Trees and Ecologically Sustainable Development (ESD) of Tropical Urban Ecosystems - ideas on more creative urban planning

FJ van der Sommen PhD candidate CDU

Perceptions of landscapes, be they natural or human created, are colored by culture, education and experience. This perception influences human engagement with these landscapes. Conflict of perceptions regarding the environment between the natural sciences and humanities in particular need to resolved if the community is to deal effectively with the complexity of environmental perturbation and hazards in tropical urban landscapes where there occur.

My own environmental perception has been influenced by education and experiences as a environmental forester engaged in industrial and environmental vegetation management in arid, temperate and tropical landscapes, as an educator, influencing the perception of natural resource management students and working with community groups such as Greening Australia and Landcare. This experience has led me to the conclusion that technical aspects of vegetation management are not a problem, but motivating people to do it, and do it effectively, is problematic. Integrating the technical (objective) and social (subjective) dimension of vegetation management research and education requires creative, holistic strategies particularly when dealing with tropical urban landscapes.

As Einstein once remarked "the world we have created today as a result of our thinking thus far has problems which cannot be solved by thinking the way we thought when we created them". The UN "Year of the Built Environment" and the 30th anniversary of Cyclone Tracy is an opportune time to reflect on contemporary thinking in relation the gradual environmental stresses created by humans in cities and catastrophic hazards imposed by the natural and modified environment, where cities are located, on its people.

Tropical cities like Darwin are in constant state of flux, both socially and environmentally, involving both population growth and urban expansion, interspersed with phases of urban decline and catastrophic destruction, and rejuvenation. These phenomena can be analyzed in time and space using digital image processing and geographic information systems technology. This approach is being used to explore the spatial urban dynamics of Darwin, with a focus on the interaction between trees suburban house and cyclones.

Tropical cities as anthropogenic ecosystems

The conceptual basis for this research is the recognition that tropical cities like Darwin are located at the higher end of the, energy/matter consumption and pollution dissipation continuum or "anthropogenic ecosystem spectrum" (AES), which is linked to increased vegetation change. Within these urbanized landscapes energy gradients are experienced from the peri-urban, with fragmented native and some introduced vegetation, through suburban landscapes, with predominance of exotic vegetation, to commercial and industrial landscapes with little if any vegetation cover. These anthropogenic ecosystems have also evolved out of low energy, native vegetation dominated predecessors which still persist elsewhere, as aboriginal land, conservation reserves, closed catchments and pastoral land, and as consequence have inherited some of some of their attributes to which new attributes have been added increasing their complexity. Urban AE within this spectrum can therefore be conceptualized immersed in "hard" and "soft" environmental "spheres of influence" (ESOI) which now drive and regulate them. The hard "spheres" comprise the primary element identified in the tradition of ancient cultures. The cosmosphere is the source of energy, or "fire". The atmosphere, or "air" comprising circulating

gases and vapor giving rise to rain. The lithosphere/pedosphere/toposphere complex or "earth" the source of minerals and fossil energy and the hydrosphere, or "water".

These primary spheres interact with and support "hard" secondary ESOI constituting all forms of life in the biosphere including human life (the sociosphere) and intelligence giving rise to technology (technosphere) the latter collectively called here, the "anthroposphere". Complex human intelligence also gives rise to the "soft" ESOI of thoughts, meaning, emotions, beliefs, and creative ideas and the experience of a "sense of place" bearing on value and amenity for urban occupants. This is called by some the "noosphere" which manifest itself in economic, legal, political and religious organizations, and the "social economy" of Prof. Lyons (this symposium) constituting major driving forces in urban AE dynamics.

These hard and soft ESOI, define both the concrete, objective, quantitative layers surrounding planet earth, like layers of an onion, together with their more, qualitative, subjective states some of which are recognized in what Dr Gibson (this symposium), has called the "creative economy" giving rise to urban character and vibrancy.

Negative changes to ESOI

The negative legacy of such human creativity in urban landscapes are quantitative and qualitative changes to ESOI including:

- Biosphere change - e.g. vegetation cover changes and species loss,
- Atmosphere change - e.g. greenhouse gas and thermal pollution,
- Hydrosphere changes - e.g. water regulation, pollution,
- Geosphere - e.g. soil, erosion, acidification, eutrophication,

In addition natural phenomena, including storms, cyclones, with associated floods, and landslides as well as disease, occurring episodically within the same ESOI of vulnerable tropical AE, pose a hazard to humans and their artifacts. Future "Greenhouse" climate change scenarios are somewhat pessimistic about the long-term consequences of, such often human exacerbated, hazardous phenomena necessitating the need more creative urban planning for dealing with both their causes and effects.

