A CONCEPTUAL FRAMEWORK FOR ARCHITECTURAL DESIGN

an ecological standpoint

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In considering "An Architecture in Harmony with Nature" or ecologically sensitive architecture, it is important to have an understanding of Nature. As Pulitzer, Prize-winning novelist and playwright Thornton Wilder (1897-1975) has observed,

> "I have no patience with people who say they love nature and go out to look at a field on Sunday afternoon. Our families, the way we live with our fellow men, are part of nature too."

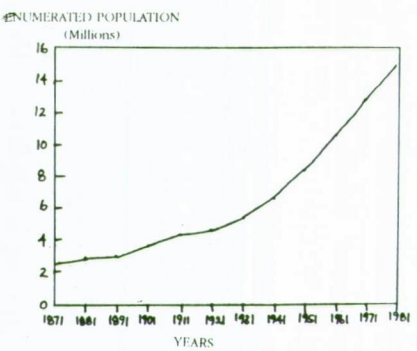
This attitude touches on what Nature actually means to Mankind, that Man's perception of Nature should be more than merely romantic and visual. Man is, in fact, dependent on his environment for survival as is any other organism. However, it is Man himself who, due to his technological advances, exerts the greatest influence on his own environment due to his uniquely effective ways of altering his environment.

While Ecology is the study that allows us to understand Nature, Structures stand as the link between cultural man and the natural world. Architecture is the major expression of that culture and provides for a quality of life which is more than merely physical.

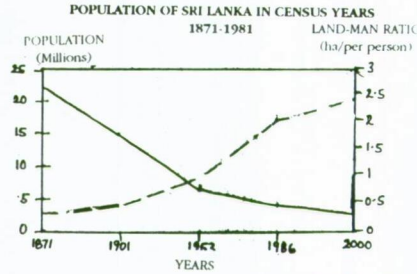
Architecture essentially deals with buildings. Buildings which are more than mere structures addressing more aspects than mere functional/structural needs. Architecture provides for, and pervades Man's cultural, social, spiritual and conceptual thinking as well. However, insofar as these buildings do not stand in isolation but stand in a given context, utilising space on this planet and resources of this planet, architects have a responsibility to address these aspects as well.

SUSTAINABLE DEVELOPMENT

The overriding concern of today is whether the resources of this planet and its ability to absorb wastes can sustain the pressures of the large human population. Sri Lanka's



POPULATION OF SRI LANKA IN CENSUS YEARS 1871-1981



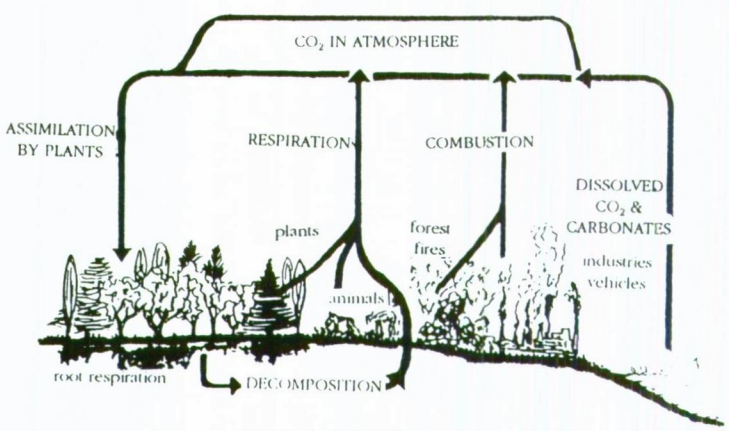
LAND-MAN RATIOS IN SRI LANKA

Source: Natural Resources of Sri Lanka – NARESA 1991

population is now so high that the land to man ratio has reduced to an extremely low figure. [0.38 ha (1 acre) pp] Thus, land for the larger number of structures required, is accordingly reduced, leaving aside agricultural, plantation and forestry lands all of which are required for our sustenance.

