Complexity Of Urban Ecosystems: The Contribution Of Human Ecology

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ABSTRACT

Urban ecosystems are complex with many material and non-physical constituents. They are not structured within traditional disciplines and professional sectors. Therefore, they ought to be considered in terms of the multiple factors that influence both the structure and functioning of these ecosystems. An ecological perspective recognizes that behavioural, biological, cultural, economic, social, physical and political factors need to be considered if a comprehensive understanding of urban ecosystems is to complement disciplinary and sector-based interpretations. Key concepts and principles of human ecology are applied in this paper to help achieve this objective.

ABSTRAK

Ekosistem bandar adalah kompleks dengan pelbagai bahan dan unsur-unsur bukan fizikal. Ia tidak distrukturkan dalam disiplin tradisi dan sector-sektor profesional. Oleh itu, sepatutnya dipertimbangkan tentang pelbagai faktor yang mempengaruhi kedua-dua struktur dan fungsi ekosistem ini. Perspektif ekologi mengenalpasti bahawa faktor-faktor kelakuan, biologi, kebudayaan, ekonomi, sosial, fizikal dan politik hendaklah dipertimbangkan jika satu pemahaman menyeluruh ekosistem bandar bagi melengkapi disiplin dan sektor berasaskan taksiran. Konsep-konsep dan prinsip utama ekologi manusia digunakan dalam artikel untuk membantu mencapai objektif.

INTRODUCTION

Urban ecosystems are human constructs because the "natural world" does not provide urban or domestic space. Cities and all their buildings and services must be conceptualized before they are constructed. The foundation and the

construction of cities implies that geographical space and environmental resources are cultivated by people to serve their daily basic requirements and sustain human societies over time. Human sustenance is dependant on the availability of basic resources and the quality of living conditions both within and beyond the geographical boundaries of cities (Boyden, 1987). The construction of cities can be interpreted in relation to those collective decisions, lifestyles and adaptive responses that individuals and groups make in relation to the local environmental conditions of their habitat, their available resources and knowledge. Traditionally, shared lifestyles, conventions and meanings about the ordering of society have also been used implicitly and explicitly in the construction of urban ecosystems (Lawrence, 2001).

The historical development of specific cities has been widely documented. During the last 8 or 9 millennia many cities have flourished, whereas others have struggled for survival and some have collapsed (Bairoch, 1988). Today, Alexandria, Delos, Jericho and Ur still exist but only as fragments of ancient civilisations and seats of authority that previously had jurisdiction over vast geographical regions extending far beyond the boundaries of these cities. These examples of the prosperity and decline of cites illustrate that the sustenance of human settlements should not be taken for granted.

Data, statistics and reports of events in many cities around the world highlight a range of contemporary problems (Hardoy, Miltin and Satterthwaite, 2001). These problems include environmental conditions; for example, an increasing incidence of summer and winter smog can impact on both ecosystem health and human health. They also include social inequalities and economic deprivation that lead to relatively high levels of homelessness and unemployment which can impact on social insecurity and community cohesion (Parry-Jones and Quelquoz, 1991). In addition there can be social, cultural and political problems leading to riots and warfare as shown by recent events in many cities in Africa and the Balkan region.

There are no simple answers to these kinds of urban problems which have both direct and indirect impacts on health and the quality of life of urban populations (Galea and Vlahov, 2005). It should be acknowledged that policy makers and professional practitioners have often identified and isolated these kinds of problems too narrowly. This means that some problems and the interrelations between them have not been foreseen (Lawrence, 1995). Consequently, negative impacts on health and quality of life have usually been addressed by piecemeal, remedial measures.

Today, there is a growing consensus that these reactive approaches need to be replaced by broader, proactive ones. In order to achieve this objective, it is necessary to implement multi-disciplinary collaborative research. For example, an ecological perspective adopts a systemic interpretation which rejects single causal statistical interpretations. Instead it examines the interrelations between a wide range of factors in the societal context in which they occur. This paper argues that it is necessary to reconsider cities and urban development in a broad environmental, economic, social and political context, and that applied human ecology can achieve this objective.

What is an Urban Ecosystem?

