The Sustainability of Cities: Determining an Appropriate Model

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Abstract: With the prediction by the United Nations that 60% of the world's population will live in cities by the year 2030, it is apparent that the immediate global future is one of urbanisation. Central to the issue of sustainability must therefore be the increasing domination of the city. Determining the sustainability of a city and the affect the city has on global sustainability must be considered from two perspectives that are largely analogous to Castells' bi-polar conflict between the Net and the Self (Castells, 1996). Cities must reconcile the conflict between being part of a competitive global city network and satisfying the day to day requirements of their own inhabitants. A sustainable city must recognise the environmental, social and economic impacts it has on not only its internal development but also through its linkages to other regions around the world. If a city sustains itself by exploiting other regions, then they are adopting parasitic sustainability practices which, from a holistic perspective, cannot be considered sustainable. The second perspective considers a city's ability to continue to develop and function in a manner that meets the daily needs of its inhabitants in a sustainable way. This aspect considers the city as a system nested within the world city system and its ability to evolve and adapt in response to externalities over which it has little or no control. This dual perspective of cities and sustainability is examined in this paper with a view to determine an appropriate model for what may constitute a contemporary sustainable city. What are the defining characteristics in terms of structure, policy and form that would ensure that a city could not only survive into the future in a way acceptable to its inhabitants but also in a way that would not undermine the abilities of other cities and regions around the world to also remain sustainable.

Keywords: *Sustainability; Cities; Adaptive Change; Sustainability Indicators; Sustainability Models*

1. INTRODUCTION

It has only been within the last 100 years that cities have attracted more than a few percent of the world's population. For the first time in history there are as many people living in urban areas as outside of them and predictions by the United Nations estimate that by 2030 over 60% of all people will live in cities (UNCHS, 2001). During the great rural to urban population shifts over the past half century, cities became supermarkets for employment, incubators of technology, suppliers of social services and shelter, portals to the rest of the world, processors of agricultural produce, adders of manufactured value, centres of learning, and, above all, places to make money through trade, industry, finance, real estate and, of course, attendant crime and corruption. In today's globalised world they are the nexus of commerce, gateways to the world in one direction and focus of their own hinterlands in the other (UNCHS, 2001). Cities are also consuming three-quarters of the world's energy and causing three-quarters of global pollution. Cities have become parasites – huge organisms draining the world for their sustenance and energy: relentless consumers, relentless polluters (Rogers, 1998).

Urban structure and regional organisation will continue to undergo substantial change as a result of social and economic change brought about by globalisation and the shift from the industrial mode of development to the informational mode of

development. All cities will require restructuring as the global hierarchy of cities dictate regional roles and a new international division of labour. The prevailing models of urbanisation have grown from the industrial mode of development, as have the strategies and policies to deal with their inherent problems. Sustainable development policies and strategies have emerged from the discontent and concern with contemporary urban expansion in a globalising world. Given the dominance of cities in an increasingly urban world, it is the development and management of cities as infrastructure for social and commercial interaction that must be better understood if global sustainability is to be an objective of contemporary society.

2. CITIES AS SYSTEMS

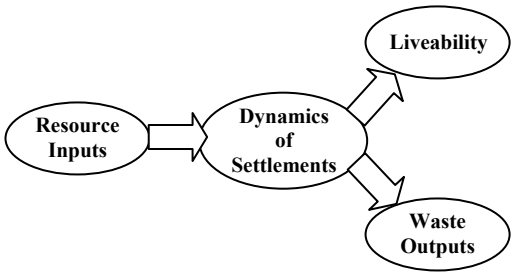
The city is obviously not a new concept, with semi-settled communities dating back to the Mesolithic era around 8900 BC and as far back as 2000 BC, very little of the physical city would be unfamiliar to the contemporary observer (Mumford, 1961). The city as a system to accommodate human purpose has endured. What *is* new however, is the dominance the city has achieved on the global landscape in such a short period of time with currently around 50% of the world's population living in urbanised areas. Although the city has been in existence for more than 10,000 years, it has only been a dominant feature of human existence for the past couple of hundred years. If we consider that just prior to the First World War, farmers comprised the largest single group in every country and 100 years before that they made up the full population almost everywhere (Drucker, 1994), we can begin to comprehend the importance cities will have on the human and global condition.

