



17th WEDC Conference
Infrastructure, environment,
water and people
Nairobi, Kenya 1991

Environmental degradation and architectural science

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THE ENVIRONMENT

The word environment is a word that could describe a wide range of situations as understood by different specialists, as defined in different disciplines and portraying different settings. The understanding of the environment in most cases is largely in the natural physical sense. One therefore needs to define his reference to the environment.

The environment of interest as far as this paper wishes to elicit is that environment that is bound by built form in urban settings. This is the physical environment that is manifest in the external spaces between buildings and that which is within buildings. Within these two basic manifestations can be a series of combinations of both.

In a sense the environment of interest is the man made environment as engendered by architecture. The built environment exists as both a macro and micro environment, where the macro environment can be said to be at the scale of urban settings such as towns and cities. Micro environments on the other hand can be zeroed down to individual buildings and streets, city squares and such spaces.

The reason that this paper sets out to dwell on this environment of interest is based on several facts and realities; These have to do with the omnipresence of buildings in our lives and particularly in urban environments. All one needs to do is to look at an urban environment and see that the basic ingredient of the "urban" is density of built form. Besides this, the number of hours that the human being spends indoors or within the confines of buildings is significant.

The built environment accommodates its occupants for various activities. These activities can be broadly categorised into those that relate to work on one hand and those that relate to residing or recreation on the other. For the majority of the people a 24-hour day is characterised by cycles of occupation of one building or another. White and blue collar jobs basically relate to a working period of 8.00 am to 5.00 pm with a one hour lunch break. Night shift periods particularly in industry are a characteristic one cannot ignore. In between these formal work periods there are the times spent at home, visiting or involved in recreational activities. No known studies have been done in Nairobi relating to occupancy patterns of the built environment. If a conservatively based conjecture arrived at a figure of 70% of the 24-hour day being the proportion of time general spent within the built environment, this would represent a really significant percentage of people lives spent indoors.

Furthermore within the urban context at the macro-environment level those people considered to be in outdoor spaces are still within the confines of the built environment and also subject to the influence of the man made environment on their lives. This fact brings the 70% figure even closer to 100% as the time spent within the built environment in urban settings!

With the rural-urban migration in developing countries an increasingly critical problem with populations in urban centres in the developing countries expected to increase significantly, environmental problems pertinent to the urban setting need to be addressed to, sooner rather than later.

ARCHITECTURAL SCIENCE

The central role that architecture has, in the environment of interest has brought into the fore over the last ten years or so the discipline of architectural science within the broader profession of architecture. Architectural science is tagged differently in different regions. In Britain and other European countries "Environmental Design" is the term applied. In the United States "Building Science" is the basic term while here in Kenya we allocate "Environmental Science" to this discipline. Architectural science in many parts of the world also involves both engineers and architects and for obvious reasons the term architectural science would require some debate before its acceptability by services engineers in these regions. This paper subscribes to the term architectural science due to the direct reference to architecture.

Architectural science has as its basic interest a study and understanding of the environmental comfort of occupants within buildings and of people without, but within the confines of the built environment. This environmental comfort is related to the physiological response of man, and to some extent the psychological, to the man made environment of built form or buildings.

The different realms of environmental comfort that are covered by architectural science, are those relating to the thermal environment, the aural environment and the visual environment. The most immediate response of the human being to these realms is the physiological, through the skin, the ears and the eyes.

The thermal environment is that which basically draws on heat gain of buildings, wind pattern and air movement in and around buildings, air conditioning and buildings and their ventilation. Building climatology is a term that is sometimes used to express this thermal environment as a man made climate due to the presence of buildings.

The aural environment on the other hand has to do basically with noise pollution and how to guarantee the

protection of those in the built environment from noise that leads to disturbance and discomfort. Noise sources could be internal or extraneous. The aural environment also extends to issues of acoustics that are suitable for pleasurable listening to various activities such as drama, music and related recreational and religious activities.

The visual environment manifest in any space is as a result of light, either in the form of natural light or artificial light. Studies on the visual environmental comfort within built form centres on the need to carry out visual tasks and maintaining of appropriate visual atmospheres of space.

In essence the discipline is a science and though it is not the intention of this paper to give a lecture on the meaning of architectural science it was felt prudent to briefly outline its definition.

ISSUES OF ENVIRONMENTAL DEGRADATION

Environmental degradation as relating to the built environment is a reality in the city of today. In the West much work has been done on this issue over the last few years. The importance of this aspect of environmental degradation can be best seen in the inception of an annual international conference titled "Building Pathology" which was first held in 1989. The aim of this conference is to bring together professionals from different walks of life - "architects, biologists, builders, building research scientists, conservationists, educationalists, environmental health scientists, engineers, financiers, materials scientists, microbiologists, museum curators, mycologists, physicians, property owners and managers, remedial treatment specialists, surveyors, service engineers and veterinarians" - all to discuss the health of buildings, and their occupants, as a way forward to promoting their health!