Ecosystem, a term used by Tansley in 1935, designates a natural unit in a delimited geographical area (biotope) that includes all plants, animals and micro-organisms (biotic components) functioning together with all non-living (a-biotic) components as well as flows of material, energy and information between these components. A human ecosystem implies that *homo sapiens sapiens* are also included in the area. An urban ecosystem is not easily defined because the definition of a city varies from country to country. The United Nations uses national definitions that are commonly based on population size. Other definitions are based on the administrative or political authority of municipalities, especially the degree of autonomy in relation to the national or regional administration. Some definitions include the socioeconomic status of the resident population, especially their livelihood (such as the proportion of all employed people with non-agricultural occupations). A combination of these characteristics can be used to interpret urban ecosystems, as shown later in this paper.

What is Human Ecology?

Human ecology usually refers to the study of the dynamic, systemic relationships between human populations and all the physical, biotic, cultural and social characteristics of their environment and the biosphere (Young, 1983). However, this was not the original meaning of human ecology, a term first used in 1921 by Robert Park and Ernest Burgess. They defined human ecology as the study of the spatial and temporal organization of and relations between human beings with respect to the "selective, distributive and accommodative forces of the environment". This definition became a landmark for many other contributions that

studied the spatial distribution of human populations especially in urban areas (Park, Burgess and McKenzie, 1925).

During the last four decades there has been a growing concern among scientists, professionals and the public about the extent and causes of an increasing number of environmental problems which have been highlighted by the mass media. This concern usually focuses on the anthropogenic causes of environmental problems (Lawrence, 2001). Growing public concern has led others to use empirical information and knowledge for the preservation of natural resources, ecosystems and the biosphere. Academic research and teaching programmes on human ecology were introduced into university curricula in North America, Europe and Australia from the early 1970s by academics who wanted to focus scientific research and university education on these crucial subjects (Marten, 2001). Many applications of human ecology during recent decades are quite different from those initiated at the University of Chicago in the 1920s. Since the 1970s, human ecology has been supplemented by contributions in ecological anthropology, environmental psychology, environmental sociology and other hybrids of traditional disciplines increasingly concerned by people-environment relations (Lawrence, 2001).

Human ecology transgresses traditional disciplinary boundaries by explicitly applying a broad conceptual and methodological framework that integrates contributions from the natural and the social sciences. This framework is represented in Figure 1. It is an interdisciplinary interpretation because it includes concepts and principles from both the natural and the social sciences. Second, it underlines the systemic interrelations between sets of biotic, a-biotic and anthropogenic factors. Hence it does not concentrate only on specific components because it considers the whole system as the unit of study for people-environment relations. This interpretation can be applied at different geographical scales including the micro-scale of urban ecosystems. It is meant to be reapplied at different times to explicitly address a short- and long-term perspective during the lifecycle. This temporal perspective can identify change to any of the specific components as well as the interrelations between them.

Key Concepts and Principles

Culture refers to characteristics of human societies that involve the acquisition and transmission by non-genetic means (from one person to
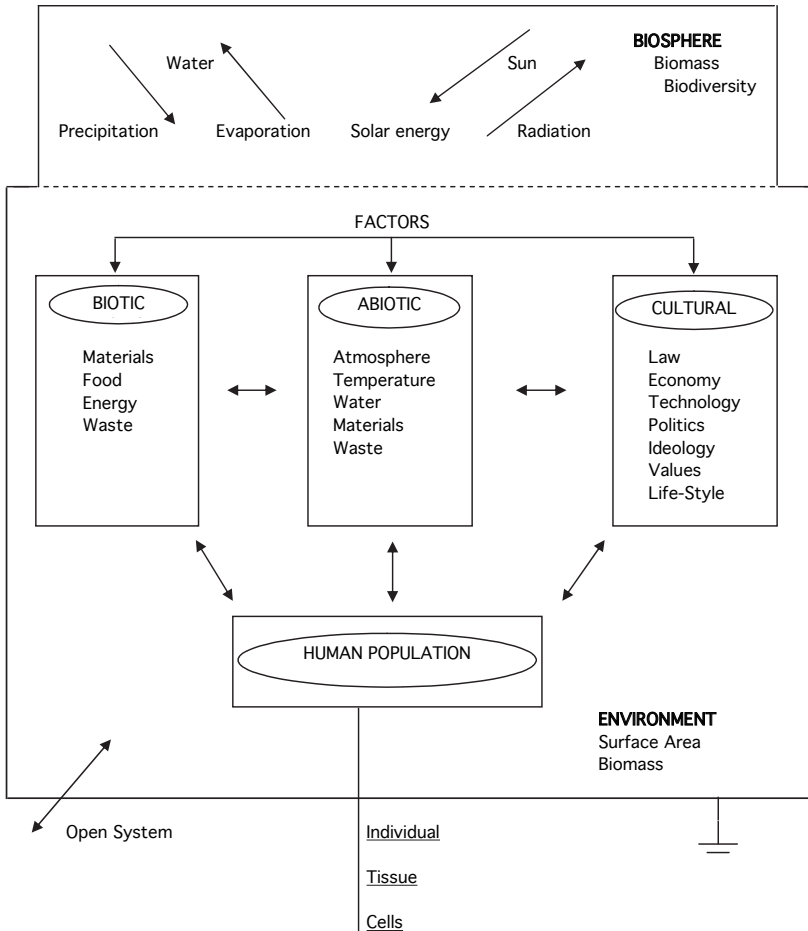
Figure 1: The holistic framework of a human ecology perspective showing the interrelations between genetic biospace, ecospace, cultural space and artefacts