THE STUDY OF ECOLOGY

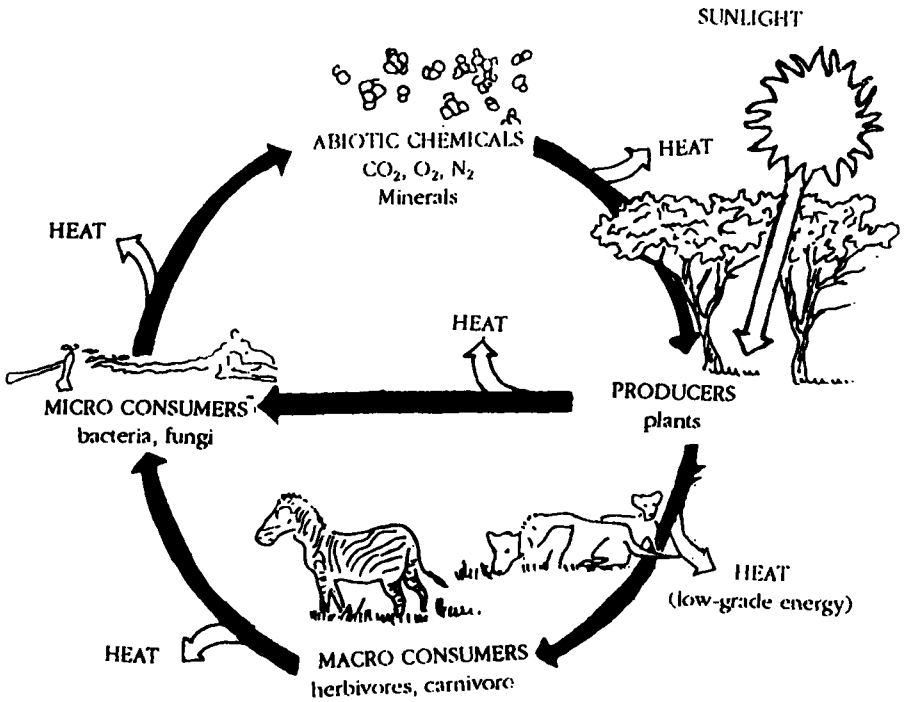
Ecology helps us to understand the structure of Nature and how it works. It is Eugene Odum's modern (1963) definition of ecology **as the study of the structure and function of nature** that is applied in the proposed framework. The concept of Ecosystems was put forward by Tansley (1935) in order to study the structure of Nature. The largest ecosystem is the Biosphere, which is that part of the Earth that sustains life. The functioning of Nature relates to materials cycling and energy flow and includes the intra – and inter-relationships between organisms and their environment.



THE CARBON CYCLE

AN EXAMPLE OF **MATERIALS CYCLING**

Shown above is one example of a materials cycle – the carbon cycle. Some materials cycles are renewable, however, the rate of renewal over utilisation may take several generations in time – an example is the geologic cycle where soil is eroded at an alarming rate (possibly 5 – 10 mm in a year and tropical soil studies have shown that soil formation through weathering from metamorphic rock is in the range of 46 mm in 1000 years! In considering energy flow, the source of energy is the sun, which is converted, directly or indirectly, to all forms of energy on this planet. Each conversion is not completely efficient, with low-grade unutilisable heat energy being given off.



ENERGY FLOW

These aspects along with that of intra – and interrelationships between organisms and their environment are of vital importance from the point of view of this paper.

APPLICATION OF ECOLOGICAL PRINCIPLES

These principles are increasingly applied to a variety of Man-modified situations, such as cities, in the search for efficient systems. Due to limited materials and resources it is found necessary to design in such a way that these materials and resources including direct and indirect sources of energy are made use of to their optimum potential.

In this light, it is imperative that in today's age we introduce, among age-old architectural principles, the principle of seeing **Man as part and parcel of the Biosphere.**

I wish to stress here, that inclusion of this as a principle which should pervade all architectural conceptual thinking is essential for the well-being of the profession of Architecture in today's age, as well as for mankind itself.

The Principle of seeing Man as part and parcel of this Biosphere when applied in relation to the other considerations of the framework is that which would ensure an Architecture which is ecologically sustainable, visually harmonious with surroundings (not discordant) and which optimises the use of land and space while satisfactorily addressing social and functional needs.

By this means an architecture which is harmonious with Nature could be realised through application of the suggested framework.

OBJECTIVE

While the overriding concern of any work of architecture is in its concept, many buildings have not been successful architectural works due to all aspects of design being not addressed. Moreover, direct and indirect environmental degradation could occur due to incomplete addressing of relevant aspects. As in ecological functioning which includes **intra – and inter-relationships, the object of presenting this framework is to ensure that all design considerations are seen simultaneously and as inter-related to each other.** Thus, all aspects of design may be addressed and evaluated allowing decision-making to be more effective. Further, if applied in the light of the above Principle, environmental degradation may be reduced.

