# Defining an Ecosystem Approach to Urban Management and Policy Development

## Acknowledgements

This policy brief outlines an ecosystem approach
to urban management presented at the Capacity
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2003 in cooperation with the ASEAN secretariat.
The report is based on work conducted at the
Institute and builds on previous collaborations with
the UNESCO–Man and the Biosphere Programme
and the World Health Organization–Healthy Cities
Programme. The paper sets forth an ecosystems
vision of city management and policy development
and provides the groundwork for future urban
ecosystem studies and assessments. Rather than
a final product, however, the characterisations,
concepts, and evidence are intended to provide
stimulus for further discussions in this area.

**UNU/IAS Report**

**Defining an Ecosystem Approach to Urban Management and Policy Development**

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# Foreword

**The mission of UNU/IAS is to develop strategic approaches to sustainable development. In this regard, cities, urbanization, and the urban environment have always been a key area of research for the Institute. From its inception, UNU/IAS has had urban and regional development as a major focus. It has successfully employed research projects on the world's mega–cities and their role in globalization processes. Realizing the ever increasing magnitude and complexity of urban environmental problems, the impact of city activities on wider ecological systems and the social and biological aspects of urban issues, the Institute has embarked on the task of developing an ecosystem approach to urban management and research.**

Part of the inspiration to work on an ecosystem approach to urban management at UNU/IAS comes from the Millennium Ecosystems Assessment (MA). The MA was launched in 2001 as a four–year international assessment of the current and future ability of the world's ecosystems to meet human needs for goods and services. UNU/IAS is working in close cooperation with the MA by coordinating its meeting and report outputs with MA needs. At the same time, however, UNU/IAS Urban Ecosystems initiative is also directed at a wider audience including scholars and urban policy makers seeking a better understanding of the conditions and costs of urban environmental challenges. The ideas in this report reflect ongoing work with scholars and city managers outside UNU/IAS.

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# 1 Introduction

**In recent years, environmental policy and research circles have advocated an ecosystem approach in light of the growing importance of ecological issues and the recognition of the interconnectedness of social, economic, and environmental systems. The ecosystem approach is particularly important for urban areas. Increasingly, cumulative and systemic global environmental problems, ranging from poor health due to lack of access to sanitation and water supply, to vehicular related local air pollution, to over–consumption and climate change can be traced back to patterns of activities and growth in cities. With global population growth centred largely in urban areas, cities will increasingly be the locations where human activities and their associated ecological impacts can be most aptly met with policy and planning responses.**

While cities have traditionally been seen as aberrations of 'nature', such a distinction neglects the opportunity to envision human built environments that can exist in balance with wider ecological systems. Sustainability can only be achieved when cities are approached as systems and components of nested systems in ecological balance with each other. Although diverse academic fields have produced concepts and applications of an ecosystem approach to understanding and managing cities, the mainstream adoption of this method remains an aspiration at present. In this regard, there is a need to articulate a vision for an ecosystem approach to urban policy development and management. The purpose of this paper is to bring together various elements of urban ecosystem perspectives in an attempt to develop such a vision. The central question of this paper is: What characterizes an ecosystem approach to urban management and policy development?

Any 'approach' to urban policy development and management, which aims to add value to current practice, must build upon or adapt to what is already in place, or at least express how the new approach departs and adds value to those existing. This can only be undertaken with any real rigor on a case–by–case basis with managers and practitioners in specific settings. As a first step, this paper puts forth a number of claims, based on a review of the literature and the latest theoretical developments in related fields. In general, an ecosystem approach to policy development departs from a previous emphasis on single–issue studies developed to support command and control regulation and places greater emphasis on integration. In this regard, urban researchers must contemplate new and appropriate methods that best deal with a variety of urban trends, conditions, and impacts simultaneously. An ecosystem approach to management departs from a previous emphasis on rigidity and control and moves toward practices that evolve and adjust to deal with technological change,

competing priorities, surprise impacts beyond urban borders, and an increasing numbers of actors in urban governance.

These departures are clearly ambitious ideals. Urban planners are typically concerned with pressing issues related to the provision of essential urban services (e.g. health care, water supply, primary education), the provision and upkeep of related public works, and the regulation of certain private activities (e.g. trades, house building land uses, traffic). Nonetheless, it is important to place practice within the context of a wider and longer–term perspective and set of goals. This paper begins by discussing some priority issues in cities around the world, followed by a review of the literature on ecosystem approaches to the city, and concludes with an closer examination of one particular ecosystem framework the Human Ecosystem Framework[1] in order to set the stage for a discussion of some key components that might characterize an ecosystem approach to urban policy development and management.

## 1.1 Ecosystem Approaches to Environmental Management

In recent years, environmental policy and research circles have advocated various ecosystem approaches. The fifth meeting of the Conference of the Parties (COP) 2000, to the Convention on Biological Diversity (CBD), for example, gave a description and operational guidance on the ecosystem approach to achieve the objectives of the convention. It calls upon an ecosystem–based strategy for the integrated management of land, water, and living resources that promotes conservation and their sustainable use in an equitable manner.[2] The CBD's ecosystem approach, unlike conventional scientific methods that often assume specialization in one area, calls for multidisciplinary thinking among a variety of actors to develop a collaborative vision of a desired future. The approach is goal and policy driven and is applied within a geographic framework defined primarily by ecological boundaries such as different land use conditions, watersheds, and groundwater system units. It also recognizes that humans, with their cultural diversity, are an integral component of many ecosystems.

Similarly, the International Development Research Centre in Canada[3] has advocated an ecosystem approach to human health and supports research on the relationship between all components of an ecosystem to define and assess priority problems that affect the health of people and the sustainability of their ecosystem. In pursuing the aim of improving human health and well–being while simultaneously maintaining a healthy ecosystem, the emphasis is on the design of solutions based on holistic

ecosystem management concepts rather than single sector interventions.

The United Nations Environment Programme's Cities as Sustainable Ecosystems (CASE) initiative advocates an urban ecosystem approach, which suggests that consumption and production systems should be modelled after the cyclical ecosystems of nature.[4] It calls for an urban environmental policy framework that is based on natural ecosystems at national, regional, and local levels, as well as on human–environment interactions and a system of prioritization, which incorporates human life, health, depletion, and productivity of resource stocks, capacity of the environment, and systematic accounting measures. The integration of many interrelated economic, environmental, social, and cultural factors is presented in terms of urban resources, processes, and impacts.

The Millennium Ecosystem Assessment (MA) was originally designed for serving the assessment needs of three international conventions namely, the CBD, the Ramsar Convention on Wetlands, and the Convention to Combat Desertification as well as national governments and local agencies.[5] Their approach is based upon analyses of the capacity of various ecosystems to provide goods and services important for humans. It includes ecological, social, and economic analyses and considers the current state of ecosystems and their potential in providing ecosystem goods and services. Considering geographic boundaries of an ecosystem are arbitrary, the approach is unique in its attempt at providing assessments at different scales.

