

# SUSTAINABILITY OF THE CITY AND ITS ECOLOGICAL FOOTPRINT

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*There are some agreed sustainability indicators, even some agreed target values regarding a sustainable city, but they still have to be underpinned by empirical evidence. The common starting point of definitions is generally the destructive impact of the city on its regional and global environment, which can be observed in form of the depletion of natural resources and the pollution of soil, water and air. A sustainable city is therefore generally regarded to be the one that is compact and preserves land, has mixed use to increase access and reduce need to travel, is socially and economically balanced, uses clean and renewable energy and recycles all its waste. However, the sustainable city cannot exist as a self-sufficient unit, in ignorance of relationship with its hinterland. The ecological footprint, which is the amount of land required to produce resources to sustain our quality of life is a yardstick for measuring the ecological bottom line of sustainability. With a sustainable city target to relieve pressure on the countryside, there is an increasing awareness of the importance of calculating city's ecological footprint and see how it relates to the target global average. Although problem of reducing ecological footprints primarily concerns the wealthiest countries, it has to be fully acknowledged in the less economically developed part of the world, while recognising that cities themselves provide many potential solutions.*

**Key words:** *sustainable city, hinterland, resources, ecological footprint.*

## INTRODUCTION

Sustainability stands for finding satisfying ways of life for all, within the capacity of the planet. With urban areas becoming our primary habitat, it becomes a major task to investigate whether a sustainable relationship can be established between cities and the planet. Most cities have managed to prosper while simultaneously destroying the environment on which their survival depends. This was made possible only by the historical expansion of their ecological footprint – i.e. the hinterland from which cities extract their resources and into which they dump their pollution and waste.

Being confronted with the limits of our planet's resources, it is time to extend the domain of urban planning from discourses on sustainability of urban form to account for all the land upon which urban populations actually depend. With global change now upon us the message of ecological footprinting acquires a keener urgency.

Achieving sustainability is possible if its ele-

ments are defined in a way that is accountable and consistent with ecological realities. Referring to this, ecological footprint accounts can help policy planners assess a population's ecological impact and compare this impact to nature's capacity to regenerate. These analyses give us a benchmark for today's ecological performance, identify the challenges for lightening people's ecological load, and allow us to document gains as a city, region, or country moves toward sustainability. In this way, the ecological footprint becomes a tool for weighing the merits of potential policies and developing effective strategies and scenarios for a sustainable future.

## THE NOTION OF SUSTAINABILITY

Before about thirty years ago, the term 'environment' was little used and had for most people the general meaning of our surroundings, without particular concern that it might be seen as a significant problem area. Today this has changed radically because our age is

seemingly beset by environmental problems and consequences of the interaction of population, resources and environment in the context of continued economic development.

Sustainable development is identified as a much broader concept than environmental protection. It has economic, social and cultural as well as environmental dimensions, and embraces notions of equity between people in present and between generations. By linking environmental protection to economic development, sustainability entrenches environmental considerations in economic policy-making.

Generally, people find it difficult to live in a sustainable way since present values, knowledge systems, technologies and institutions make it easier to live unsustainably (1). Another great obstacle for implementation of sustainable development is that many people feel threatened by change, especially when viable alternatives are not clear. While simple to spell out, sustainability is hard to

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implement. Some initiatives have successfully reduced human pressure on distinct ecosystems, but on the whole, humanity has not lived up to the challenge to reduce, or even stabilize human pressure. There are numerous reasons, among the most prominent being that the challenge seems too daunting and in the short term it is always easier to procrastinate than to change established patterns.

Not knowing what is sustainable, not knowing where we are, or where we are going makes our future even more risky. Only clear and measurable objectives help us manage for sustainability. Simple benchmark yardsticks that compare human consumption with nature's limited supply help refocus public attention on the sustainability challenge. They clarify ecological boundary conditions and make way for meaningful debates on development.

Although many sustainability issues are global or national in scope, we relate most directly to what is happening in places where we live. While the whole range of environmental issues is important and all are interrelated, it is the issue of urbanism that seems to provide the problems that are among most intractable and difficult to solve.