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another, between human groups and societies as well as over generations) of shared beliefs, customs, information, institutions, language, rules, symbols, technology and values (Lawrence, 2001). Although culture was often interpreted by anthropologists to be a monolithic and static concept, today it increasingly designates a relativistic and pluralistic concept within and between human groups, societies and nations.

Urban Ecosystems are fundamental human constructs that are crucial components of human culture (*anthropos*) that partly define the condition and status of individuals and households in relation to others in their society. Cultures of everyday life explicitly concern:

1. The artefacts and techniques of human groups (housing units, infrastructure and services). This can be considered as the material culture of daily life which can be used to express and communicate cultural and social/group representations that are a sign of identity (Low and Chambers, 1989).
2. The social organisation of human groups, especially norms about kinship, household composition and social relations. The urban environment not only expresses social conventions but also social differentiation, and perhaps it reinforces social exclusion instead of cohesion (Halpern, 1995).
3. The meanings attributed to the physical and nonmaterial components of human habitats and how these are expressed by language; for example, a housing unit, a dwelling, a home (Lawrence, 1987).
   Many ethnographies show the interrelations between these dimensions of culture, how these dimensions are defined by different groups, and whether or not they evolve over time.

Cultivation implies that one should identify and understand the active, perhaps mobile interrelations between individuals and their habitat. It can also account for the cognitive and symbolic interrelations between individuals, groups and their past and present (Duncan, 1981). Cultivation also stresses the importance of intentionality within the ongoing practices of domesticity, especially the way that individual, social, and cultural identities are expressed and communicated.

Resilience is an inherent property of ecosystems that enables them to absorb external disturbances and, perhaps, even benefit from change (Boyden, 1987). For example, fire is usually not a disaster for grassland ecosystems but one means to maintain them by regeneration processes over the long-term. The precise way that an ecosystem responds to a planned or unexpected external disturbance depends on the nature of its impact and the internal properties of the ecosystem. If the ecosystem is elastic then accommodation processes will absorb change without modifying its initial state. This is illustrated by the case of Nomads in their daily search for nutrition. If the ecosystem is plastic then assimilation processes will deal

with change by altering the initial state of the ecosystem. Examples of this in industrial societies include an explicit change in the local economy of a region, or the productive output of a factory, in response to changes in the supply of raw materials, or a falling demand for the produced artefacts.

Analyzing Urban Ecosystems: Applied Human Ecology

Cities and towns can be interpreted as human constructs that result from the interrelations between ecological, economic, material, political and social factors at the local, national and international levels (Lawrence, 1995). Cities such as Bangkok, Cape Town, Kuala Lumpur or London are interesting examples of the intersection between these sets of factors, and how some of these factors have remained while others have been modified over thousands of years. Given the changing nature of these factors it is appropriate to discuss ways and means of sustaining urban ecosystems. This approach underlines the fundamental principle that all human societies regulate their relation to the biosphere and the local environment by using a range of codes, practices and principles based on scientific knowledge and community know-how. Societies can use legislation, surveillance, monetary incentives and taxes, as well as behavioural rules and socially agreed conventions in order to ensure their sustenance.