This paper presents a framework in three parts –

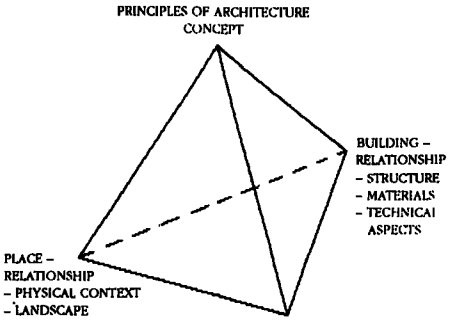
1. the inclusion of architectural principles applicable, as indicated above,
2. a model for architectural design and
3. a model drawn from ecological principles for seeing buildings in their context.

A MODEL FOR ARCHITECTURAL DESIGN

It is in this light, that I wish to put forward a model for architectural design.

The form chosen for this model is that of a tetrahedron. This is a foursided solid geometric figure, with four corners and six edges. Each corner connects to every other corner through the edges or through the sides (planes).

It is this property of the tetrahedron which makes it a suitable model due to the aspect of interaction often stressed in principles of ecology. I have placed the four main considerations in Architectural design at these four corners indicating that each is inextricably linked to the other. Moreover, these considerations together, applied with expertise, make



up an entity, complete and total, which we can call an architectural work.

The major considerations are as follows:

the concept – this aspect influences all design decisions taken in other aspects – it has as its background philosophical thinking on all areas relevant to the required project – it draws on basic architectural principles for its assertion and uses the elements of architecture for its realisation.

the people relationship – this aspect deals in the first instance with the function of the building. Function is in four parts – designing the space to accommodate the activity, the interrelationship of the various spaces one to another, meeting comfort conditions of the users and the emotional/ psychological impact of the space on the user/visitor. Responsible design would optimise the use of land and space in such a way as to create a healthy society in body and mind. Moreover, the social context and cultural factors of the people would have to be considered. These would influence the nature of surface adornment of the building envelope and contribute to its identity. Form and meaning of buildings are largely derived from this aspect.

the building relationship – this deals with the choice and selection of structure, choice and selection of materials and technology of building. This is a particular aspect where architects may contribute towards responsible resource management in the light of environmental issues today. Optimising the use of resources, using appropriate technology and responsible disposal of waste are aspects to be thought of at design stage.

the place relationship – an important aspect from the point of view of this paper – it deals with the physical context within which the building lies – the landscape, be it urban in character or otherwise. The second model which forms part of the framework proposed by this paper is applicable here.

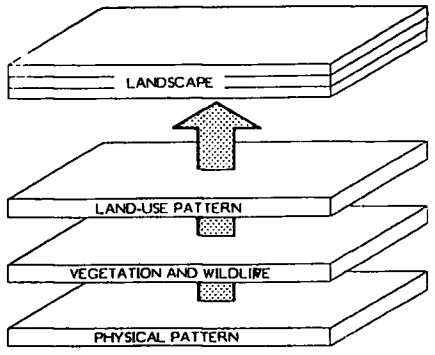
THE ASPECT OF TIME

If we now visualise this model encapsulated in a bubble it could float through Time. All four considerations, of Principles, Place, building technologies and user requirements could change with Time. If for instance the model is floated back a 100 years, the overriding concepts were largely influenced by the need to dominate the surrounding landscape or people. This was possible where buildings of importance were few and land plentiful. Materials and techniques prevalent at that time differed in some ways from that we have today. Thus if this model is floated back to the present time and the bubble burst, the criteria applicable in the four corners may include new approaches and new products.