#### **A SUSTAINABLE CITY**

For most urban centres as they are presently structured, it is clear that they do not perform as sustainable entities. Unless they become so, the international effort to achieve a sustainable civilisation will undoubtedly fail, as the ecological impact of the world's rapidly growing urban population inflicts increasing devastation on the Earth's biosphere. The world's major environmental problems can only be solved as part of the way we run our cities.

Original concerns over modern urbanism arose in the context of 19<sup>th</sup> century urbanisation and industrialisation in Europe and North America when it was 'only Britain, North-West of Europe and the USA that had more than 25 percent of urban residents' (2), and only 2 percent of the world population was urbanised. Since then, a world in which most people lived in rural areas has been transformed into a predominantly urban world, with almost half of population living in urban areas in the year 2000. In addition, if we observe current level of urbanisation

of 80 percent in the EU for example, it is noticeable that urban population of mostly developed parts of the world is having and will continue to have a growing impact on the earth's environment through its increasing number and its rising per capita resource demands.

The observation that cities are not ecologically sustainable is no value judgement, simply a fact. Cities occupy only 2 percent of the world's land surface, but use some 75 percent of the world resources, and release a similar percentage of wastes. Their concentration of intense economic processes and high levels of consumption both increase and stimulate their demands on resources.

The metabolism of most 'modern' cities is essentially linear, with resources flowing through the urban system without much concern either about their origin, or about the destination of their wastes: inputs and outputs are considered to be largely unrelated. This linear system is profoundly different from nature's own circular metabolism where every output is also an input which renews, and thus sustains, life (3). To become sustainable, cities have to develop a similar circular metabolism, using and re-using resources as efficiently as possible and minimising material use and waste discharges into the natural environment.

#### **The Compact City**

The compact city is a term, which is widely promoted as the sustainable urban form representing a normative solution for a problem of urban sprawl. Sprawl is perceived to be and has been proven to be, a less sustainable form of living and the compact city has been seen as an antidote to it. The benefits that compact city is quoted to achieve regard greater energy efficiency and less pollution, because its higher residential densities preserve land, enable residents to live closer to shops and work, and to use sustainable means of transportation. Apart from environmental gains, the compact cities are argued to encourage social mix and people's interaction. Yet, there is evidence which suggests that such arguments are 'at the very least romantic and dangerous, and do not reflect the hard reality of economic demands, environmental sustainability and social expectations' (4). Compact

city is associated to an assumed capacity to relieve cities' surroundings from demand for more settlements but what is often missing is that the compact city promoters focus their attention to the city and largely fail to discuss the relationship of the city with its hinterland.

#### **Are Cities Where They Are Shown on the Map?**

Some conventional notions on urban sustainability view the city as a self-contained, bounded territorial unit and the sustainable city as the one that is self-sufficient and self-reliant. However, a city cannot exist without its hinterland, and that hinterland can encompass territories much larger than the city proper reaching enormous amounts of land, which is already happening with cities of the wealthiest countries.

Many cities tend to be large consumers of goods and services, while draining resources out of external regions they depend on. All of the resources which people use for their daily needs and activities come from somewhere, even if not from their immediate surroundings. As a result of increased level of urbanisation, increasing consumption of resources, and growing dependencies on trade, the ecological impact ('ecological footprint') of cities extends beyond their administrative boundaries.

#### **WHAT IS AN ECOLOGICAL FOOTPRINT?**

The ecological footprint challenges common assumptions about economy, society and nature. It also reveals the sustainability gap confronting society – the difference between ecological production and human over-consumption.

The ecological footprint (EF) of a given population, be it that of a city, region, country or the whole world, is the total area of ecologically productive land and water occupied to produce all the resources (food, fuel, fibre) consumed and to assimilate all the wastes generated by that population using prevailing technology.

Developed as a planning tool to guide individuals and communities toward sustainability, the footprint is a yardstick for measuring the ecological bottom line of sustainability – a tool that helps answering the common questions of what sustainability might really mean and how we will know if we are being "sustainable".

