable energy source amongst others as key for achieving eco-friendly building. Finally we conclude that moving from a sectional prism of viewing environmentalism largely driven by sectional issues involving pollution, resources and biodiversity to a more holistic view point that recognizes the inherent interdependence of all life systems is the right way forward and we therefore call on Architects to embrace it.*

KEYWORDS: Building, Ecological Design, Eco-Friendly, Sustainable Development, Green Architecture.

INTRODUCTION

For the past two decades, the world has witnessed some level of significant industrial and technological revolution. (Darwish, 2015) opined that this revolution, despite its acclaimed benefits to humanity has resulted to a worrisome level of interaction with our environment. And if our current ways of interacting with the environment are not checked, the world all over will begin to experience rapid and increasingly dangerous effects to their quality of life. One point of a great concern, with regard to the eco-system, is that as the global greenhouse gas level continue to rise, the planet's temperature will corresponding rise, resulting in the melting of the ice caps and seriously altering global weather conditions (Darwish, 2011).

For instance, building materials from their resource extraction through manufacturing, use and disposal have become a vital part of the total human effects on global ecosystems and the earth's climate. According to Rousseau (2015), in the past half – century, with the rapidly advancing pace of urbanization worldwide, finding the raw materials and energy to produce

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building materials as specified by architects, and absorbing the waste from their production, use and disposal have become a pressing global challenge. Current estimates calculate that the world built environment account for approximately one third of all global greenhouse gas (GHG) emissions whilst consuming 40% of the world's energy (UNEPSBCI, 2009) and (USAEPA.Environmental Protection Agency, 1999). According to united nation Environment Program-UNEP (2008), these figures are expected to double by 2030 as shown in figure 1. The implication is that within the next 16 years, the major ecological threat to coastal regions such as West Africa which is highly populated, is the new/existing buildings and the built environment. This trend and threat are enough to challenge developers, Architects and government agencies to lead the way with regards to developing ecologically minded buildings, as in both design and construction materials, as well as eco-conscientious neighborhood (Rousseau, 2015).

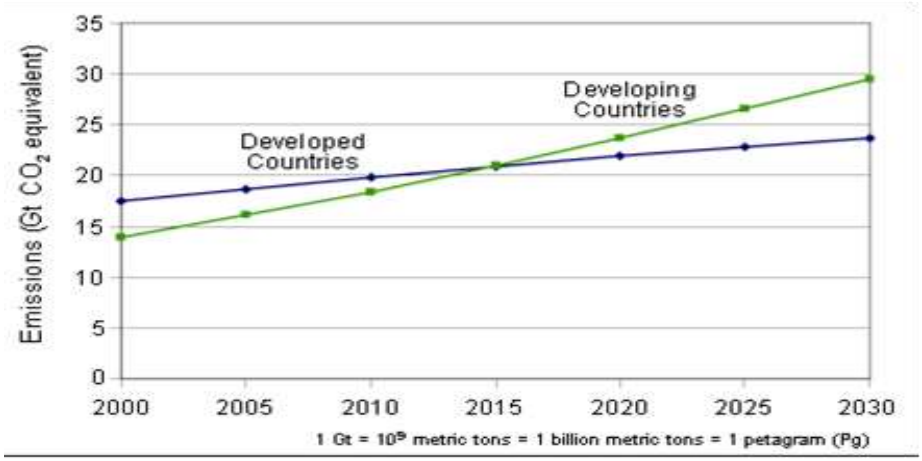

Fig.1: World Greenhouse gas emissions by region (Source: (USAEPA.Environmental Protection Agency, 1999)

Since population increase results in increase demand for housing and more housing development ultimately results in higher environmental impact, the challenge in Architectural practice today is the struggle to find the ways to balance or harmonize environmental technology, protection of resources and aesthetic content of the built environment. And without these vital components, ecologic/green design cannot be realized.