Within the MA, the urban ecosystem is seen as being both a system in itself as well as an important, if not essential element in understanding the transformation of all other ecosystems (as a driver). As such, the MA is attempting to define an urban ecosystem at different scales.[6]

Other groups using variants of the ecosystem approach include the Resilience Alliance (RA) and the Sustainability Science Initiative. The RA is a consortium of institutions that seeks novel ways to integrate science and policy in order to discover foundations for sustainability.[7] These institutions have capitalized on recent discoveries in the way ecosystems, institutions, and economies interact to support or degrade the resilience of systems that sustain the livelihoods of people. They believe that the path to sustainable development and management of global and regional resources lies in a combination of social, environmental, and economic analysis.

The Sustainability Science Initiative is a forum on science and technology for sustainability that works to facilitate information exchange and discussion among the growing and diverse group of individuals, institutions, and networks engaged in the field of science and technology for sustainability. It seeks to provide access to emerging ideas, relevant activities, key documents, and web sites.[8]

While not specifically employing the urban ecosystem approach, there are efforts undertaken by United Nations Educational Scientific and Cultural Organization – Man and the Biosphere (UNESCO/MAB) (Biosphere Reserve Programme) and World Health Organization (WHO) (Healthy Cities Programme) that are using similar concepts for managing urban environmental problems. The Biosphere Reserve concept is derived from the traditional protected terrestrial and coastal ecosystem approach, but the notion has evolved to include areas of promoting solutions to reconcile the conservation of biodiversity with its sustainable use, including areas around cities.[9] Biosphere Reserves have been designed as tools for reconciling and integrating the conflicting interests and pressures that characterize land–use planning today.

The WHO's Healthy Cities programme attempts to promote healthy environments for a broad range of problem from infectious diseases and air pollution to unhealthy lifestyles, drug abuse, and violence within cities. The Healthy Cities programme does not provide a blueprint for a master plan, but rather defines a process that addresses the main health problems, their causes, and responses developed by all key actors within a city. Significant elements of the programme include commitments to participatory approaches in setting health strategies and a city or municipal health plan are often part of its development plan or city vision.[10]

In late 1970s and early 1980s, a variety of new types of environmental management plans were developed in Japan. In some metropolitan areas such as Osaka, it was recognised that environmental impact assessment (EIA) did not adequately protect the urban environment, as these assessments were performed on a project–by–project basis, without jurisdictional coordination. In order to cope with this problem, some local governments with multiple development projects in their jurisdictions developed environmental management plans based upon future visions. Such visions took into account both positive and negative impacts of development plans and projects. These types of dynamic environmental management plans were used to support EIA and frequently revised once a new development plan or project was undertaken.

Some municipalities, in order to obtain consensus among citizens and local residents on the future of the city, used a second type of environmental plan for specific instances when there were no criteria to define the level of conservation or nature protection. For instance, if a forest in Japan has national or prefectural significance, law provides for its conservation. There are many secondary forests with no legal protection, but that provide amenity to local

residents. It seemed difficult for local governments to choose protection over development without the views and comments of citizens. To cope with this, some local governments developed environmental plans with three major components, future visions, scenarios to attain future visions, and concrete, specific programs and projects to be implemented. Specific procedures were developed to obtain consensus.

Finally, a third approach developed by some cities in Japan was an environmental guidance system, a unique approach to protecting the carrying capacity for water systems, airsheds, and other ecosystems. By studying natural systems, a general appreciation for the carrying capacity for water systems, airsheds, and other ecosystems was developed. Environmental guidance maps were developed to illustrate the carrying capacity of these systems, and used to provide guidance for developers particularly in terms of selection of the project location.

These programmes are only a selected few that have and are using aspects of the ecosystem approach for managing the urban environment. The increasing popularity and worldwide acceptance of the method emergence demonstrates a confluence of thinking, at the theoretical level, that a holistic ecological approach to solving problems is needed to deal with today's environmental problems. At the same time, however, the work on an urban ecosystem approach to urban policy development and management has only begun. There is a need to identify a framework within which further studies can be conducted and policy needs can be satisfied.

# 2  Why Do We Need an Ecosystem Approach to Urban Environmental Management and Policy Development?

**While the environmental problems in cities in the developed and developing world manifest differently, what is becoming increasingly evident is that the social and ecological components of these problems are inseparable. Within cities everywhere, the concerns of development and those of environment and social welfare demand an integrated approach for their resolution. However, different cities in different parts of the world at different stages of development have varying priorities. Therefore, we have divided cities into three categories: least developed, rapidly developing, and developed world cities.**

## 2.1  Cities in the Least Developed World

Least developed world cities in Africa, Asia, and Latin America have experienced little benefits from globalization flows. At the same time, they face rapid urbanization and the need to simultaneously expand and modernize their infrastructure while dealing with profound internal socio–economic inequalities as well as severe environmental deterioration. The tremendous pressures on these locales have helped to create both ecological and socio–environmental problems within the city and surrounding hinterlands.

In general, the most critical environmental burdens of low–income and smaller cities tend to be local, such as inadequate and unsafe piped water supply, lack of proper sewerage and storm water drainage, lack of provision for garbage collection and disposal, indoor air pollution that results from burning biomass, poor health care services, and others (Bartone, Bernstein, Leitmann, and Eigen, 1994; McGranahan, Songsore, and Kjellen, 1996). There are also a range of social problems including over–crowding, slum and squatter settlement challenges (the UNCHS suggests that forty to fifty per cent of those living in Calcutta, fifty to sixty per cent of those living in Bombay, Delhi, Lagos, and Lusaka and sixty or more per cent of those living in Dar es Salaam, Kinshasa, Addis Ababa, Cairo, Casablanca, and Luanda are living in slums and squatter settlements),[11] crime, loss of greenery and biodiversity, urban flooding, and susceptibility to other natural disasters. Hence, the ecosystems within their borders and in their direct hinterlands are suffering.

Without economic growth, rapid urbanization has encouraged the pervasion of poverty. Structural and institutional problems, including inadequate governance structures, land tenure arrangements, and lack of access to credit have also encouraged the poor to draw down the natural resources within and around cities. They continue to denude and degrade the landscape in search of space for living, biofuels for cooking, and water for their daily needs (Hardoy, Mitlin, and Satterthwaite, 2001; Brundtland, 1986). Moreover, with large shares of its citizens in poverty, government revenues are low, leading to an inability to deal directly with these problems.

Many of these countries were hard hit by epidemics such as HIV/AIDS and malaria. In 1999, approximately thirteen million people died of infectious diseases. Sub–Saharan Africa is home to seventy per cent of the world's HIV–positive population and has bore the majority of the 2.6 million AIDS deaths. Exacerbating the problem is the lack of resources to put into public health care systems. Expenditures in this area for low–income countries averages one per cent of gross domestic product, compared to six per cent of GDP in high–income countries (International Federation of Red Cross and Red Crescent Societies, 2002).