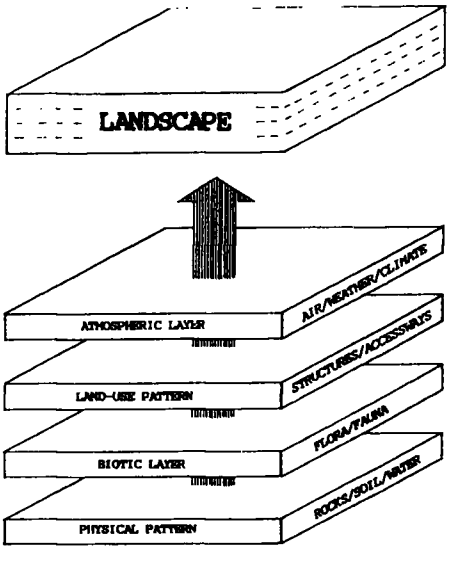
THE PLACE-RELATIONSHIP MODEL

The second model proposed in this framework deals with the place-relationship of the first model. This is an area in which buildings affect degradation of the physical environment in a more direct manner. It is thus, the responsibility of architects (in the light of the Principle stated earlier) to prevent or forestall environmental degradation due to buildings, preferably at design stage. The model, drawn from ecological principles is an aid towards addressing all aspects of context and thus achieving a completeness in design.

An early concept utilising these ecological principles was put forward by three landscape architects from the Netherlands, Gerard Van Waesberghe, Pieter Germeraad and Anton Bijholt (1982) as shown in the diagram.



LANDSCAPE AS A SET OF RELATIONS
(after Van Waesberghe, Germeraad & Bijholt)



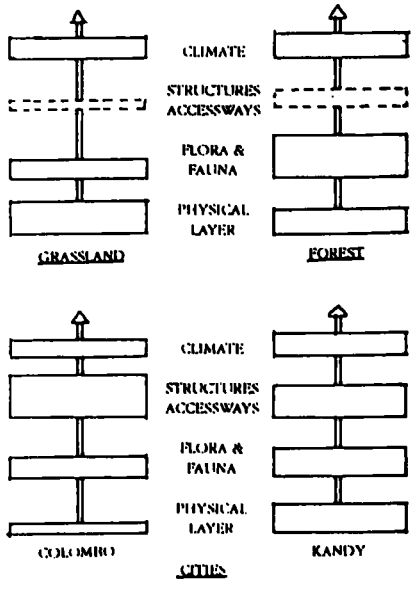
LANDSCAPE AS A SET OF RELATIONS

They put forward the idea that understanding the basic relationship of organisms (including man) and habitat can introduce a proper degree of caution and reduce the likelihood of environmental degradation. Landscape, in this context, is not a coincidence of natural and cultural elements, but a coherent set of relations between physical data (rock, soil, water, geomorphology), biological data (vegetation and fauna) and data of human society (land use patterns and artefacts) which includes structures.

Using this as a basis, it can be appreciated that the base for a given landscape (of a 'place') is the physical layer which, in conjunction with the

atmospheric conditions of the given place, will determine the biological data creating spatial conditions for human society, their accessways, artefacts and structures. It is the result of these interrelations that we call landscape. Taking this approach a step further, we may indicate different types off landscape in a similar manner.

In natural landscapes which human society has chosen not to invade, buildings would not be present, or perhaps limited. However, in cities or urban centres, buildings form an intrinsic part in this coherent set of interrelations that form the urban landscape.



DIFFERENT LANDSCAPE TYPES
THICKNESS OF LAYER PROPORTIONAL TO DIVERSITY

In addition, the relative diversity within each layer may be indicated by the thickness of the layer. Thus the diversity (of species) among flora and fauna of a forest is high, while a high diversity of man-made structures, accessways and in general the social fabric may be seen in a city.

In adopting this model, the landscape should be considered as the result of the process that gave shape to it in the past and consequently, as the base for future developments.

The model may be applied in the consideration of a townscape, individual buildings or groups of buildings, since it indicates the place – relationship. As in consideration of ecosystems one can set the boundaries as desired. By studying the elements of each separate layer, while realising the interaction between them, a completeness or totality of outlook can be achieved.

ASSUMPTIONS

It is assumed that the framework is for the use of knowledgeable professionals. However, more detailed study of environmental issues could be taken up through Continuing Professional Development Programmes (CPD).

FURTHER CONSIDERATIONS

This paper proposes only the principle and overall framework for design. However, some considerations in each layer are indicated in the following figures. Also the areas in which environmental degration can occur can be more readily seen. This is in fact the objective for presenting the model.

For example, the consideration of the physical layer would mean that the topography, soil conditions – permeability, plasticity, composition, bearing capacity, friability etc., geology (if applicable), presence and nature of water bodies, drainage patterns and so on should be known. If the data of each layer is known, a comprehensive and coherent picture of the landscape builds up.