All living organisms, individuals and species aspire to survival. The mechanisms used to sustain humans depend on their capacity to adapt to changing local conditions such as climate and the availability of resources (Laughlin and Brady, 1978). Adaptation for sustaining human settlement processes and outcomes are based on both ecological principles and cultural practices. These principles and practices stem from the fact that specific localities or sites provide intrinsic opportunities and constraints for all living organisms, including human individuals and groups, to sustain themselves. This is well illustrated by the unique site chosen for many cities including Cape Town and Istanbul. The site of any human settlement is also a small part of a much larger region that has intrinsic interrelated sets of ecological, biological, geological and cultural characteristics. Therefore, no site of an existing or future construction should be interpreted in isolation from these interrelated sets of characteristics.

During the last decade, the concept of a sustainable city became (and it still is) an international and national political objective (Lawrence, 1996). It was the topic of international conferences held under the auspices of the United Nations, other international and national authorities and

many non-governmental organisations (NGOs). In 1996, the Habitat II Conference in Istanbul provided an occasion for government delegations to support the idea of sustainable cities or sustainable urban development even though there was no agreed definition of a sustainable city. This ambiguity shows that a sustainable town or city is a human construct that is grounded in complex sets of ideas, concepts, policies and projects that are meant to be applied in specific geographical localities. Human ecology stresses that sustaining urban ecosystems involves a wide range of human practices that ought to adapt to the dynamic circumstances of a constantly changing world at both local and global levels.

Many contributions on urbanization and sustainable development have focused on the practical implementation of urban policies and housing projects as a way of achieving a vision or goal of what sustainable urban development ought to be (Lawrence, 1995). In addition, much attention has been given to identifying what is unsustainable about urban development, whereas little concern has been given to understanding the meaning of a sustainable urban ecosystem. Human ecology can help bridge that gap between knowledge and practices because it transgresses traditional disciplinary boundaries by explicitly applying a broad conceptual and methodological framework that integrates contributions from the natural and the social sciences.

Urban Ecosystems as Product and Process

In order to direct the debate between scientists, practitioners and policy decision makers about sustaining urban ecosystems, some conceptual clarification is necessary. First, it is important to distinguish between building urban ecosystems as a **product** (that is the analysis of the urban environment as the physical outcome of decisions about how to accommodate human life in cities), and building urban ecosystems as **process** (by referring to the multiple sets of processes that occur in cities and between cities and their hinterlands). It is common to adopt only one of these interpretations as Lawrence (1995) has shown. This article suggests that both should be applied simultaneously in order to deal with the complexity of urban ecosystems. When this integrated interpretation is applied, then the components of urban ecosystems reflect the ordering of resources, people and their activities, as well as a set of goals, priorities and actions that are meant to achieve desired ends.

Building an urban ecosystem involves choosing between a range of options in order to achieve objectives that may or may not give a high priority to health and quality of life. The complexity of building cities raises some critical questions including: What parameters are pertinent for a specific building task, such as the construction of a new residential neighbourhood? Whose values, goals and intentions will be taken into consideration? How and when will these goals and intentions be achieved? What will be the monetary and non-monetary costs and benefits of specific options? In order to answer these kinds of questions it is necessary to recall those inherent characteristics of urban ecosystems. In order to distinguish urban ecosystems from other kinds of human settlements, notably and rural towns, it is important to identify the distinguishing characteristics of cities.

The first characteristic of cities is **centralization**. The choice of a specific site, and the definition of the administrative and political boundaries of a city distinguish it from the hinterlands. Studies in urban history and geography confirm that many factors have been involved in the location of cities (Bairoch, 1988). For example, coastal sites for ports like New York, Cape Town or Sydney can be contrasted with sites on inland trade routes such as Geneva or Vienna. It is important to note that modern economic rationality has an interpretation of the World and human societies which has rarely accounted for the climatic, geological and biological characteristics of specific localities. This has meant that urban populations have been confronted with unforeseen natural and human-made disasters including earthquakes, flooding and landslides (Mitchell, 1999).