The role of vegetation in urban environments

Vegetation change, in particular, features strongly as both a contributor (clearing) to AE hazards and a panacea (planting) for dealing with their adverse consequences. The functional role of vegetation has been recognized in rural land management (wind breaks, salinity and erosion control, greenhouse gas assimilation) but this role is rarely appreciated in cityscapes. Many professional urban vegetation designers, planners and managers as well as many individuals the general community of landholders, have long appreciated the amenity value of vegetation. There is however a lack of an overarching, holistic philosophy, and research paradigm for improving understanding of the functional role of vegetation in regulating harmful urban processes. This limits creative and effective vegetation planning design and management, particularly as an adjunct to the engineered structures of the technosphere. Although engineers and architects, for example, recognize vegetation cover, as a terrain factor in the cyclone coding of houses, no research data exists on what the moderating factor should be.

Part of the problem is that a multiplicity of academic disciplines within the natural, pure and applied, sciences and humanities, are engaged in research and education, on matters pertaining to cities as a whole, deal subjectively, with their own "environmental spheres of interest"(ESOI), thereby providing piecemeal information to users of information. Such compartmentalized and

fragmented of information is often difficult to integrate but is also often incompatible with the needs and aspirations of these users. Both objective and subjective ESOI of urban AEs, constituting two sides of the urban environmental coin therefore need to be treated synonymously in the studies of urban processes.

The ecological sustainable development paradigm

The pseudo scientific, paradoxical, political paradigm of "Ecologically Sustainable Development" (ESD), incorporated in the UN Agenda 21 pertaining to Urban ESD, and more recently in UN Global Compact (Prof. Birch this seminar) attempts, somewhat unsuccessfully to address this problem. The terms "ecological", "sustainable" and "development" have been much used, abused and variously defined by a plethora of interest groups creating more confusion for the appliers of knowledge, leading to inaction if not abandonment of the concept.

It is also significant that the ESD "camel" (designed by a committee), has its philosophical roots in the, now almost abandoned, applied ecological forestry concept of "sustained yield". Such somewhat mechanistic and deterministic ecological thinking however still dominates the, often biocentric, approaches to ESD, but it is being increasingly challenged by many. A concept of *towards* ESD is however still worth pursuing only because of the inferred intent of "integrated" approach, (mentioned by Professor Birch in this symposium), to environmental education, research, and planning that it promulgates.

Essentially the biocentric concept of ecology, referring to the study of the "holistic" relationship between any organism and its ESOI implied by ESD is a useful one for addressing the dynamics of human related landscape dynamics. This approach has been viewed both topologically (vertical connection of ESOI) and chorologically (horizontal connection between ESOI and systems) by geographers (using GIS) and functionally, as vertical and horizontal energy/matter (and biota) and information transfer process, by ecologists and landscape ecologists. Such ecological thinking is also incorporated in the radical ecological model of "Gaia" proposed by James Lovelock, which provides a useful global model for exploring the ecological relationships between ESOI. Classical ecological theory underpinning such ESD thinking however is somewhat mechanistic and deterministic seeing homeostatic, stable conditions as the norm. This gives rise to the concept of "sustainable", being suggestive of a perpetual motion machine. This view is in defiance of the law of thermodynamics making it a questionable paradigm particularly for those AEs where consumption by fire, herbivore and humans consumers accelerate thermodynamic decline. The western, Aristotelian /Newtonian paradigm, based on a hierarchy of causal driver and regulator agents, leading to deterministic responses, is therefore considered inappropriate to understanding the complex dynamics of AEs, such as cities.

More significantly, although the vital role of the biosphere and anthroposphere as ecological regulators is generally recognized, the biosphere in general and humans in particular as a driver of such systems is generally under rated. Humans in fact are generally seen as negative ecological aberrations and rarely as a positive agent of ecological self-regulation, or as a counter to thermodynamic decay. The incorporation of human thought and behavior as an ecological variable is seen to contradict the objective foundation of the classic science research paradigm.

The need for more creative holistic thinking

A shift in such biocentric thinking is required, to one which is less mechanistic and deterministic, and integrates all disciplines engaged in ESD. More particularly this shift needs to recognizes the ecological contribution of human intelligence, knowledge, and motivation to driving and regulating ecosystems towards sustainability (or destruction), particularly in cities. This approach

therefore needs address the polarization between natural and human sciences and humanities, fostered in university faculties, as recognized by CP Snow some 50 years ago.