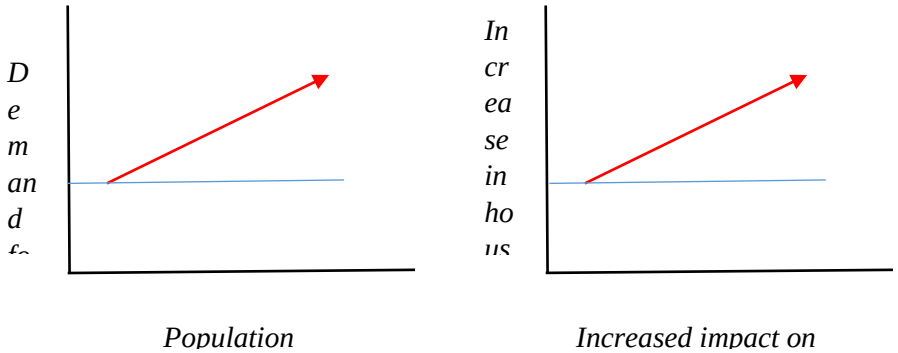

Fig 2: illustration of the relationship between shelter and impact on ecosystem

Source: Author's illustration

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Frank Lloyd Wright, was a symbol of the biggest resistance and a rare innovator, whose work shaped the basic principles of architecture harmonization with content. He can also be considered as a predictor of the environmentalist movement since the very beginning of the 20th century, long before the word "Ecology" was commonly used (Jashari-Kajtazi, 2009). Frank Lloyd Wright once said as Quoted by Jashari-Kajtazi (2009), "I would have wanted to have a liberated architecture, an Architecture that belongs to the space/place it lies in – something that makes the landscape more beautiful, rather than deform it". However, the challenge facing environmental architecture is the professional selection of over emphasizing technological advantageous materials and understanding the social and aesthetic aspect. The aim of this paper therefore, is to critically review environmental technology as a working tool and natural sciences as a source of inspiration for ecologic design.

Plate 1: Frank Wright: "Waterfall House", Bear Run – Pennsylvania (source: www.greatbuilding.com)

ECOLOGY AND BUILDING DESIGN

The term ecology is derived from the Greek root 'oikos' meaning 'house' combined the 'logy' meaning the science of or 'the study of' – As such ecology means science of study of house, household and environment i.e. plants, animals, micro-organisms that live together as the land, in the oceans, in the air and in the fresh water (Darwish, 2011). Ecology can also be defined as the study of living systems and their relations to one another therefore, the concept of ecological design can be described as "the creation and responsible management of a healthy built environment, based on the efficient use of resources and on ecological principles" (Scott, 1999). Kajtazi (2009) Suggested that, Eco-friendly architecture is the use of nature symbolism to create relations between architecture and its cultural context – by merging architecture in landscape. It can also be seen as the environment design and construction techniques that support the acceptance of the new green architecture and

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interpreting objects in the context – thereby creating ecologically responsible and sustainable architecture. Kajtazi (2009) further stated that, eco – friendly architecture is longsighted architectural and urban planning ideas which give an imagination of the future, based on general social and political changes which may influence construction and environmental policy.

Eco – Sustainable Buildings

Sustainability can be seen as the continued ability of a society, an eco–system or any such interactive system to function without exhausting key resources and without adversely affecting the environment. According to Brundtland commission (1987) sustainable development is the development that meets the needs of present without compromising the ability of future generation to meet their own needs (Brundtland,World Commission on Environment and Developement, 1987). The concept of living within the capacity of supporting eco – systems has been suggested as a basis for sustainable development (Deodher, 2011). In architectural and urban planning context, sustainable development has also been defined as development that is non-damaging to the environment and which contributes to the city's ability to sustain its social and economic structure. Hence, a sustainable building is one that is economically viable, environmentally pleasant and socially acceptable. However, Ellingham and Fawcett(2013) was on the opinion that A building is sustainable over its lifetime if it continues to make a positive contribution to physical capital, with the activities taking place in it adding to human well-being, and without it being an excessive drain on natural capital (Ellingham & Fawcett, 2013). Buildings can be said to be sustainable if the following main objectives are considered in the design and construction;

- Social progress, i.e. taking into consideration needs of everyone.
- Protecting environment effectively
- Making use of natural resources

However, most architect and engineers of modern design and construction find it easier to design and construct buildings in a vacuum as if nature does not exists – poor ventilation, poor lighting etc., much fossil fuel is being consumed to make most buildings in our cities habitable. An ecologically aware architect would design buildings differently. His concept would be to design a building that creates aesthetic, economic, social and ecological sense. Sustainable architecture seeks to replace human dominion over nature with a more fulfilling relationships with the natural world (Ferreira & Mendes, 2004).