The expansion of the built-up area, the construction of roads, water reservoirs and drains together with land clearance and deforestation can lead to drastic changes to landscapes and ecosystems which lead to negative impacts on ecosystem health and human health. Rapid urban development has been associated with new diseases (McMichael, 1993). Natural foci for disease vectors may become entrapped within the peri-urban extension and new ecological habitats for the animal reservoirs may be created. Within urban agglomerations, disease vectors may adapt to new habitats and introduce new infections to spread among the urban population. The principal vector for urban malaria, is reported to have adapted to survive in the urban environment in India and the Eastern Mediterranean region (World Health Organization, 1992).

The second characteristic of cities is **verticality**. During the 8000 - 9000 year history of cities, societies have constructed buildings of several storeys. Bairoch (1988) noted that Jericho included buildings of seven storeys. This characteristic underlies the compact or dense built environment of cities in contrast to the dispersed character of rural towns. The height of buildings in cities increased dramatically from the late 19th century with the construction of skyscrapers, first in Chicago, then other cities around the World. The relations between high-rise housing conditions and health status are not easy to decipher owing to the vast number of confounding factors. However, there is empirical evidence that those residents who do not choose where they live, especially households with young children who are allocated housing units in high-rise buildings, may suffer from stressors that impact negatively on their health (Ekblad, 1993; Halpern, 1995).

Concentration is the third characteristic of cities that is directly related to the two preceding ones. Urbanization is dependent on the availability of natural resources and the exportation of waste products in order to sustain their populations (UNCHS, 2001). Urban ecosystems import energy, fuels, materials and water which are transformed into goods and services. The high concentrations of activities, objects and people in cities, and the flows between rural and urban areas, mean that city authorities must manage the supply of food and water as well as the disposal of solid and liquid wastes in a sustainable way. Urban history confirms that cities are localities that favour the rapid spread of infectious diseases, fires, social unrest and warfare (Bairoch, 1988).

In terms of questions related to public health, concentration can be quantified in terms of activities, building density and population density. Surveys of empirical studies show that the number of persons per meter of habitable floor area is related to the propagation of infectious diseases such as tuberculosis and cholera (Gray, 2001; Rosen, 1993). Concentration also implies relatively easy access to all community services, including primary health care, and social welfare.

Diversity is a refining characteristic of cities that can be used effectively to promote ecological, economic and social well-being. Diversity is known to be an important characteristic of natural ecosystems because it enables adaptations to unforeseen (external) conditions and processes that may impact negatively and even threaten survival (Laughlin and Brady, 1978). In the same way, we have learnt from history that those cities with a diverse local economy have been able to cope much better

with economic recessions and globalisation (Duffy, 1995). This was not the case for Detroit, Glasgow, or cities of the mid-West in North America. Therefore, diversity - be it economic, ecological or cultural - is an important principle that enables human settlements to adapt to unforeseen factors that can impact on their sustenance.

Social, economic and material diversity are inherent characteristics of cities. The heterogeneity of urban populations can be considered in terms of age, ethnicity, income and socio-professional status. These kinds of distinctions are often reflected and reinforced by education, housing conditions, employment status, property ownership and material wealth. Data and statistics show that in specific cities different neighbourhoods are the locus of ethnic, political, monetary, and professional differentiation between "us and them" and "here and there". When these dimensions of human differentiation become acute they are often reflected and reinforced by spatial segregation and social exclusion in urban agglomerations. In recent decades, there has been several empirical studies which show how these characteristics of urban neighbourhoods, especially acute socio-economic inequalities and lack of social cohesion, are linked to morbidity and mortality (Marmot and Wilkinson, 1999).

Information and communication is the fifth characteristic. Cities have always been centres for the development and exchange of ideas, information and inventions (Castells, 1991). It is well known that targeted information is crucial for effective preventive measures in public campaigns about risk behaviours including tobacco smoking, alcohol consumption, drug abuse and safe sexual intercourse. City authorities can play a crucial role in health prevention and promotion by communicating information in innovative ways. There is much to be learnt from successful marketing strategies by private enterprises if public health campaigns about risk behaviours are to become more successful than they have been. Health education is a key factor in increasing the responsible behaviour of individuals, social groups and communities.