Cities are far more than physical containers storing people, goods and knowledge. Cities are in themselves an expression of society, requiring software in the form of management, governance, commerce, culture, education and community to facilitate a milieu for human existence and interaction. Without the human lifeblood that flows through the streets of the physical city, the urban structure ultimately becomes as irrelevant as the cadaver to the human soul.

Cities are as natural as the rainforests. They are built by humans using natural resources just as bees build hives, beavers log trees and dam rivers and ants construct their own cities to house their colonies. Of significant difference is the scale of impact. The global domination of cities and their resulting impact on the planet's biosphere will continue to test the ability of the intricate web of global ecosystems to adapt to this urban predator of natural resources. Cities and the environment within which they exist are therefore indivisible. Issues of sustainability can only be addressed by acknowledging that cities are themselves systems of complex interactions that are nested within global ecosystems.

Systems cannot be sustained by maintenance of the individual components making up the system. In the words of Fritjof Capra "Living organisms and ecosystems, too, may become continually unstable, but if they do, they will eventually disappear because of natural selection, and only those systems that have stabilizing processes built into them will survive. In the human realm, these processes will have to be introduced into the global economy through human consciousness, culture and politics. In other words, we need to design and implement regulatory mechanisms to stabilize the new economy" (Capra, 2002). Cities cannot remain sustainable nor contribute to global sustainability by addressing individually the complex interwoven components that define them. Intervention in the functioning of individual components will invariably lead to complications in other components. This is a fundamental characteristic of systems.

The 'Extended Metabolism Model' developed by Newman and Kenworthy (1999), acknowledges the city as a system, operating in a similar way to biological ecosystems, in that it balances inputs of resources with outputs of waste and liveability (Figure 1 below). A distinguishing difference between the city system and an ecosystem relates to the unique self awareness of humanity and its ability to forecast future consequences (to a greater or lesser extent) of its own actions.



Source: (Newman and Kenworthy, 1999) - amended

Figure 1. Extended Metabolism Model

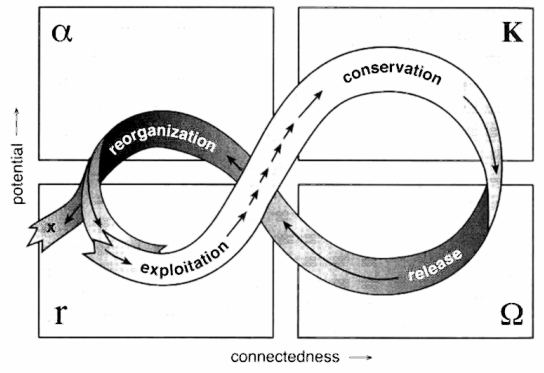
The city as a system is as vulnerable as other natural systems. Even if a balance was achieved between inputs and outputs, the city could not be

considered sustainable due to the consequences of unexpected disturbances.

3. ADAPTIVE AND MALADAPTIVE SYSTEMS

Cities do not exist in isolation. Individually they form one part of a world system of cities and regions, interconnected through linkages of trade, migration, capital and information flows. These connections mean that cities are vulnerable to externalities over which they have little or no control and they must therefore be able to respond to unexpected disturbances that affect their internal functioning. To remain sustainable, the city must continually reinvent itself, adapt and evolve as the world city hierarchy dictates regional function.

The term "Panarchy" has been devised by Gunderson and Holling (2002) to describe evolving hierarchical systems and provides a fundamental base from which to examine the sustainability of cities. Taking the city to be a system nested within the world city system it is unrealistic for a city to achieve an absolute or static sustainable state. The city must remain dynamic and retain the ability to move through the various phases indicated in figure 2 below.