Due to these factors, these cities are increasingly vulnerable to natural disasters. Without adequate governance and public spending, increasing numbers are locating to flood plains, within swamps, and in areas without basic water supply and sanitation. This type of growth increases the likelihood of loss of human life with natural disasters. Indeed, among the total reported deaths from disasters from 1992 to 2001, over 53 per cent were in low–income countries compared to 4.4 per cent of deaths in high–income countries (International Federation of Red Cross and Red Crescent Societies, 2002).[12]

International pressure from the multilateral organisations has encouraged economic development without adequate attention to environmental and natural resources. This pressure has impacted environmental/ecological relationships. One study of over sixty countries that were in the structural adjustment programmes of the World Bank and International Monetary Fund, suggested that the lack of attention to environmental and natural resources considerations did not put these countries on sustainable development pathways (Reed, 1992).[13] Increasing pressures for privatization (of water supply delivery for example) is creating conditions where localities are subject to the influences of decisions made by such international organisations as the WTO for the delivery of basic services.

There is a small set of these cities that are beginning to experience the impacts of globalization and the transfer of technologies as they link to the world economic system. Increasingly, lower income cities within Asia are linked to the global network of trade and foreign direct investment (FDI). With these linkages has come the rapid growth of motor vehicles,

for example, and subsequent traffic congestion and air pollution. While some of the technologies bring advantages, for example the use of cellular phones that do not need vast infrastructure investments, they are also bringing new challenges (e.g. managing rapidly changing environments) without the benefits of rapidly increasing tax revenues. These cities are at the brink of rapid development.

## 2.2 Cities in the Rapidly Developing World

The development trajectory for countries and cities that are rapidly developing is unprecedented. First, current levels of economic growth are much more rapid than those experienced by western cities during their high growth periods. Nations developing during the current period are undergoing compressed and collapsed transitions.

Rapid growth has been facilitated by governmental institutions that provided national policies and coherent, but inequitable development strategies for major metropolitan centres (to their benefit and at the cost of other regions within their respective countries). These include government involvement in creating economic stability (Korea, Taiwan, Hong Kong, and Singapore) and trade and investment openness (Hong Kong, Singapore, and ASEAN–4). That is, many of the cities in this category have benefited from the largesse of their national governments and received both local revenues and national funding and support. While they have been able to compete successfully with emerging technical processes in western cities (i.e., government policies have facilitated the world city formation process) they have paid the price in terms of environmental burdens. Asia, for example, has the world's most severe environmental problems (Asian Development Bank, 1997).

In contrast to the experiences of the western cities, where the emergence of environmental challenges appeared over longer periods of technological and socio–economic change and in sequential order, these cities have a new mix of environmental problems. City managers within urban centres must increasingly deal with sets of environmental burdens simultaneously. Within a single city, there are pressing challenges associated with basic sewage and sanitation, industrial water and air pollution, and greenhouse gas and green–space concerns.

For example, some of these cities are experiencing intensive traffic and air pollution problems. In 1995, more new cars were sold in Asia than in North America and Western Europe combined. As the chief contributors of local pollutants ($NO_X$, $O_3$, CO, volatile organic compounds, and suspended particles), motor vehicle usage in these cities is a major source of smog and health problems such as respiratory–related illnesses, which in turn carry related social and

economic costs. In Bangkok, for example, where transport accounts for seventy per cent of urban energy consumption, it has been estimated that as many as 4,000 to 5,500 premature deaths per year are attributable to short term exposures to outdoor airborne particulate matter. Children in Bangkok have some of the highest blood levels of lead in the world. In many of these cities, water supply and sanitation systems are underdeveloped and large proportions of the urban population are without adequate services. Increasingly these cities are sources of consumption related challenges that have accompanied the rise of a middle class and the emergence of regional if not global pollution challenges.

The transition of environmental problems experienced sequentially and over many years in western cities is both 'compressed' and 'collapsed', creating overlapping sets of challenges emerging over a short period of time, in cities of this category. Given the forecasts for urbanization and industrialization in the region, the severity of the situation is likely to increase. From a policy perspective, globalization has produced important questions concerning how to manage a mix of environmental problems in order to ensure the environmental integrity of the region and long–term viability of economic growth.

## 2.3 Developed World Cities

Developed country cities have successfully overcome several 'traditional' environmental problems, but are now experiencing a variety of emerging environmental challenges. The ecosystems within their borders are less degraded than their counterparts in other parts of the world and, in some cases, these cities provide more services than expected (including higher levels of biodiversity).[14] On the other hand, increasing numbers of households (as household size shrinks) combined with automobile and telecommunications technologies, air conditioning, and balloon–frame building technologies facilitated the expansion of urban land uses, consuming land at greater rates than that of population growth. As a result, urban encroachment has consumed peripheral agricultural land and eroded rural forest areas. Sprawl, as some term the process of this uncoordinated growth of cities at their margins, is contributing to a variety of regional and global problems including increased energy consumption and carbon dioxide emissions, a major cause of global warming. In Europe, for example, the increasing number of households is expected to account for 12.5 million new dwelling units during the five–year period 2000–5 and 11.5 million units for the next five–year period 2005–10. In the US, in many metropolitan areas, development has consumed thousands of acres of woodlands. The Washington, DC area, for example, lost 211,062 acres of farmland, forest, wetlands, and other open spaces in the 1980s. While fifty–three per cent of the wetlands of the lower forty–eight states were lost between the late 1700s and mid–1980s,

urban development and road construction in recent years have consumed significant amounts of these productive assets. California continues to loose wetlands at a rate of almost 5,000 acres per year. Other issues associated with urbanization include degradation of water resources and water quality, changes in hydrology, increased inputs of water pollution and nutrients, increased acidity, and higher water temperatures of lakes, ponds, and streams (US Environmental Protection Agency, 2001).

Rapid increases in vehicle travel have negatively affected the environment in numerous ways. The growth of travel degrades air quality, impairs water quality, and increases traffic noise. Since 1970, per mile motor vehicle emissions have been decreasing as a result of vehicle emissions control systems and cleaner fuels. Increasing vehicle miles travelled, however, threatens to reverse this trend in the near future for carbon monoxide, sulphur dioxide, and particulate matter (PM10). Further, motor vehicles also release hazardous air pollutants. According to an EPA study in 1993, mobile sources released about twenty–one per cent of the 8.1 million tons of air toxics nationwide. The release of nitrogen, metals, and various polycyclic aromatic hydrocarbons that end up in water bodies impacts water quality. Transportation is also a significant source of greenhouse gas emission. In 1997, the transportation sector emitted thirty–two per cent of US $CO_2$ emission from fossil fuels, or 473.1 million metric tons of carbon. From 1984 to 1997, carbon dioxide emissions from transportation in the US increased by twenty–five per cent (rising from 379 million metric tons). Yet in addition to carbon emission, vehicle travel contributes to emission of two other greenhouse gases, methane, and nitrous oxide. Total emissions of these gases for the US in 1997 were 213 metric tons of methane and 205 metric tons of nitrous oxide (US Environmental Protection Agency, 2001).

Consumption of resources provided through trade, is affecting ecosystems around the globe. From ecological perspective, the growing 'ecological footprint' of these urban centres[15] is typically many times their total administrative area. London's ecological footprint, for example, is 120 times the area of the city itself and Tokyo needs 1.2 times the land area of all of Japan to sustain its levels of consumption.[16] Rees (2002) has calculated that the total footprint of all cities is now greater than the land area of Earth. This analysis suggests that consumption in cities, largely those in the developed world, are drawing down the natural capital of the planet.