Mechanization is the sixth characteristic. Cities have depended on machines to import supplies, to treat waste products and to efficiently use their built environment. Contemporary cities are heavily dependent on machinery for a wide range of functions and services that guarantee sanitary living conditions. Mechanical and technological characteristics of cities that impact directly or indirectly on health include industrial production, transportation, the processing of mass-produced foods and the increasing use of synthetic materials in the built environment (UNCHS, 2001). In

particular, the incidence of accidents in urban areas is a major challenge for public health. For example, in 1998, injuries caused by motor vehicle accidents were ranked 10th among leading causes of mortality world-wide and 9th among the leading causes of disability . Today, children and young adults in all regions of the World bear a disproportionate burden of these accidents, and the burden is significantly higher in urban areas compared with rural areas, and also in developing countries compared with developed countries (World Bank, 2001).

Political authority is the seventh characteristic. The city was the polis in ancient Greece, meaning it had a specific political status which is still the case today in the form of municipal government. During the 1990s, much attention has been given to urban governance rather than municipal government. Governance can be defined as "the sum of the ways through which individuals and institutions (public and private) plan and manage their common affairs. It is a continuing process that may either lead to conflict or to mutually beneficial co-operative action. It includes formal institutions and informal arrangements, as well as the social capital of citizens" (UNCHS, 2001, p 90). Governance is based on the effective co-ordination of three main components: market-based strategies for the private sector, hierarchical strategies articulated by the public sector and networking in civil society. The goal of governance should be to develop synergies between these partners so there is a better capacity to deal with the most urgent priorities.

Synthesis

The interrelations between architecture, urban planning, health, social and environmental policies have been poorly articulated until now (Lawrence, 1996). However, it is crucial to acknowledge the important role of urban ecosystems as localities for the management of resources, as places for accommodating diverse ways of life and as forums for inventions of all kinds.

This paper has argued that our capacity to deal with human settlements is insufficient for several reasons including their diversity and complexity; the difficulty of identifying and measuring the interrelations between them and all their components; and the need to understand the relative importance of these components in precise localities at different geographical scales and over time. Therefore, it is necessary to shift from multidisciplinary to interdisciplinary concepts and methods.

Today the relationship between researchers and practitioners in different disciplines, especially in the human/social and the basic/natural sciences, is often considered to be a source of conflict. Nonetheless, this need not be the case as applications of human ecology since the 1920s show (Lawrence 2001). The concepts and principles presented in this paper illustrate how crossing disciplinary boundaries can lead to the development of new terminology, innovative concepts and new knowledge. This is an important challenge if human ecology is to be applied effectively to improve our understanding of urban ecosystems.

Policy makers in most countries still have great difficulty in measuring, describing and explaining constancy, change and differences of the human and non-human characteristics of cities. Part of the difficulty has been the lack of systematic data collection. A dynamic set covering several characteristics is required across a range of administrative levels and geographical scales. Alone, official statistics based on national census returns do not provide comprehensive accounts of the quantity and quality of the housing stock, urban infrastructure and services in rapidly developing urban areas and they ignore illegal buildings in informal settlements. Today, there are several kinds of innovative techniques and tools that can be used to monitor and analyse the spatial distribution, dynamics and interrelated nature of environmental, housing, demographic and health profiles in urban areas. There have been significant developments in the collection and interpretation of data, indicators and information during the 1990s which warrant further systematic applications. For example, geographical information systems (GIS) which represent data from diverse sources (including remote sensing) in order to identify relationships between the represented components of urban areas.

CONCLUSION

One hundred years ago, about 80% of the World's population lived in rural areas, whereas in the year 2001 about a half of the global population lives in cities. The twentieth century was characterized by a growth in the number, population size and total surface area of cities on a scale previously unknown, and this trend is expected to continue. Today, urban ecosystems are multi-dimensional and complex. No single discipline or perspective can understand and explain them in a comprehensive way. Collaboration and co-ordination of contributions is necessary. However, the study of people-environment relations in general, still remains divided between the

social and natural sciences as well as between the theoretical and applied approaches in each of these sciences. The main obstacle that hinders an integrated framework is the compartmentalized disciplinary approaches of scientists and professionals who do not share definitions and interpretations but adopt exclusive interpretations. There is a need to replace the addition of multiple disciplinary contributions by interdisciplinary approaches such as human ecology.

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