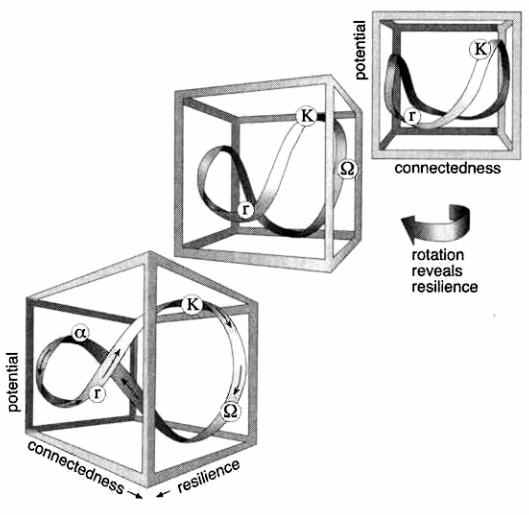


Source: (Gunderson and Holling, 2002)

Figure 2. Adaptive Cycle Phases

The city moves from a reasonably high level of potential as it defines its function in the 'α phase'. It is in this phase that internal connections or the city's 'connectedness' is relatively low. It is reorganising its socio-economic systems and hence connections are being identified as the city is testing various innovations in response to external parameters and internal requirements. This phase corresponds to industry restructuring during economic recession or social transformation. Once the city identifies its new function and chooses its economic path, the city's potential drops and the process of exploitation commences. In this 'r phase', the city begins forming connections that will assist it in its path towards greater efficiency and capital accumulation. As the system slowly begins to move towards the 'K phase', its potential begins to rise, although generally such potential is allocated to a narrow range of activity, and connections increase to become a highly connected and hence rigid network. The brittleness of this over connected system ultimately results in loss of stability through some internal or often external disturbance. The city system becomes subject to collapse in a relatively short timeframe as in the 'Ω phase', before stability once more returns as the city begins its process of rebirth back in the 'α phase'.

As the city moves through these phases it does so within three specific parameters. Potential and connectedness have already been noted, however the third parameter of 'Resilience' is also important to the stability and sustainability of the city. This third dimension, as illustrated in figure 3 below, represents the capacity of a city to experience unexpected disturbances and maintain its essential functions as a city.



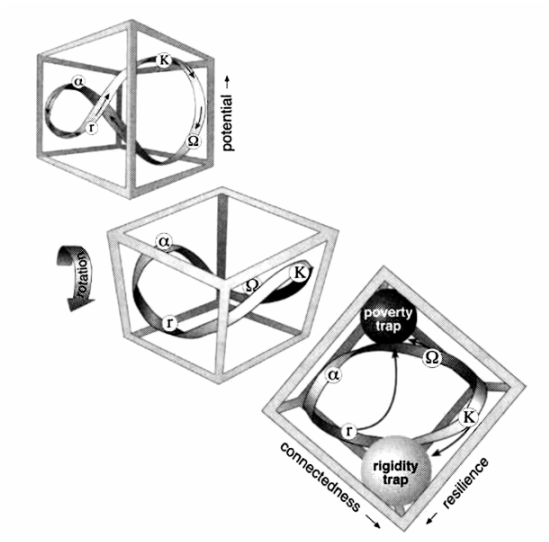
Source: (Gunderson and Holling, 2002)

Figure 3. Adaptive Cycle Parameters

The fundamental parameters that serve to define the structural elements of a city's sustainability are therefore its *potential* - to determine what the city is capable of, its *connectedness* – to determine to what extent the city can control its own destiny and finally its *resilience* – to determine how vulnerable a city is to unexpected disturbances.

If a city system begins to destabilise, and its resilience capacity is not sufficiently high, the possibility exists for the city to collapse. This

represents an example of the worst case scenario for a city and may occur when particular conditions relating to its structural capacity are compromised. The adaptive cycle converts into a maladaptive cycle when its parameters of potential, connectedness and resilience all become low rather than a combination of low and high as in a healthy adaptive condition (see Figure 4). Examples of such cities include those that have fallen into complete despair, where social organisation has been decimated by conflict, economies have collapsed and opportunities to adapt to new circumstances are minimal.



Source: (Gunderson and Holling, 2002)

Figure 4. Maladaptive Systems

While the breakdown of a city system to the extent that it is abandoned represents an extreme case, it is more usual that the city will continue with various ailments that negatively impact on various segments of society, on the environment or both.