## 2.4  Challenges for Urban Policy Development and Management

Previous environmental policy successes have typically been based upon regulations for best technologies, arresting pollution from point sources, changing fuel types, and other fairly straightforward policies, which relied on specialist knowledge emanating from segregated fields of study. While the importance of specialized research is not in question, both policy makers and scientists increasingly debate its efficacy as a source of policy support for current challenges. Decision makers dealing with environmental issues are demanding ways to deal with surprise and uncertainty. Decision makers need new approaches that focus on how to accommodate rapid changes in the environment to allow them to adapt their management strategies quickly to new conditions.

New methods of urban environmental studies have emerged in recent years that aim to better integrate sets of knowledge. The ecological footprint,[17] for example, provides a conceptual tool for understanding the impacts of cities as drivers of ecosystem change. Many new information technology applications, including GIS applications and different modelling techniques are being employed. Qualitative scenarios and back–casting techniques are also being used to help structure science and research into more strategic applications and political processes. There is a need to build and expand upon such techniques and to present results in a way that allows decision makers to comprehend trade–offs among sets of objectives across issues and scales.[18]

In almost all countries, providing goods and services to the urban citizens is the responsibility of the city authority, including services for basic needs as well as other amenities such as recreation and aesthetic requirements. However, various local agencies are often guided by national policy, where various ministries make their own priorities. Increasingly international institutions, such as the WTO, the International Monetary Fund, and the World Bank, make decisions that impact localities. These trends are creating policy gaps between government agencies, levels of government and between the private and public sectors.

While local governments have in the past relied upon central government resources, as they do not have sufficient tax power, local governments are increasingly asked to take a more active role in promoting coordination among the social and environmental dimensions of urban problems. At the same time, governments are rarely structured to take such an approach. While there are many calls for integrated studies and policy coordination, such aspirations may underestimate the legal and financial incentives that are required for such cooperation. Much more attention needs to be given to the specifics of local and regional political processes and institutional competencies for urban environmental management. One example is the degree to which so–called informal processes in many developing world cities shape land use and development

patterns. In a city with a high degree of informality (or alternatively, weak state controls), local state agencies may not have adequate influence on solving local environmental conditions.

## 2.5  Summary

Trends seen differently in various parts of the world, call for new approaches to deal with the increasing complexity of environmental burdens and the shifting political and institutional context in which solutions must be developed. The method must be integrative and provide for new ways to both attack environmental challenges and develop policies (e.g., enhance public participation; develop financial and human resources). It must also be flexible enough to deal with unique situations. While there are no 'silver bullets' to solve these growing demands, the ecosystem approach has much promise. The ecosystem approach portends to integrate various environmental issues at both different scales and among disciplines. Further, the user–driven, adaptive management style and politically inclusive aspects of the approach may provide for a way forward in policy development and management in times of uncertainty and increasing vulnerability. In order to define fully an ecosystem approach to urban management, it is useful to first review the trajectories of the concept's development.

# 3  A Brief History of Ecosystem Approaches to Understanding Urban Dynamics

**As demonstrated in a previous section, there are currently a number of different approaches to environmental management that claim to use the ecosystem approach. The core requirement that a specified physical environment and its associated organisms are functionally linked is central to using this method. Many different conceptual structures have been built upon this understanding.**

Adding to the sense that the concept is being used in a variety of different ways, its application is used by an increasingly diverse set of academic disciplines. Anthropologists, sociologists, geographers, landscape architects, and urban planners, among others, have used the concept of ecosystem, while drawn from biological sciences, to define an approach that blends human activities and 'natural' processes.

We argue in this section that the ecosystem concept derives from the notion that the city is both a 'system' and a 'natural' entity. Therefore, it can be approached with similar concepts to those used by systems engineers and ecosystem biologists. At the same time, there are limitations to the strict use of this term in the biological sense, as the linkages between elements and flows within the urban ecosystem are not as 'tight' as those within a natural system. Actions of people heavily influence cities for which no model in any of the sciences can satisfactory predict or explain. Thus, within the city as a 'natural entity' metaphor, a variety of different strands of thinking has developed. Reviewing these notions provides the basis for developing an understanding of an ecosystem approach to urban management and policy development. The review suggests that there are currently developed ways in which the ecosystem approach can be used to overcome a variety of issues that have helped to create the complex environmental management situations described in the previous section.

## 3.1  The City as a System

The city as system has been a central metaphor for urban management in the second half of the 20th century. The systems approach is essentially a formalized method of determining the role of components within the overall operation of a system (Exline, Peters, and Larkin, 1982). At the core of the theory is that each system has coherence or unity, which enables us to distinguish it from other systems and to view it as a complex whole. Thus, a system is analogous to a 'set' in mathematics, where what is common to a set is what unifies and distinguishes it from other sets. What makes a system not just a set in terms of distinct parts, but that it is also a set of interconnected parts. The structure of a system is determined by the structure of its parts and their relationships.

General systems theory evolved mainly as a response to the increasing specialization and compartmentalization that occurred in both the natural and the social sciences. Systems were thought to exist in two forms: open and closed. An open system interacts with its environment; a closed system is isolated from it. Cities, or parts of cities, can be viewed as both open and closed systems because they have within them nested sets of partially closed systems, and as a unit exchange energy and materials with the larger environment.

The systems approach to urban planning focuses on the articulation of various components of a city and the flows and processes between them. In this sense, urban planning involves exercising control over the workings of parts of the entire system. This notion was a radical departure from previous views of addressing urban environmental problems. Before the application of the urban systems approach, planning was largely an exercise in design.[19]

The new approach brought significant changes to planning cities. Planners and city managers were required to understand and appreciate the complex inter–relationships between various and diverse phenomena that gave rise to urban development. Moreover, planners needed to understand how changes in one part of the city would affect other parts. Proposals for development were evaluated in a significantly different way than when finding the right urban form was the central focus. Systems theory also emphasized activity, dynamism, and change rather than producing detailed 'end–state' master plans; and planners were required to produce adaptable flexible plans. These documents focused on trajectories, rather than end–state blueprints for a fixed future. Planners, rather than having a more limited role, were given greater importance in urban development. As planning was an ongoing process of monitoring, analysing, and intervening in fluid situations, their input was needed on a daily basis. Approaching cities as a set of interconnected activities mandated the need for social, economic, environmental, as well as physical and aesthetic analyses. This included a broader remit for planning than previously encountered.

Scientists in this tradition worked with large–scale quantitative models and produced specific planning applications. These applications were based on optimizing techniques and long–range forecasting models. Despite the many merits of this approach and the value it added, there were at least three weaknesses. First, it did not deal effectively with the biophysical components of the 'systems environment'. Second, and related to the first, optimization exercises were based on the idea that all components to planning exercises

could be evaluated on the same footing. The idea that some environmental considerations were not quantifiable or that is was difficult to derive monetary values necessitated their removal from models. Finally, the modelling and applications that came from the systems approach to planning were frequently described in highly abstract, technical, and mathematical terms. They were therefore unusable to decision makers and indeed to those not familiar with details of model interpretation.