Latent Environmental Degradation

The most clearly understood form of environmental degradation is that which has to do with the natural environment. For the purpose of this paper the term latent has been used for

that environmental degradation which does not directly refer to the natural environment but which has a direct effect on the physiology as well as the psychology of man.

Noise Pollution - Noise and its sources, has come to be considered as one of the worst environmental problems in cities (1) and it is considered in this paper as a source of latent environmental degradation. Environmental noise in cities are as it were a trade mark of city development and growth. This noise can be in the form of industrial noise, construction noise, traffic noise (road traffic) and at times aircraft noise. These different forms of environmental noise will have peculiar characteristics from one environment to the next. The built environment will largely determine whether these forms of noise are controlled and thus reducing noise pollution for the occupants of buildings, or whether it enhances the noise pollution for the occupants of buildings.

The effect of noise on man are significant. Intense noise can lead to temporary loss of hearing and if exposure to intense noise is prolonged it will certainly lead to irreparable damage to hearing. In addition to this there are automatic physiological responses that have been attributed to noise exposure (2) at lower levels. These have been related to the cardiovascular system, respiration, pupil dilation, skin resistance and even hormonal responses. Although it has not yet been established as to the extent that these responses take place it is clear that they could be harmful in real life.

The most important form of noise pollution is perhaps that which disrupts sleep. This is critical for residential neighbourhoods and accommodation facilities in cities around airports, along major highways and around factories and entertainment centres. This is when background noise levels are low at night and it can lead to disruption of sleep in three ways (3). It can prevent one from falling asleep, it may awaken them once they have slept and it may cause shifts from a deeper to a shallower level of sleep.

Besides noise pollution brought about by environmental noise there is also the issue of interference by noise within buildings leading to breakdown of communication between people. This could hamper productivity, relationships and confidentiality wherever required. This problem is particular to the built environment and it will be in direct control of the designers given the task to design the built environment.

Factors contributing to the latent environmental degradation engendered by noise can be related to poor planning (by all parties involved in the process), the lack of necessary information regarding noise and apathy by those charged with the responsibility of creating healthy liveable environments.

Visual Environmental Degradation. The other form of latent environmental degradation is that which relates to vision. About 75% of information reaches the brain via the visual system. This highlights the importance of vision in our lives.

An overwhelming majority of tasks carried out by occupants in buildings are visual tasks. For these tasks to be carried out efficiently and comfortably there must be the requisite visual conditions present. Issues such as glare and glare index, luminance contrast, level of illumination, colour, size of critical detail and age of occupants are important considerations if visual environmental comfort is to be achieved. There is also the need by architects and lighting designers to consider both natural and artificial lighting. An excessive reliance on artificial light is not considered healthy unless the space so requires and prolonged lack of natural light has been linked to mental disorders.

Poor lighting conditions will also lead to deterioration of eyesight as well as regression in productivity of those involved. Once again poor planning, lack of information regarding lighting and apathy by the design team are factors that contribute to visual environmental degradation.

Climatic Environmental Degradation

A more conventionally understood form of environmental degradation other

than the latent form, is that addressing itself to climate. In this paper climatic environmental degradation will be restricted to that degradation relating to architectural science.

Urban Climatology. The most basic need for shelter can be said to be that of protecting the occupants from the natural climate or the natural elements. However at the urban scale it is evident that in addition to the protection that buildings offer, they are also prone to modifying the external climate and even imposing an artificial internal climate. These modified climates without sensitive control can be major sources of environmental degradation. This urban climate can be broadly categorised into the macro and micro climates.

The macro-climate of the urban settings can lead to environmental degradation on two major fronts. Temperature and air movement. It is a well known fact that there is a warming up of cities and this is related to density of built form and the capacity for buildings to store heat as well as radiate it. In hot regions in particular careful use of building material is required. Here in Nairobi, a drive along Uhuru Highway in the afternoon exposes oneself to the effects of environmental degradation as rendered by insensitive use of reflective glass on View Park Towers. The effect is one of excessive heat radiation on the highway as well as glare. One need not draw a picture of the problem during a traffic jam!

The wind climate is modified extensively by built form. Within the city of Nairobi various slab design buildings have created serious turbulent air flow problems on the external spaces around them and the embarrassment caused to ladies wearing dresses brings out this environmental problem clearly. Air movement that is induced by built form can also introduce additional problems. One of the forms of propagation of noise is through the air. Sound waves can be effected by the wind gradient in the way they travel and issues of noise pollution and acoustic privacy could also develop. Built form that impedes air movement when it is desirable is also a potential source of compounding excess air temperature

and humidity in the environment.