Figure 1. - An illustration of the "ecological footprint". Source: <http://www.olywa.net/roundtable/footprint/index.html>



Initially, EF was conceived in 1992 by William Rees and Mathis Wackernagel as a tool to teach young urban planners in training a rudimentary fact of human ecology: although more and more people are living in cities, the land that actually supports them lies far beyond the urban boundary. Since that time, the concept of EF has been firmly established in the discourse on sustainable development, ecological economics and urban studies.

EF analysis differs from the classical concept of Carrying Capacity of the environment. Rather than asking the question of Carrying Capacity 'How many people can the earth support (individuals/area)?' EF asks 'How much land do people require to support themselves (area/individual)?' In other words, the ecological footprint is the measure of how much ecologically productive land and water a defined population unit needs to support its current consumption and to take care of its wastes. Under prevailing technology, it measures the amount of arable land and aquatic resources that must be used to continuously sustain a population, based on its consumption levels at a given point in time (5).

### How to Calculate EF

There is a finite area of biologically productive land and water on our planet, which equates to 11.4 billion hectares after all unproductive areas of icecaps, desert and open ocean are discounted. Divided between the global population of six billion people, this total equates to just 1.9 hectares per person (6). Accepting the World Commission's recommendation of 12 percent of biologically productive land needed

for biodiversity preservation, one can calculate that from approximately 2 hectares per capita of biologically productive area, only 1.7 hectares per person are available for human use and this represents a 'fair earthshare'. These 1.7 hectares become the ecological benchmark figure for comparing people's ecological footprints.

EF calculations are based on two simple facts: 1) we can measure most of the resources we consume and many of the wastes we generate; 2) these measurements can be converted to corresponding areas of productive land and sea.

Consumption is divided into the following 5 categories: food, housing, transportation, consumer goods, and services. Land is divided into 8 categories: energy land, degraded or built land, gardens, crop land, pastures and managed forests, and 'land of limited availability', considered to be untouched forests and 'non-productive areas'. Data are collected from disparate sources such as production and trade accounts, state of the environment reports, and agricultural, fuel use and emissions statistics. The ecological footprint is calculated by compiling a matrix in which a land area is allocated to each consumption category (7).

### Ecological Footprint Figure Warnings

According to the 1999 figures, with the world average EF of 2.3 hectares per person humanity has already exceeded the planet's capacity to sustain its consumption by 35 percent. While the EF of the average African or Asian consumer was less than 1.4 hectares per person in 1999, the average Western European's footprint was about 5.0 hectares, and the average North American's was about 9.6 hectares per person. In comparison to this, the footprint of Serbia and Montenegro's consumer is closer to Asian than the Western European average with 2.14 ha/person<sup>1</sup> (6).

<sup>1</sup> This figure was given in the WWF's *Living Planet Report 2002* for the estimated population of 21.1 million in Federal Republic of Yugoslavia and therefore should be recalculated.

Table 1. - Ecological footprint of countries by their level of income (6).

COUNTRY	ECOLOGICAL FOOTPRINT
High income countries	6.48 ha/person
Middle income countries	1.99 ha/person
Low income countries	0.83 ha/person

Countries with ecological footprints lower than 1.7 hectares per person have a global impact that could be replicated by everybody without putting the planet's ecological long-term capacity at risk. However, if every nation had the same rate of consumption and waste production as the three countries with the biggest EFs (the United States, the United Arab Emirates, and Singapore) at least another two Earth-sized planets would be needed. In the context of growing populations with rising material expectations, the question of providing everybody with essential resources becomes a major challenge. The right thing would be that those with biggest ecological footprint adopt an ethic of 'voluntary simplicity' and radically reduce their consumption and waste production. Although we simply cannot grow our way to sustainability in a world that sees people first as potential consumers and only second as responsible citizens, only a small minority of the world's population is in any position to adopt a post-materialistic perspective, and only a minority of these choose to do so.

Based on the UN and FAO reference scenarios, the world's EF will continue to grow between 2000 and 2050 to a level between 80 and 120 percent above the Earth's biological capacity. Of course, it is very unlikely that the Earth would be able to run an ecological overdraft for another 50 years without some severe ecological backlashes undermining future population and economic growth.