## 3.2 The City as a Natural Entity

The notion that the city is a natural entity dates back at least to the early nineteenth century. In 1830, William Cobbett wrote of London as an organism that spread its tentacles across the English countryside (Douglas, 1981). Often, the city was likened to the human body as nineteen–century urbanists described its various functions. Recently, Melosi (2000) suggests to his students that there is no difference between a city and an anthill. His argument is that the product of human labour should not be regarded differently from the product of other living organisms. A city, therefore, is analogous to a beaver dam or a prairie dog town. While the comparisons between cities and natural entities cannot be extended too far, the point that Melosi and others have made is that cities cannot be excluded from our understanding of and responses to the natural world.

There is a rich and varied history of the notion of the city as natural entity. Since the nineteenth century, the concept has taken on various trajectories. Some of these lines of thinking remain today. Notwithstanding oversimplification, we have divided the many currents into three general categories. The first we call the urban ecology approach. The second, the city as flows approach. The third is the biosocial approach from which developed the human ecosystem framework.

### 3.2.1 Urban Ecology

The urban ecology approach was and remains largely within the realm of biology. In this understanding, ecologists have looked upon cities as unique types of natural ecosystems. Cities are therefore not unlike natural landscapes (coastal scrub, grassland, oak woodlands, marshes, and stream–sides), holding a wide range of species. Many of these types of studies have applications to urban planning (see for example, Hough, 1990).

Urban ecology keeps humans and human activities separate from the ecological world. Those working within this approach are largely interested in the concepts and processes of the stresses, disturbances, structures, and functions of urban ecological systems, and how urban ecosystems relate more generally to larger ecosystems (excluding people). These types

of studies have also been called the 'bio–ecological approach' (Grove and William R Burch, 1997).

Despite the separation of human and natural processes, there are interesting results and new techniques that have emerged from these studies, which have the potential to provide understanding of the relationships between human density and various ecological activities. One is the examination of changes in natural processes and conditions that occur along the rural–urban gradient. Another is how natural processes can be restored within areas disturbed by humans (Givoni, 1991). These studies provide details of how to reverse and deal with human–induced hazards and adverse health effects and how urban ecosystem processes can be use to mitigate problems.

While these and similar studies provide insight into the biology of systems within cities, they remain only marginally useful in providing a policy framework for dealing with the complexities of cities, as they do not focus on the role and influence of social structures and activities in ecosystems processes.

### 3.2.2 The Flows Approach

A technique that attempts to incorporate results of human activities into the understanding of urban dynamics is defined as the 'flows approach'. Like all ecosystems, a city can be studied in terms of inputs and outputs of resources, materials, and energy. The study of 'urban metabolism', as the first studies in this field were called, began in the 1960s (Wolman, 1965). This line of thinking was then promoted by the UNESCO/MAB's first international effort to consider cities as ecological systems. In the mid–1970s, Stephen Boyden piloted the UNESCO/MAB pilot project on Hong Kong as an ecological system (Boyden and Celecia, 1981). The approach viewed the city as an ecological system with quantifiable flows of energy materials and information. Since the human population was a dominant component, the approach required the study of intangible aspects of human experience such as feelings, perceptions, and values.

The two–decade project produced over 100 studies. The studies were directed at increasing the efficiency, self–sufficiency, and 'humanness' of cities, and minimizing their impact on near and distant hinterlands in an effort to make the city system more sustainable and liveable and to conserve resources. Notable examples of such studies and the 'points of entry' of their conceptual and methodological frameworks include patterns of extra–somatic energy flow (Hong Kong, Gotland), use of plants as indicators of chemical changes in the urban environment (Vienna, Rome), urban food production (Buenos Aires, Lae), urban forestry (Madrid, Xalapa), managing urban space for children (Toronto), use of sensitivity models for urban and regional planning (Lower Main–Frankfurt), and vegetation and urban climate (Dayton, Valencia).

Important studies in cities such as Hong Kong, Rome, Barcelona, Lae, Bangkok, and Seoul encompassed a spectrum of natural and social disciplines as well as actors. Assessments of sources and flows of energy and materials (e.g., water, foodstuffs, polluting substances) were complemented by studies of urban nature (with particular concern for biological and genetic diversity in cities) and the role of culture and societal organisation making city living 'urbane'. These included psychosocial studies in Hong Kong and Rome (Celecia, 1996).

From the urban metabolism school came a popular and effective adaptation of the approach to demonstrate the impact of urban activities. The concept of ecological footprint and carrying capacity, as forwarded by William Rees in early 1990s, has been instrumental in providing the first measure of the environmental impact of cities (Rees and Wackernagel, 1996). Ecological footprint analysis illustrates that high–density human settlements no longer have boundaries that coincide with land needed for their daily activities. Thus, cities in the developed world cannot achieve sustainability on their own. Indeed, they demonstrate that the human history displays the 'Easter Island syndrome' (Rees, 2002).

By looking at the city as a whole and by analysing the pathways along which energy and materials move, these studies have demonstrated how cities are increasingly out of the web of natural flows. This calls for a reintegration of urban activities with natural processes, increasing the efficiency of resource use, the recycling of wastes as valuable materials, and the conservation of energy (Newcombe, Kalma, and Aston, 1978). Urban metabolism studies can be used as tools in pointing to environmental problems (and economic costs), related to growth of inputs (as resources), and management of outputs (primarily the wastes). At the same time, this approach often calls for radical responses to these trends. This comes in the form of changes in behaviour (see for example Rees, 2002). While these options are interesting, they require restructuring of entire societies. The urban metabolism and ecological footprint analyses, have provided excellent critiques of the impact of cities on the environment, but have been weaker on providing solutions that city managers can use in their daily work.
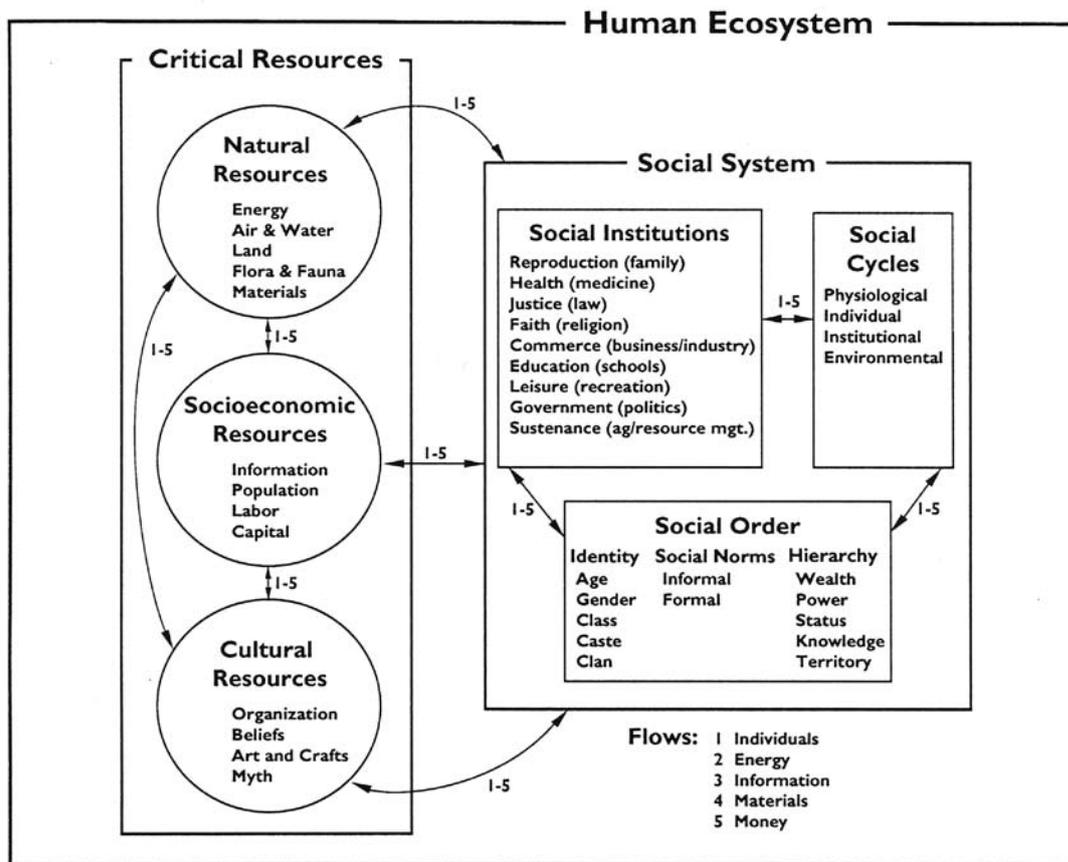
### 3.2.3  Biosocial Approaches