The micro-climate is more restricted to the individual building and in particular the interiors. Again temperature and air movement are the two major components that are modified. In the case of this micro-climate the architect has more control in manipulating the building materials, building form, window openings and so on to create a suitable thermal environment for occupants. Thermal discomfort will lead to thermal stress and hypothermia on the other extreme. Excess heat or cold could also lead to ailments such as common cold, influenza and headache to name a few. Lack of air movement also compounds stuffiness.

Poor planning, lack of information and apathy are likely factors leading to climatic environmental degradation

Sick Build Syndrome

The sick build syndrome has undergone serious studies in the last few years in developed countries. A combination of latent, climatic environmental degradation and use of environmentally hostile building material as well as work pattern of individuals has been attributed as the cause of the syndrome, although there are still a lot of areas not clear about the syndrome. It is clear however that the building itself, as well as its related services such as air conditioning and artificial lighting, and the environment it creates, is the root of this problem.

PREVENTION OF ENVIRONMENTAL DEGRADATION

Much of the work relating to the specific environmental degradation under consideration has been carried out in the West. This means that developing countries have a limitation as to the application on their specific problems. However the work that has been done in the West and the information now available regarding environmental degradation can serve as useful tools and lessons respectively, for the developing world.

The resources available for developing countries also calls for solutions that can apply appropriate technology as well as considering economical approaches to problem

solving. The extensive use of passive system as against active ones for building services as an attitude by architects and engineers alike should be encouraged.

Standards

Architectural science and matters leading to environmental degradation and its prevention involves the formulation of standards. Standards have been developed in the Western world and their application has reduced environmental degradation. Many developing countries apply standards developed in the West. In the absence of their own standards it could be said to be prudent to adopt this attitude particularly where standards could be absolute. However the subjective response of people and the influence of environmental forces in this subjective response calls for more attention on context, in the application of standards.

Standards in daylight factor developed in the West require extensive testing before they can be embraced in the tropics. Sky conditions in the temperate climates are quite different from those in the tropics and different lighting conditions could amount to different subjective responses. Simulation studies on sunlight and sunshading devices (4) indicate illuminance levels in office buildings in Nairobi to be much higher than the recommended level of 300-500 lux (5) as formulated in Britain.

Standards in acoustics gives 35-45 dB (A) as the noise criteria for libraries. Preliminary studies (6) have shown that the Jomo Kenyatta library of the University of Nairobi acquires background levels of upto 65 dB (A). Although this is quite a preliminary study there are no indications of disruption to reading activities.

Research

For any development and formulation of standards, research must be seen as a forerunner. In Kenya, research on issues of architectural science is not adequate. The little research that has been done is not comprehensive enough. There is also no known research in the immediate region that has been undertaken to lead to this development.

In the developing countries where funding of research can be difficult, the interest of bodies and organisations that have a direct bearing on architecture is vital. Both the public and private sectors as well as professional institutions and the building industry can be a potential source of research funding. Charity begins at home and even with funding from foreign sources being welcome this would be a noble effort by local organizations. In Kenya, the Architectural Association of Kenya, Institute of Engineers of Kenya, Ministry of Public Works, the manufacturing and building industry and local authorities amongst others could be a potential source of funding.

In addition to funding, is the need for collaboration between the various organisations, particularly for the developing of standards. Through collaboration, research that is useful will be undertaken and it can be formally channelled into meaningful standards.

Building Legislation

Building legislation will be realised if there is enough information regarding the built environment. Standards relating to architectural science is part of the information that would be necessary. Aspects such as adequate lighting levels for different building types, size of window openings and positions did the colours of facades of buildings are some useful guidelines that would be useful for designers and for the protection of the built environment.

Environmental Law - The development of environmental law relating to the built environment within the law of the land would contribute towards generating sound enforceability of building legislation.

Intra-Regional Co-operation.

The amount of work that is necessary for developing building legislation in developing countries, is legion. This task can be made more manageable with co-operation within regions that have similar climatic conditions and cultural histories as well as support from the West.

A region such as East and Central

Africa could co-ordinate their efforts towards this end and thus reduce the bulk of time, energy and resources that would otherwise be spent. Work for instance that has been done in Zambia in recording the sky luminance distribution could be useful for developing lighting standards in Kenya.

Inter-Disciplinary Collaboration

The built environment does not lie in the hands of the architect alone. There is a team of professionals who all contribute towards the development of the built environment. It would be vain to end this paper without recognising that, and highlighting the need for co-operation within that team so as to better understand the issues and hence create environments that are conducive to human development.

A spirit of co-operation at all levels will lead to the protection of the environment so that the God given gift of creative faculties of man can be employed for the protection of the environment as God had intended when he created man.

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