Cities or regions that rely on a particular resource, such as mining centres, generally have very low potential to adapt to a new economic base should there be a disturbance to their core business. What these cities lack is the diversity found in ecosystems that provide a greater number of homeostatic feedback loops. A resilient city is one that gets and acts upon appropriate feedback (Jacobs, 1985). As a further consequence of such cities relying on the export of a single commodity, their ability to determine their own destiny is minimised. In a global market, such cities must produce their primary export in the most efficient manner possible to ensure their price remains competitive. This required efficiency means that connections within the production system must be high, however its control over external influences, is low. With low potential for change, low resilience through poor feedback and low ability to control external influences, these cities perpetually run the risk of entering a spiral of decline.

Many of the early industrialised cities such as Manchester in the United Kingdom and Detroit in the United States experienced decades of decline due to poor or faulty feedback from national levels down to the city level. Without appropriate feedback, corrections weren't made and as a result particular skills became obsolete.

4. THE SUSTAINABLE CITY MODEL

The model of the sustainable city lies below its physical exterior within the city's social core. It manifests itself in countless different forms depending upon the area's history, culture, economic base, climate, geography and politics to name just a few of the determining variables. Sustainability must predominantly address enduring human purpose as the core of any city development strategy. The sustainable city has no prescriptive specification however it does have defining elements. While the ultimate barometer on the performance of a city is the human condition of its inhabitants, it is necessary to examine other components to determine its sustainability in terms of being able to maintain a high quality of life for its inhabitants without compromising the human condition in other regions. A city may only be considered sustainable if its structure and operation acknowledges the indivisibility of the planet.

The concept of the sustainable city according to Rogers (1998) must recognise that the city needs to meet social, environmental, political and cultural objectives as well as economic and physical ones. Rogers elaborates by listing the key attributes of such a city to include equitable access to basic services, beauty in its art and architecture, creativity to optimise human potential, resource efficiency and minimal ecological impact, ease of contact, mobility, integrated and compact communities and diversity.

Determining the sustainability of a city, must be considered from two perspectives that are largely analogous to Castells' bi-polar conflict between the Net and the Self (Castells, 1996). Cities must reconcile the conflict between being part of a competitive global city network and satisfying the day to day requirements of their own inhabitants.
The following indicators have been categorised into these two distinct perspectives. Firstly, the city as an element within the global network,

where to be considered sustainable it must develop and operate in a way that is in accordance with the common global good (the Net) and secondly as a system within itself, whereby it must develop and operate in a way acceptable to its own inhabitants (the Self). As population plays a central part in the sustainability debate, it is important that, wherever appropriate, indicators should be represented as a per capita measurement.

4.1 The Net

'The Net' relates to the impact the city has on other regions around the world through its deliberate linkages of trade, foreign investment, migration, etc. and its non-deliberate linkages such as global warming, pollution, natural resource depletion, etc. Parameters of sustainability and their indicators from the perspective of 'The Net' may include:

- Economic position (Current account balance & Trade balance)
- Climate change (Greenhouse gas emissions, Deforestation)
- Air quality (Days of moderate or high pollution)
- Natural water body quality (Biological quality)
- Natural resource efficiency (Household waste, recycling, energy generation)
- Energy (Amount / type of energy generation)
- Open society (Refugees, Political structure).

These indicators provide a quantitative measure of how a city is impacting on the natural environment, the use of natural resources, the international economy and the global society. For a city to claim sustainability it cannot be depleting natural resources in other regions, be polluting the common biosphere, be producing refugees or be engaging in unfair trade practices. If a city sustains a standard of living by undermining current or future opportunities for other cities and regions to maintain a similar living standard, then it has adopted parasitic sustainability practices which cannot be holistically considered sustainable. The city must recognise the rights of other regions to equitable access of common capital, whether it is people, the environment, natural resources or money.

4.2 The Self

'The Self' relates to how the city develops to meet the needs of its own inhabitants and how the city may adapt to protect itself from disturbances over which it has little or no control. Measurable indicators of sustainability from the perspective of 'The Self' may be subdivided into two groups – condition and capacity.