Interestingly, sociologists also employed ecological metaphors for the city. In the 1920s and 1930s, the Chicago School of Sociology applied principles of ecology to social theory with the objective of studying the community as an evolutionary entity. According to Vasishth and Sloane (2002), the founding sociologists of Chicago School derived their urban theory from their conception of science and nature, particularly ecology and evolution. They used

work from animal ecology and cell physiology to understand the role of competition and cooperation as mechanisms of change and progress. These sociologists were the founders of the study of society through efforts to empirically measure and map urban patterns and processes using principles of ecology. The management implications adopted from this theoretical point of view essentially were based on laise faire economics and free market attitudes toward urban development.

In the 1970s, William Burch, Jr started with the sociological viewpoint, but added natural components to his analysis. As a result, he began to articulate a 'bio–social approach' to human ecosystems. He and his students examined the energy, materials, nutrients, population, genetic and non–genetic information, labour, capital, organisations, beliefs, and myths and the knowledge that affects the distribution of critical resources within a human ecosystem. This work developed into the human ecosystem framework (HEF). The human ecosystem is a coherent system of biophysical and social factors capable of adaptation and sustainability over time, and argues that human ecosystems could be a starting point for the management of urban and other ecosystems (Machlis, Force, and William R Burch, 1997; Pickett, William R Burch, Dalton, Foresman, Grove, and Rowntree, 1997).

The framework (See Figure 1) includes three kinds of critical resources including natural resources (e.g. energy, wood, water), socioeconomic resources (e.g. labour, capital), and cultural resources (e.g. myths, beliefs). Rather than a 'self–regulating' system, the flows of these resources are regulated by an unpredictable social system. The social system is composed of three subsystems including social institutions, social cycles, and the social order. The social order further includes three key mechanisms for understanding the organisation of behaviour including personal identities (e.g. age, gender), norms (e.g. rules for behaving), and hierarchies (e.g. wealth, power). The power of this model is the inclusion of an array of social and biophysical factors that define the urban ecosystem.

Machlis, et al (1997) argued the HEF is not a theory, but a conceptual framework that provides a number of important insights in human ecosystems. First, it provides the basis for using a systems approach to integrate socio–cultural and biophysical systems by describing the internal behaviour of these systems and their interactions with each other in terms of flows and cycles of critical resources and allocation mechanisms. Second, it relates socio–cultural and biophysical patterns and processes at different scales. Third, by articulating the relationships between and among socio–cultural and biophysical patterns and processes, different types of system change such as resilience, resistance, persistence, and variability are highlighted. Fourth, it facilitates the explicit spatial measurement, classification, and analysis of socio–

**Human Ecosystem**

**Critical Resources**

**Natural Resources**
Energy
Air & Water
Land
Flora & Fauna
Materials

**Socioeconomic Resources**
Information
Population
Labor
Capital

**Cultural Resources**
Organization
Beliefs
Art and Crafts
Myth

**Social System**

**Social Institutions**
Reproduction (family)
Health (medicine)
Justice (law)
Faith (religion)
Commerce (business/industry)
Education (schools)
Leisure (recreation)
Government (politics)
Sustenance (ag/resource mgt.)

**Social Cycles**
Physiological
Individual
Institutional
Environmental

**Social Order**
Identity    Social Norms    Hierarchy
Age         Informal        Wealth
Gender      Formal          Power
Class                       Status
Caste                       Knowledge
Clan                        Territory

**Flows:**  1  Individuals
2  Energy
3  Information
4  Materials
5  Money

*The Structure of Human Ecosystems, Machlis et. al (2002)*

*Figure 1*

cultural and biophysical patterns and processes. Finally, this framework fits within a broader understanding of ecological systems for social and biological scientists.

The HEF has been applied as a framework and landscape approach in Baltimore, Maryland and more recently in Phoenix, Arizona, and has been incorporated into the National Science Foundation's long–term ecological research (LTER) network, established in 1980. The model is useful in providing pathways for solving everyday problems within cities in an integrated, holistic manner. It overcomes the problems associated with the systems approach by including biophysical influences and includes human influences making it more useful than approaches that exclude people.

While the HEF provides the necessary framework for focusing research efforts, it does not describe the functions or processes that are inherent within the urban ecosystem. Further work in this area is necessary and depends on the unique characteristics of each city.

## 3.3 Summary

The concept of ecosystem has developed as both a discipline and an approach. Its primary focus on interactions between living things and their non–living environments has provided a pivot for cooperation among a host of discipline spanning the natural, social, and human sciences. Given this agenda, it is not surprising that the ecosystem approach provides the inspiration and underpinning of many collaborative efforts that deal with complex issues and problems related to the environment and resources, which cannot be addressed by compartmentalized single–discipline approaches.

While the HEF is conceptually inclusive, defining the cause–effect relationships combining variables and integrating sectoral models into the overall framework remains a challenge. The HEF provides the basis for defining a framework for urban environmental management, especially given the need for interconnecting social, economic, and ecological systems within cities. Given the comprehensiveness of the model, its application to policy–making will potentially involve components that allow decision makers to weigh trade–offs among a variety of options, as well as identify synergistic solutions. The HEF provides a solid basis for future urban ecosystem studies, management approaches, and long term urban planning.