Moreover, buildings as they are designed and used in cities today, symbolize uncontrolled consumption of energy and natural resources (such as Stone/Aggregate, Sharp Sand and Wood) with a consequent negative environmental impact. A good example is the mining pits scattered across northern part of Ebonyi State – Nigeria. See plate 2.

The design and construction of buildings based on sustainability concept by use of eco-friendly building materials and application of suitable retrofit options to the existing buildings could significantly improve energy use efficiency in the building sector.

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A)

B)

Plate.2 (A&B): Abandoned stone Quarry pits in Abakiliki, Ebonyi State.

(Source): Author's Field work

Understanding the Concept of Ecologic and Green Design

Studies on Nigerian traditional architecture revealed that buildings and homes/dwelling units were built with much consideration for the environmental conditions. Energy resources were probably less available then, man had little choice but to learn how to make the best use of nature's element and ecologic materials. Evidently, Ecological and green design and building materials in the construction industry works for the present and future improvement in the life quality (Fan Shu-Yang, Freeman, & Cote, 2004). The basic principle of ecological or eco-friendly building design and construction includes the following:

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- Saving of existing material resources
- Maintenance of a clean and healthy environment both in terms of topographic changes and the degree of air, water and soil pollution.
- Reduction of the embodied energy in buildings.
- Measures regarding the lessening of heat losses.
- Provides an optimal ratio between the surface of the building envelope and the building volume.
- Ensuring of adequate thermal inertia.
- Provides hierarchy of spaces requiring different temperatures and their orientation in relation to the cardinal points.
- Requires use of renewable energy sources such as solar and geothermal energy etc.
- Encouragement of investments for the conservation of energy (Aktas, 2013).

Ferreira and Mendes (2004) summarized the principle of ecologic design by stating that any form of design that minimizes environmentally destructive impacts by emulating and integrating with natural ecosystem can be referred to as eco-design or eco-friendly design/building. Therefore, the aim of eco-friendly design is to provide a framework for an environmentally appropriate system of design and management by in cooperating both anthropogenic and ecological values, at relevant spatial and temporal scale (Aktas, 2013).

According to Yang et.al (2004), the concept of ecofriendly or eco-design involves several key aspects of architectural decisions as explained below:

1. Move toward Resource Sustainability

Sustainability in human economy must be based on the wise use of renewable resources, which are capable of regenerating after harvesting and can potentially be available for many generation (Yang et.al, 2004). On the other hand, although non-renewable materials can contribute to economic growth, they diminished by use and so cannot be used as the primary basic of a sustainable economy. These principles can be applied to the design, construction and operation of buildings and sites (Yang et.al, 2004) and (Yeang, 1999).

2. Maintain Ecological Integrity

Eco systems are life systems – that support biodiversity and natural communities, at the same time providing critical support for the human enterprise. Thus, maintenance of the integrity of the ecosystems should be a major consideration in sustainable architectural design process. The purpose of eco-friendly design is to integrate human activities with the structure and dynamics of natural flows and cycles of materials, organisms and energy (Aktas, 2013). To understand how the different designs would maintain the integrity of eco systems or the natural values, the architect needs a detailed understanding of local eco systems and environment. These includes, climate, topography, soil, and water, flows of energy /materials, biotic communities and critical habitat at-risk species.