APPLICATIONS

This model then serves as a checklist for investigations, feasibility, design synthesis, Initial Environmental examinations (IEE), Environmental Impact Assessments (EIA) along with energy flow studies, and feedback (post implementation) studies.

Examples of environmental degradation taken by layer may be as follows:

In the case of soil – impoverishment, erosion, instability and siltation of water bodies are to be considered.

In the case of water questions that may arise are whether the demand can be met, overuse, pollution direct and indirect, ponding on high lands can cause earth movements and poor drainage which may assist erosion.

	CONSIDERATION	ENVIRONMENTAL CONCERNS
P	Land form	Extent of Variation
	Slope Gradient	
H	Drainage Pattern	Whether UNDISTURBED/DIVERTED
Y	Spatial Character	
S	Composition (Surface Texture)	
	Geology	Earth Movements
I	Soil Profile	
C	Soil Permeability Percolation	Erosion
	Soil Texture	Top Soil Loss (nutrient loss)
A	Bearing Capacity	Whether Sufficient for structures - Limitations to be known
L	Presence of Water Bodies	Possible Pollution Immediate/short term/long term
L	Type (following still, underground)	Siltation
	Rate of Movement	Eutrophication Sand Mining
A	Beach Environments (dunes, backshore, HTL, LTL)	Coastal Degradation Coral Mining
Y	Reservations	
E	Erosional Env	Erosion
	Depositional Env.	
R	Erositional/Depositional	

Considering rocks – over extraction may cause earth movements.

In the atmospheric layer, it is known that construction activity contributes to the TSP (Totally Suspended Particulate matter – dust, soot, ash etc.) that causes respiratory problems in humans.

	CONSIDERATION	ENVIRONMENTAL CONCERNS
A	Air Composition	Presence of Pollutants
T	Air Quality	[Co, O_3, SO_2, NO_2, Lead,]
M	Particulate Matter	High Level of TSP may Cause Respiratory Diseases
O		[Sources. Among others – Construction activity]
S		
P	Aspect of Sun	Possible Natural Lighting
H	Insolation [Level, duration]	Solar Energy Converters
E	Day Length	Glare/Shadows
R	Wind Speed	Influences extent of
I	Wind Direction	Void/Apertures for Ventilation
C	Seasonality	Disposition & Pattern
	Humidity	Relates to Apertures Water Features
L		
A		
Y	Precipitation	Run-off
E	Type	Collection/Disposal
R	Intensity	Drainage
	Average Annual	Retention Areas

Similarly, in the biological layer which includes vegetation – removal of vegetative cover assists erosion, increases soil temperature, exposing soil to sun allowing formation of hard pan (reduces soil friability) and in turn reduces water infiltration and increases quick run-off thus reducing dry-weather flows. Certain types of vegetation may assist soil conservation or biological control of pests and diseases.

In the case of structures, accessways and artefacts, traffic congestion and vehicle exhaust emissions, altered ground levels and water tables due to displacement by foundations and underground constructions, altered drainage patterns and microclimates due to structures of large volume, discordant visual experiences due to poor design, poor maintenance are considerations.

	CONSIDERATION	ENVIRONMENTAL CONCERNS
BIOTIC LAYER	Bioclimatic Region	Habitat Destruction
	Floristic Region	Removal of Vegetative Cover
	Composition of Species	(Causes erosion, increased surface (Flora) water run-off
	Relating Abundance	formation of hard pan
	Dominant Species	
	Age (Young/Prime/Degrade)	Loss of Resource (timber, fuelwood, medicinal plants, natural fibres, food sources)
	Type - Agriculture Minor Crop Social Historic Conserved Habitat Fuelwood	Loss of Resources unknown Loss of Ecosystem Diversity Loss of Species Diversity Loss of Gene Pool
	Composition of Species (Fauna) Wild/Domestic	
	Type	Habitat Alteration could cause Reduction of Species
	Mobility	Poaching/Trapping
	Abundance	Proliferation of Pests