# 4 An Ecosystem Approach to Urban Management

**What follows is not an attempt to overcome the conceptual tensions within the variants of the ecosystem approaches described above, but an effort to extrapolate upon the review (with particular emphasis on the HEF) and distil a few aspects that could define an ecosystem approach to urban policy development and management. The recommendations are normative and focused on defining an ecosystem approach to urban management. They are not directed at any city and an attempt has been made to be policy–relevant not policy–prescriptive.**

In general, an ecosystem approach will aim to make cities liveable and to facilitate the internalization of urban impacts on other ecosystems through greater flexibility in management and further integration in policy development. More specifically, we suggest that an ecosystem approach will aim to manage over space and time scales, integrate biophysical and social components, adapt and deal effectively with uncertainty, create flexible institutions for management, visualize and identify planning problems with appropriate tools and methods and work to identify trade–offs and synergies in undertaking interventions.

## 4.1 Multiple Scales

In terms of management, the issue of scale has both temporal and spatial aspects. Planners must differentiate between the geographic scales of impacts of urban activities. Wealthier cities are typically associated with an increasing/wider environmental impact, while the growth and development of urban ecosystems is related to a variety of drivers that operate at different scales. In order to deal with these issues, we suggest that urban strategies must be applied at different spatial scales.

We can look at these same scale issues over time as well. For example, different system drivers operate at different speeds. The rates of urbanization, economic growth, technological transfer and development have fundamentally changed from what was previously encountered. Globalization and related flows have sped up transformations bringing both positive and negative impacts. This should lead to rethinking of the applicability of policies across nations and even within particular locales over periods of time.

A number of drivers that operate at different temporal and spatial scales influence urban ecosystems. Therefore, the approach mandates that the drivers of change be identified in terms of their speed and scale of impact. Appropriate interventions will necessarily have multiple objectives and varying timeframes. This will include more than a focus on immediate returns, but also with a view towards long–range goals.

Management interventions in urban ecosystems must take into account their impacts at different scales. Management decisions at one scale often have unknown or unpredictable effects on other ecosystems and at ecosystems at other scales. Possible impacts need careful consideration and analysis. The ecosystem approach must either work within the current institutional frameworks or suggest creative and possible solutions (new arrangements and organisation for institutions involved) to address the decision making context.

## 4.2 Integration of Biophysical, Engineering, and Social Sciences

In the past, the social and biophysical sciences have had little dealings with each other and have developed methodologies that prevent their working closely together. Increasingly, scholars and practitioners agree that expertise from one field alone cannot solve complex contemporary problems. The sciences must work together to solve the world's current dilemmas, and nowhere is this truer than in the world's cities. In doing so, new ways to integrate social issues (e.g., economics: income, employment, poverty; health: nutrition, access to water, sanitation, disease, service care; demography: urbanization, fertility, household family planning, gender) with the physical science issues (e.g., ecology, physics, chemistry, geology, physical geography) must be developed. To make these analyses most useful, there is a strong need for issue or problems oriented work.

Managing the urban ecosystem is different from managing other ecosystems, due to the high input of human activities into its structure and function. This is not to suggest physical aspects be ignored. Rather issues such as biological diversity, water filtration, soil depletion, deforestation must be integrated with issues such as sewerage, water supply, transportation, social institutions, and norms and values. In the past, there has been a tendency to manage components of cities as separate and functional units, without attempts to integrate across areas. Problem solving efforts even leave out some components.

Often, the research community has not been able to translate scientific research findings into policy. Scientific findings have been presented in a way which managers find difficult to understand. This has created gaps between scientists, managers, and the public. The ecosystem approach to urban management must produce scientific findings that correlate with policy and are readily accessible to the public.

## 4.3 Adaptation and Dealing with Uncertainty

Increasingly, adaptive management is accepted as a legitimate urban strategy. Adaptive management accommodates learning, uncertainties associated with limited knowledge, unexpected outcomes, surprise, vulnerability, and outside shocks. The importance of understanding that 'things change' must be incorporated into urban management to facilitate the mediation or accommodation of these changes.

Not only is this true at the metropolitan level, but it can be applied to all levels of society. For example, it could be applied to decisions and actions taken by individuals, in terms of the rethinking the level of commitment to personal plans and strategies, and at the household level, in terms of how families respond to rapid and unexpected changes. In general, too often plans and strategies are created that are not flexible enough to deal with the variety of 'surprises' that are increasingly experienced within cities and the larger ecosystems within which they impact.

Urban ecosystems change, including population, economy, environments, species composition, relations to hinterlands, water and air quality, biodiversity, soils, and forests. Management regimes should be able to adapt to changes. Apart from their inherent dynamics of change, ecosystems are beset with a complex of uncertainties and potential 'surprises' in the human, biological, and environmental realms. The ecosystem approach must utilize adaptive management in order to anticipate and cater to such changes and events, and should be cautious in making any decision that may foreclose options, but consider mitigating actions to cope with long–term changes such as climate change. The adaptive management is itself a learning, experimenting, and improving process and reduces the uncertainty by incorporating it into decision making process.

## 4.4 Flexible Institutions and Management

The principle of subsidiarity states that management should be decentralized to the lowest appropriate level possible. This ultimately, it is argued, provides for better coordination of programs and activities and promotes participation of stakeholders at different levels.

Decentralization implicates many issues besides political systems including tradition and culture–related matters, and these institutions vary widely among countries and regions. Implicit in this principle is the match of management capacity (institutional and human resource) and authority (e.g. taxing) of different levels of government. While there are merits to subsidiarity, there are many challenging implications in involved in its implementation. The

temporal and geographic scales within which urban ecosystems operate demand integrated multi–scaled governance (at best) and coordination among scales of governance for problem solving (at least).

The numbers of those implicated in urban activities and their impacts on the environment is increasing and becoming more diverse. The set of actors includes those from government, non–governmental organisations, and the private sector. Urban governments are playing new roles as facilitators of private investment in new sectors such as water and waste management as well as dealing with an increased role for non–governmental organisations. While these developments also pose challenges, they present opportunities for engaging a larger and cross–sectoral set of actors to solve problems.

The ecosystem approach should include options for new management systems. In this recommendation, there are at least three components. The first is the provision of information (in terms of the integration of many different forms), the second is the inclusion of diverse actors and voices, and the third is the way in which information translates into action.

Information from all sources is critical to arriving at effective ecosystem management strategies. Better knowledge of urban ecosystem functions and the impacts of human use are desirable. All relevant information from any concerned area should be shared with all stakeholders and actors. Assumptions behind proposed management decisions should be made explicit and checked against available knowledge and views of stakeholders. The relevant scale of impact must be considered in combination with the relevant set of actors. Locations of facilities that are for the entire community should not be made by the decisions and actions of actors whose interest is on smaller units.

Most problems of urban ecosystems are complex, with many interactions, side–effects, and implications, and therefore should involve the necessary expertise and stakeholders at the local, national, regional, and international level, as appropriate. Where traditional divisions inhibit coordination, temporary and flexible governance arrangements may be helpful in dealing with specific issues in the city.