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3. Emulate Natural Ecosystems

Natural ecosystems are characterized by complex patterns and dynamics of biodiversity, materials and energy, occurring at various spatial and temporal scales. Yang et.al (2004) stated that these patterns reflect the long and short term influences of biological evolution (including speciation and extinction), disturbance and successional regimes, environmental change (i.e. in Climate). Species introductions and anthropogenic influences associated with pollution and other stressors. The pivotal goal of eco-friendly design is to emulate these natural ecological qualities when planning and designing for anthropogenic activities, so the resulting effect will be relatively natural. See plate 3 which illustrate the seamless harmony between the built and natural environment .For this to be possible, it is important to:

- Design towards an integrated web of building economic and ecological activities. The tools of ecological footprint and life cycle analysis are particularly useful to the architect for identifying linkages and understanding the web of integration of building, economic and the natural world.

- Accommodate the natural regime of ecological stressor and disturbance E.g. Horticultural landscaping.

Plate 3: Emilio Ambasz: "ACROS building", Fukuoka – Japan

Source: retrieved from www.emilioambaszandassociates.com

Partly with this in mind, Benyus (1997) proposed a new science-based model referred to as biomimicry, which "studies nature's models and then imitates or takes inspiration from these designs and processes to solve human problems." He further suggests that humans should use

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nature as a mentor for adaptive designs and functions: "doing it nature's way has the potential to change the way we grow food, make materials, harness energy, heal ourselves, store information, and conduct business" (Benyus, 1997).

4. Eliminate Natural Debt

Construction activities cause environmental damage which is often not repaired or offset. As a result, the so-called profits of the construction enterprise does not account for all the environmental cost of production resulting in an accumulation of "natural debt" (Yang et.al 2004). As such, eco-design seeks to comprehensively account for all of the costs and environmental implications of alternative choices of design (Aktas, 2013). Eco-designers considers whether all the comprehensive aspect a project contribute to meeting the needs of a proposed development, as well as the possibility that there might be unfavorable environmental impacts. Once identified, steps are taken to eliminate or reduce them to avoid the externalities of natural debt, so as to achieve fully costed and economic profit.

5. Meet the Inherent Needs of Human

Human economics and building construction activities cannot exist without using natural resources - as sources of food, materials and energy. At the same time, humans must also have opportunities to engage in livelihoods consequently, some degree of environmental damage is coursed by human economy. A goal of eco- design is to help meet the vision of ecological sustainability by finding ways of manufacturing goods, construction of building, and planning more complex structures, such as industrial parks/export processing zones and businesses, while reducing resource consumption and avoiding ecological damage as much as possible.

APPLICATION OF ECO-DESIGN CONCEPT

The principles and concept of eco-design can be applied at various levels of environmental design and planning. Ranging from residential buildings, to neighborhood or estate and industrial parks.

1. Building Design

Ecological design solves many environmental problems by the simple application of passive architectural systems integrated into the built form (Blume, 2011). Much progress has been made in this regards, however it is still important to pay more attention to energy and resource efficiency in the construction and operation of buildings. The environment like our bodies can metabolize nutrients and waste. Eco-architecture focuses on these processes, integrating ecological functions into the buildings to catch, store and filter water, purity air and process other nutrients (Ragheb, El-Shimy, & Ragheb, 2015). Other examples includes;

- The use land can be optimized by avoiding sprawling building designs and by efficiently allocating internal space to various needs.
- Energy use can be reduced by passive or active solar heating technologies, use of shading overhangs and reflecting surfaces in summer and efficient insulation, windows, light and appliances; externally, trees can be planted or

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positioned to adequately provide shade in summer and wind – shielding in winter.

- In urban areas dominated by high rise buildings, use of green roof is an eco-friendly solution. Green roofs last longer than conventional roofs, reduce energy costs with natural insulation, create peaceful retreats for people and animals, and absorb storm water, potentially lessening the need for complex and expensive drainage systems and cooling system. On a wider scale, green roofs improve air quality and help reduce the Urban Heat Island Effect, a condition in which city and suburban developments absorb and trap heat.