### City's Ecological Footprint

Eco-footprinting shows that wealthy cities and communities prosper by appropriating the carrying capacity of an area vastly larger than the spaces they physically occupy. Some cities are situated and sited better than others to take advantage of natural resources, but all depend on hinterlands, i.e. areas from which city resources are drawn.

Throughout history, areas with rich agricultural hinterlands have enabled the growth of cities. Nowadays, due to the new economy and increasing size of cities, instead of using the local hinterlands for their support, cities may draw on resources great distances from where they are located. This has been facilitated by technological revolutions, especially in cheap transportation, which allowed the import of materials (and export of waste) further away from cities.

Table 2. - Some examples of city's ecological footprints and the amounts of required territory in comparison to city's geographical area

CITY	ECOLOGICAL FOOTPRINT	HOW MANY TIMES BIGGER TERRITORY IS REQUIRED THAN THE CITY GEOGRAPHICAL AREA
London	6.6 ha/person	293
Paris	6 ha/ person	300
Toronto	5.3 ha/ person	201
Oslo	7.8 ha/ person	90
Berlin	4.7 ha/ person	32

The table given above illustrates that affluent cities have ecological footprints much larger than the ecological benchmark figure of fair earthshare. For example, London ('the mother of megacities') has the ecological footprint which is 6.6 ha/person. This translates to a territory around 300 times larger than London itself (8), which equates twice the territory of the UK. Now, is that a problem? If there are 300 London areas available to support London, obviously not. But we are in the world that is ecologically constrained and can't support such consumption patterns of cities in wealthiest countries that are severely stressing the global ecosystem while settlements in the developing world need more raw material, energy, and economic development simply to overcome basic economic problems (9).

So, cities are really where the action happens, where we have to find out how to live in a more sustainable way. In doing so, one should keep in mind that most of environmental demands and impacts that can be traced to cities have nothing to do with the structure, form, or other inherent properties of cities per se. Rather, they are a reflection of societal and individual

values and consumer behaviour. In such situation, the wealthy clearly have a moral obligation to make their cities more ecologically benign and as part of this they will have to reassess their private consumption patterns.

### FUTURE SCENARIOS

To deal with the uncertainty of future possibilities, we need 'scenarios' – asking the question 'what if' certain trends are followed with certain actions in certain conditions (10).

Following the previous discussion on ecological deficit (the amount by which the ecological footprint of a population exceeds the biological capacity of the space available to that population) and the role that cities take in forming such a deficit, it is possible to recognise three development scenarios in relation to the sustainability of a city.

#### Scenario 1: Return to a lifeless state

Once humanity is in ecological overshoot (the situation when human demand exceeds nature's supply at the local, national or global scale), development based on the same level or expansion of resource consumption becomes a negative sum-game. In this projection of a bleak future, an old economic maxim that goes "grow or die" could very well become "grow and die".

Present EF figures for both nations and cities of the developed world indicate that we are already exceeding the planet's capacities and that further expansion of human activities will liquidate the very natural assets on which present and future generations depend. This scenario of 'business as usual', which presumes no change in our current behaviour, suggests a self-destruction of cities, similar in outcome to the historical destruction of Machu Picchu that was swept away by invaders or Pompei that was stricken by the natural disaster.

For such an extreme case, as the Greens argue, the objective policy should be "zero growth", which presumes rapid shift towards bio-centric values and lifestyles. However, zero growth doesn't take in account uneven distributional effects of economic activity in the world and therefore is not a helpful objective. After all, successful programs for a sustainable society cannot be built on martyrdom and suffering.

#### Scenario 2: Living within the limits of a naturally renewing eco-system

To make sustainability a reality, we must find ways for people to thrive in all senses without needlessly overtaxing the ecosystems that support us. Perhaps it is not possible to design cities with zero ecological footprint – that use no more energy or water than native flows – that emit nothing that can't be biologically rendered on site, but the challenge is to get close to it. The imperative of this scenario is to achieve balanced relationship between city and its hinterland.