4.2.1 Condition Indicators

The first group relates to the measurement of development outcomes to determine city condition. While these indicators don't provide any indication of the city's ability to maintain a healthy condition they do provide a baseline from which to track changes in the city condition. These parameters and indicators may include:

- Economic output (GDP & GDP per capita)
- Social condition (Divorce rates, Time spent with family and friends)
- Work (% of people of working age in work, Income distribution, Job satisfaction)
- Education (School expectancy, Business Partnerships, Qualifications, Training)
- Health (Health expectancy)
- Shelter (% in non-decent housing, Housing affordability, Living space)
- Security (Vehicle theft, violent crime, burglary, Domestic violence)
- Accessibility (Private vehicle km travelled, Public transport km travelled)
- Culture and leisure (Participation in sport, participation in cultural activities, Government funding of cultural and leisure activities).

4.2.2 Capacity Indicators

The second group relates to measurement of the city structure to determine capacity for adaptation and sustainability. These indicators relate to the adaptive cycle mentioned above and attempt to determine a city's potential, its connectedness and its resilience. It is less important to determine where within the adaptive phase cycle a city is positioned than it is to establish the city's capacity to continue to move through the cycle. Capacity parameters and indicators may include:

- Innovation (Patents, Research and Development expenditure) [Potential]
- City-region development (Import replacement) [Potential]
- Social Capital (Community groups & NGOs) [Connectedness]
- Integrated Planning (Stakeholder Approvals) [Connectedness]
- Economic Diversity (Spread of Industry) [Resilience]
- Political structure (Public Private Partnerships) [Resilience].

The challenge for researchers and policy makers lies in the fact that many of these indicators are only available at a national level rather than at the city-region level. While national data serves as a useful indication of general condition, it doesn't provide the level of feedback required at the city level any better than a raised temperature indicates to the physician where in the body an infection has occurred. To ensure feedback to cities is timely and accurate, these indicators must be collected at the city region level in order for appropriate responses to be facilitated through design and policy.

5. CONCLUSION

To develop cities in a sustainable way, the characteristics of a sustainable city must be determined in a manner that is measurable and provides understanding of the complex interactions between the environment, the economy and society.

The city is not an isolated system. While it has an impact upon the sustainability of systems that occur within it, such as its various neighbourhoods, its transport system, its economy etc., it also has an impact upon systems within which it itself exists, such as regional and global ecosystems and economies.

The analysis of the condition indicators described above under 4.2.1 provides a diagnosis of the city at a single point in time or, if extended to a longitudinal study, would provide useful trend data for assessment of the city's health. This data does not however provide sufficient evidence of the city's sustainability and just as seemingly healthy cities have declined throughout history, and in some cases even been abandoned, so too may healthy cities today also decline through not developing appropriate capacity within the city structure to be able to cope with unexpected disturbances and adapt to changing circumstances in a manner that will not dramatically affect the quality of life of its inhabitants. Additional data must therefore be collected from indicators of such adaptive capacity to assess the potential the city has to change, to what extent the city can control its own destiny and how resilient the city is to unexpected disturbances. The indicators listed in 4.2.2 above provide some indication of the capacity of the city to continually evolve and retain a healthy condition as per the indicators in 4.2.1.

A city that retains a certain condition by negatively exploiting other cities and regions cannot be considered sustainable. The city must acknowledge an indivisible planet and avoid shunting problems from one region of the world to another. Measurement is therefore also required to assess the flows in and out of the city. The indicators listed under 4.2.1 provide another perspective to the city's sustainability by quantifying what levels of human, natural and financial capital are being consumed by cities.

The scale of the city is only one spatial perspective from which to consider the issues of sustainability, however it is perhaps the most appropriate or at least most pragmatic scale from which to manage sustainability at other spatial scales. Mankind has the ability to influence sustainability by understanding how the city system relates to humanity and the biosphere and taking the necessary action to ensure development is sensitive to others in both the current and future generations.

As Chief Seattle so eloquently stated in 1854 when addressing the American President, "Man did not weave the web of life: he is merely a strand in it. Whatever he does to the web he does to himself" (Olds, 1979). The urbanisation of the globe is in no small way affecting the web of life. How people deal with cities is how they prescribe their own future.

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