	CONSIDERATION	ENVIRONMENTAL CONCERNS
LAND USE PATTERN	Form, Scale, Mass of Structure	Visual Discord Too High Population Density
	Frequency of Occurrence	Fragmentation of Land
	Disposition on Land	Built Area/Open Area Ratio too High/Low
	Plot Sizes	Maintenance
	Building Coverage	Altered Microclimates
	Material Used	Altered Meso Climates
	Surface Treatments	(heat gain, reglectivity of Light, heat)
	Voids - Extent/Pattern	Glare Conditions Permanent Shadowing
	Extent of Building Below Ground	Altered Ground Conditions
	Sky Line Social Pattern	Altered Water Tables Altered Drainage Paterns
	Accesways - Extent Pattern Hierarchy	Unhealthy Social Concentration Traffic Congestion
	Volumes of Traffic	Pollution - Noise Vehicles Exhaust Emissions
	Type of Vehicles	
	Zoning of Activities	Idustries Poor Water Quality
	Extent of Open Areas Types - (parks, gardens, promenade)	Lack of Privacy Increased Rate of Surface Water Run-Off
	Ancillary Structures (Signs, Seats, Post-box, phone)	Too Excessive Solid Waste Accumulation
	Infrastructural Services - Electricity, Water	Lack of Central Sewerage Facility
	Supply, Sewerage, Telecom Media, Lighting, Refuse Etc.	Maintenance of other Services

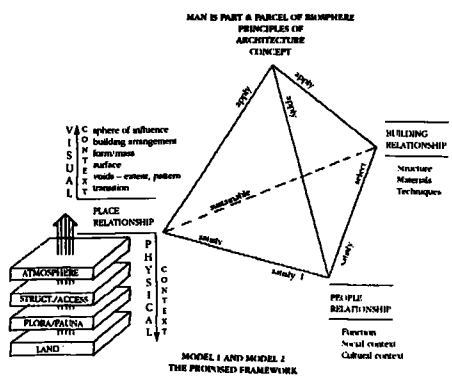
Also generation of excessive solid wastes,. irresponsible liquid waste disposal leading to polluted waterways and so on are some aspects of environmental degradation.

(Some of these aspects are being addressed by the Colombo MEIP [Metropolitan Environment Improvement Programme].

It must be stressed that no entity can be separated, but necessarily interact one with the other. However for the purpose of investigation, evaluation, planning, identifying problem areas and implementing solutions it is convenient to use this framework.

THE TOTAL FRAMEWORK

The two models coupled together provide a complete overview of design considerations.



It is my view that this completeness would assist in overcoming environmental degradation that may occur through aspects being overlooked. For example, design decisions in meeting comfort conditions, which is an aspect of function, when seen in relation to the atmospheric layer and climate conditions would necessarily evolve particular design solutions which in turn should be evaluated against architectural principles and the appearance of the envelope.

For example, in a hot climate of dust-laden winds, apertures would be small reducing contrast and glare conditions from within, while allowing for ventilation, but screening out wind-blown sand, small apertures would then read as a low solid to void ratio externally or collectively seen as a framework of punctures over a larger external surface. This aspect should be evaluated against other structures in the given context of 'place' and the attitude of the people to the internal-external relationship.

EXCEPTIONS

It is of importance today to establish the functions which demand grandeur and dominance of people and context, limiting these to only the fewest buildings, (landmark buildings), and deriving concepts for the remainder in keeping with the principle that all others would act as acknowledges or backdrop, thus creating a more harmonious scene for human perception, and thus controlling the use of rare and precious materials.

CONCLUSION

Responsible design decisions in terms of seeing Man as part and parcel of the Biosphere would ensure energy efficiency, space optimisation, and careful material selection in terms of availability and optimisation of resources using appropriate technology.

As long as the energy budget is low, the functional aspects of a building efficient, the visual outlook harmonious, the waste disposal responsible and the cultural/social relationship acceptable in terms of architectural principles and concept, a building could be an architectural work of repute meeting the requirements of this day and age and ready to meet the future. It is my hope that this framework would assist in this regard.

This paper was presented at the Public Affair Forum of the Annual Sessions in 1993 on the theme of "An Architecture in Harmony with Nature".

Note: Archt. David Jackson, President CAA has commented:

"At the conference in Sri Lanka the Institute there, led by President Architect Mihindu Keerthiratne, put on a well informed event and almost all of the Institute members attended. I was privileged, with my wife who is an environmentalist and landscape architect, to address that congress. Our presentation complemented the local papers. I recall with great pleasure and interest **the original work delivered by Architect Shereen Amendra.** She linked the atmosphere, the planet and animal world and water and earth, and described their frail interdependence and our dependence on that linkage.