A holistic conceptual chronological model

Developments of ideas in complexity theory, quantum physics, cosmology, as well evolutionary biology, bearing on the emergence of complex and chaotic systems, have much to offer to more creative thinking, research and education in urban ESD. This is being increasingly recognized by many theoreticians on both sides of the academic divide and more particularly is found to have some resonance with Aboriginal worldviews. Such theories deal with the chronology of emergent entities, called a "holon", which is any system, including human individual, and its environment, immersed within the layers of ESOI. These ESOI can be conceptualised as in filled "Russian Dolls which have over time evolved interactive, functional relationships with each other, giving rise to emergent holons. It is of significance that the primary “soup” of such holons is the quantum matter and forces particle arising out of the “Big Bang” of the universe and now constitute the matter of all holons, which may also be contributing the functioning of the creative mind. The wave particles duality of such primary matter is little understood and may be linked to the perplexing quantity/quality duality by which we experience holons, and may explain the uncertainty associated with accommodating both in research and management. If this is so it may provide the unifying link between objective and subjective experiences of the urban environment.

Systems, with internal (endogenous) structure, processes, and regulators which emerge from the “soup” of ESOI, include cyclones, trees and houses as well as individual and groups of people which interact with these in urban landscapes. Pre-existing holons, give rise to, nurture but can also destroy such holons. Such holons once they appear, therefore grow, fluctuate, at a state far from thermodynamic equilibrium, and invariably decline and disappear in time and space, in generally unpredictably ways. This is evident in studies of physical, biological and human ESOI evolution and human cultural history. These emergent holons also form networks (called a “holarchy” by the physicist David Bohm) with each other, making them both dependent on, but also vulnerable to, energy/matter transfer processes within this network. Holons, such as trees and houses are therefore generally perched at the threshold between order and chaos, and are particularly vulnerable to sudden unpredictable perturbations within the holarchy such as cyclones, creating difficulties for planners, designers and managers. This suggests the need for precautionary approaches to planning as advocated by many proponents of ESD, and a more probabilistic statistical approach to tropical urban research.

Natural fluctuation in Holon energy states, due to interactions between endogenous (thermodynamic) factors within the Holon and exogenous processes within the Holon network or “holarchy” has been exemplified by the interaction between Cyclone Tracy and suburban houses and trees in Darwin in 1974. The rate and extent of house or tree holon change to this catastrophic energy transfer processes was influenced by both the endogenous attributes of the holon affected, which for trees include their morphology, anatomy and physiology and for houses their engineered structure, and also the nature of the ESOI of these holons influencing cyclone energy (and flying matter such as debris) assimilation and its buffer capacity.

Some research on trees and urban sustainability

This holistic concept is being explored in a case study using digitized geographic information on

- the size and location of Cyclone Tracy (atmospheric holons)
- topography and soils (geospheric holons) of the cyclone path, also affecting growth
- the structure and composition of houses affected (technosphere holons),
- ownership (noosphere), and

- tree cover (biosphere holons) at the time of the cyclone Tracy.

Analysis of housing damage and tree cover to date has established statistical links between tree Holon cover increases and reduced house damage particularly where houses were

- government rather private built houses
- ground level brick rather than open elevated fibrocement houses
- at the cyclone eye perimeter, particularly north of the cyclone, where wind were stronger (north orientation)
- at higher elevation, steeper slopes, and possibly southwest aspects
- of an older age

ESOI impacting on tree Holon cover states (growth rates, health, and vigor), and vulnerability of trees to cyclones is a further complication being investigated in this study.

Future research options

Investigation so far reveals complex interactions between trees, house and cyclone holons within urban landscapes which suggest a reduction rather than an increase in hazards, with potential positive benefit of tree cover emerging in certain circumstances. The state of tree holons within urban holons may also contribute to the amelioration of other urban processes in the atmosphere, such as heat cell development, and greenhouse gas accumulation; the hydrosphere, such as water flow regulation; the geosphere, such as enhancing soil fertility, moisture conservation and erosion control; the biosphere, such providing habitat for urban wildlife, while also providing economic benefits to the sociosphere in timber resources where hazardous trees require removal. All of these functions compliment that of cyclone buffering. Such tree-house Holon relationships need further investigation in sustainable tropical cities planning possibly using this conceptual framework. Such objective research needs however to be complimented by studies dealing with those qualitative attributes of tree and and their relationship to human holons in the urban anthroposphere, which establish meaning and value essential to the human well being, by drawing on knowledge within the humanities. Such values include those which impact on aesthetics, human health and well-being and peoples “sense of place” attracting and keeping people them in Darwin. What better place to foster such integrated research then in landscapes where the traditional culture has recognized these holistic links and in the city and university named after the scientist who made a significant contribution to understanding the chronological relationship between the biosphere and anthroposphere, underpinning emergent ideas of complexity in his theory of evolution by natural selection- Charles Darwin.