Plate 4: Picture showing green rooftop

Source: retrieved from www.howthingsworks.com

- Landscaping can be naturalized by utilizing existing topography and only native plants in horticulture, e.g. Talinum Triangulare also known as Florida spinach or water leaf , see Plate 5. And by designing to emulate natural communities appropriate to local conditions while still maintaining pleasant aesthetics and low-impact recreational use (Yang et al).

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Plate 5: - Use of Talinum Triangulare for horticulture in Abakiliki, Ebonyi State.

Source: Author's field wor

- Building materials and furniture can be selected or specified to be efficiently manufactured from renewable resources, durable yet reuse or recycled and not to emit indoor pollutant.

- Traditional or vernacular design elements can be incorporated into buildings to improve their energy and material efficiency, aesthetics and comfort while still respecting cultural heritage. A very good example is the use of Adobe or other thermal mass to buildings constructed in the northern part of Nigeria. See plate 6.

Plate 6: – Adobe roof found in northern part of Nigeria

Source: Retrieved from www.nidokidos.org

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2. Urban Planning

Eco-design can be applied to both the improvement of existing urban area and communities as well as planning for new cities. According to Yang et al 2013, improvement of existing urban areas start with identifying the environmental problems such as inefficiencies of use of materials and energy with regards to excessive transportation distances, inadequate coordination among businesses in the use and disuse resources. Other environmental challenges includes; environmental pollution, and conflicts with indigenous biodiversity. Tiezheng (2002), added that, other factors to consider and dealt with include commuting distances, the development of economically integrated neighborhoods and equity issues. These improvement can be retrofitted into existing structure and functions of an urban area or implemented when it is being re-designed (TieZheng, 2002). To a large extent, these can be achieved by;

- Minimize the use of energy and materials i.e. by encouraging the use of renewable sources, by recycling, decreasing transportation distances, encouraging the consumption of locally grown food, and by promoting public transit, use of bicycles and taking a walk.
- Provide a high level of ecosystem function, by avoiding the pollution of air, water and soil and by maintaining carbon storage in vegetation (by providing vegetation parts within urban areas, /awns and tree etc.)
- Naturize urban ecosystems by increasing or maintaining the dominion of good native species and their communities, for example, an urban forest, urban vegetation parts dominated by native trees such as Udala tree (cherry tree) palm trees etc. can provide environmental services related to cooling, heat retention, pollution mitigation, carbon storage and aesthetics, while also providing economic benefit to the neighborhood.

RECOMMENDATIONS:

The use of simple passive design and eco-friendly choice in selecting building materials and construction method can help a great deal in minimize the effects of climate change brought about by the built environment, thereby preserving the eco-system. In the light of this, we recommend that architects should:

i) Study the ecology of the site properly before embarking on building designs.

ii) Where possible, should specify Recyclable and/or locally manufactured with low embodied energy.

iii) Preserved the natural environment as much as possible during construction.

iv) Energy efficiency should be propagated through the use of passive solar design, solar roofing, solar energy, wind power and other renewable energy sources. This would help to reduce dependence on fossil fuels.

v) Proper legislations that encourages green design methods should be enacted.

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CONCLUSION

Esty and Chertow (1997) emphasized the need for us to think ecologically, moving from an environmentalism largely driven by sectional issues involving pollution, resources and biodiversity to a more integrated "ecologicalism that recognizes the inherent interdependence of all life systems". At the rate the development needs of this world is using the scarce and limited resources on earth, it is becoming obvious that unless there are major changes to ecological thinking and behavior, the future civilization as known today is endangered. Environmentally, embracing Eco-design also known as green architecture will help to reduce pollution, conserve natural resources and prevent environmental degradation. It is an approach to building that minimizes harmful effects on human health and the environment. The onus is on the eco or green architects to help safeguard air, water, and earth by specifying or selecting eco-friendly materials and construction techniques, and integration of eco systems into building/ landscape designs. It must be noted that the highest goal of eco-design or green architecture is to be fully sustainable. Also known as sustainable development, eco-friendly architecture, earth friendly architecture, environmental architecture, natural architecture (USGBC, 2002).

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