The ecosystem approach must promote policies and planning targets that are accompanied by financial backing and managerial support to ensure implementation. Projects should be structured to attract adequate financing though public, private, and user funding.

## 4.5 Tools and Methods

To implement the ecosystem approach new tools and methods must be generated. These tools might

include GIS software, scenario building, and new economic valuation techniques. What is important is to include a variety of techniques from various disciplines. As scientific knowledge is only one form of 'knowing', planners should include an examination of other forms, such as 'traditional knowledge', whenever possible.

There is no single tool or method that can deal with the ecosystem approach. Up–to–date tools include GIS, strategic environmental assessment (SEA), and life–cycle analysis (LCA), among others. Potential pitfalls of these approaches are 'data availability', 'time', and 'money' since applying sophisticated tools often requires significant amount of data and information and substantial time and investment for preparation. The tools are undoubtedly powerful but there are cases where such analysis can be omitted. Similarly, some tools cannot be applied as they are now, and need modification to suit specific conditions of different areas. Moreover, there are clear limitations associated with the application of these tools to cross–disciplinary studies, particularly if they demand the integration of the inter–disciplinary researches into a single model to maintain scientific rigor and validity.

As the ecosystem approach is a holistic approach in environmental management that does not cover a single discipline, but integrates many disciplines such as social, biological, physical, and engineering sciences. Each discipline required different tools and methods to conduct research in their respective field. It is possible to short–list several modern tools or methods based on the policy objectives.

## 4.6  Tradeoffs and Synergies

The ecosystem approach brings a systemic, holistic approach to an extremely complex set of inter–relationships. The goal of the approach is to provide greater clarity and an expanded set of factors in terms of what might be lost or gained in making decisions. Therefore trade–offs and wider gains must be articulated as clearly as possible. An integrated urban ecosystem approach will involve generating enough information for policy makers such that trade–offs and synergies between various options in terms of social, economic and ecological values, can be addressed at various spatial, temporal, and management scales.

# 5  Conclusions and Next Steps

**An ecosystems approach to urban policy development and management is an emerging and promising approach. This evolution of this approach can be divided into two components. First is the "systems" element. By itself, the "systems" approach to understanding and managing cities has had a considerable impact, there have been shortcomings, not the least of which was the exclusion of biological effects in city management and an over emphasis on managerial control. The second element is the perspective of the city as a "natural" entity. Groups of scholars and practitioners that have emphasized this approach have created a variety of alternative visions.  Work on the ecosystem approach that includes both human (social and political) factors and bio–physical factors is the most promising. Among these the human ecosystem framework (HEF) provides the basis for applying the approach to cities.**

From this work we have distilled a series of characteristics, which could frame a discussion for developing an ecosystems approach for urban management. We hope that these defining characteristics will promote discussion among our colleagues. They have already presented opportunities to develop agenda for further work for the institute.

Taking the above into account, UNU/IAS is contemplating a two–pronged approach to exploring the potential of the ecosystems approach to urban management. First, through capacity development exercises with city managers, the Institute, in collaboration with its partner will attempt to develop practical guidelines to apply ecosystems approach in the field.

Second, the Institute will carry out a research project that explores both the promises and challenges of using the approach. This research will include case studies that examine the applicability of the approach as well as theoretical studies.

It is our hope that this work will lead to pilot project(s) that result in the development plans, which apply the ecosystems approach in specific locations. All these activities will include preparation of materials for both training the dissemination of research results.

# Endnotes

**1** For more information see http://www.ecostudies.org/bes/

**2** The fifth meeting of the COP in Nairobi also devised twelve principles of ecosystem approach and five major points as operational guidance for the implementation of the convention. Few of the major principles could be cited as follows (the details can be viewed at the web site http://www.biodiv.org/decisions/default.asp?lg=0&dec=V/6)

**3** See http://www.idrc.ca/ecohealth.

**4** See http://www.unep.or.jp/ietc/NewApproach/CASE/CASE.doc.

**5** Recently the MA has been invited to contribute to the Convention on the Conservation of Migratory Species. For more information see http://www.millenniumassessment.org/en/.

**6** Currently, the 'urban ecosystem' is being included as part of the 'Trends and Conditions' working group of the MA and there is at least one 'Sub-Global' urban assessment being conducted. The role of urban ecosystems has not been addressed directly in either the 'Response' or 'Future Scenarios' working groups.

**7** The Alliance grew out of the work that compared different ecosystem types around the world, and how they were managed. For more information see http://www.resalliance.org/.

**8** For more information see http://sustsci.harvard.edu/index.html.

**9** For more information see http://www.unesco.org/mab/.

**10** For more information see http://www.who.int/hpr/archive/cities.what.html.

**11** See "Global Trends" from the Global Urban Observatory at http://www.unchs.org/habrdd/global.html.

**12** Off the total number of reported deaths during this period (622,363) 277,574 (44.6 per cent) were from droughts and famines and 96,507 (15.5 per cent) from floods (Red Cross, 2002).

**13** This study did not, however, establish correlations between policies during the 1980s and environmental degradation. It documented that the prevailing patterns of resource use within these nations entailed considerable waste and loss of national wealth.

**14** An interesting hypothesis is that due to zoos, botanical gardens, and seed banks cities are actually higher in biodiversity than they would have been expected under 'natural' conditions.

**15** The area of land and water ecosystems required, on a continuous basis, to produce what the population consumes, and to assimilate the wastes that the population produces, wherever on Earth the relevant land/water is located (see Rees, W. E. (2002). Globalization and Sustainability: Conflict or Convergence? *Bulletin of Science, Technology and Society* 22(4), 249-268).

**16** Information available at 'The Global Development Research Centre' website http://www.gdrc.org/uem/footprints/index.html.

**17** See for example, M Wackernagel and W Rees, (1996). *Our Ecological Footprint*. New Society Publishers, Gabriola Island, Canada.

**18** Our approach to 'sustainable urban development' is based upon the notion that there are 'no free lunches' and that trade-offs must be made. The idea then, is to present scientific information to policy makers in a way that allows them to foresee, as best as possible, the impacts of making such trade-offs.

**19** For histories of urban planning in this regard see, for example, Friedmann, J (1987). *Planning in the Public Domain: From Knowledge to Action*. Princeton University Press, Princeton, and Taylor, N (1998). *Urban Planning Theory since 1945*. Sage Publications, Thousand Oaks.

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The Institute of Advanced Studies of United Nations University
(UNU/IAS) was inaugurated in April 1996. We conduct research,
postgraduate education, and capacity development, both
in-house and in cooperation with an interactive network
of academic institutions and international organisations.

The thematic direction of our research concerns the interaction
of social and natural systems. Thus, our research combines
the social sciences (law, economics, politics, and policy) with
some of the physical and life sciences (genetics, ecology, and
biology) at both theoretical and applied levels, and is aimed
at the development of informed policy–making to address
global concerns.

The current research agenda focus on strategic paths to
sustainable development, and under this broad theme,
our projects examine issues of biodiplomacy, sustainable
development governance, urban ecosystems, science and
technology policy options for developing and least developed
countries, and education and sustainable development.

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