As previously argued, the ecological impact of cities usually spreads well beyond their administrative boundaries. On the other hand, sustainability requires us to reintroduce the concept of proximity in order to help increase the efficiency of urban consumption patterns. For instance, could at least some of the food consumed in the wealthiest cities come from local hinterland? Until recently the planned agriculture of China required that cities were surrounded by belts of agricultural land where food was produced for them. Such connection to the land is beginning to return in a very modest fashion through the rise in popularity of community farms and markets to serve urban districts (11).

Cities, particularly those in the most developed countries, have yet to prove they can be compatible with a healthy biosphere and that they can help liberation of ecological space. Eco-friendly urban development could well become the greatest challenge of this century, not only for human self-interest, but also for the sake of a sustainable relationship between cities and the biosphere, on which humanity ultimately depends.

#### Scenario 3: Engineering artificial renewing eco-systems

Knowing that the ecological footprint of the present world population/ economy already exceeds the total productive area available on Earth and that in future, instead of present requirement of 2 phantom planets, we will need 5 or 10 additional planets, this third scenario projects on the possibility to produce viable artificial biospheres.

As we stand now, despite our increasing technological sophistication, humankind remains in a state of "obligate dependence" on the produ-

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ctivity and life support services of the ecological space. Therefore, this scenario speculates on possibility to extend our planet's limits by either increasing bioproductive area on this planet (making use of non-productive areas, e.g. deserts and oceans) or we start colonies on other planets. At the moment, this looks more like a science-fiction scenario but like Scenario 2, it represents a possible alternative to returning to the lifeless state.

## CONCLUSIONS

Ecological Footprint analysis provides us with a number of critical insights regarding sustainability of the city. Firstly, it rises a cautionary signal for sustainable future by indicating the level of ecological deficit reduction that is required from a city to become sustainable. A city's EF can be used to measure its current consumption against projected requirements and point out likely shortfalls. In this way society as a whole can compare the choices we need to make in the near future about our demands on nature – or else nature will make our choices for us.

The use of bioproductive area as an aggregate unit makes EF a powerful and resonant means of measuring and communicating environmental impact and sustainability. By quantifying the material flow requirements for sustaining the present lifestyles, EF addresses the issue of uneven distributional effects between cities/nations of wealthy and developing countries.

In questioning who gets what in resource distribution, EF brings out the awareness that there are natural biological and physical limits to what we take from nature and pinpoints that in order to reduce our impact equitably those that take the most will be required to scale back the most.

Moving sustainability of the city forward becomes far more likely if strategies are chosen that both improve people's quality of life and reduce the size of city's ecological footprint. These strategies concern both city's supply side (protection, conservation, and restoration of natural ecosystems), and city's demand side (improved resource-efficiency with which goods and services are produced, reduced per capita consumption, and controlled population size).

It is true that EF analysis shows certain limitations, especially in explaining the total dynamics that lead to the outcome, but it serves well enough in documenting the outcome (the city performance) on its sustainable development path.

## References

- (1) Carew-Reid, J. et al.: Strategies for National Sustainable Development – A Handbook for their Planning and Implementation, Earthscan Publications, London, in association with IUCN and IIED, 1994
- (2) Pacione, M.: Urban Geography a global perspective, Routledge, London, pp.67, 2001

- (3) Girardet, H.: Giant Footprints, URL: <http://www.gdrc.org/uem/footprints/girardet.html> (19 August 2004)
- (4) Thomas, L. and Cousins, W.: The compact city: A Successful, Desirable and Achievable Urban Form? In: Jenks, M. et al. (ed.) *The Compact City A Sustainable Urban Form?* London: E & FN Spon, pp.56, 1996
- (5) *What is an Ecological Footprint?* URL: <http://www.gdrc.org/uem/footprints/what-is-ef.html> (19 August 2004)
- (6) *WWF Publications: Living Planet Report 2002.* URL: [http://www.panda.org/news\\_facts/publications/livingplanet/index.cfm](http://www.panda.org/news_facts/publications/livingplanet/index.cfm) (10 August 2004)
- (7) *Background to Ecological Footprints and Project Methodology.* URL: [http://www.sustainability.ac.t.gov.au/sus\\_reps/vol3\\_content/Vol3\\_chap1.pdf](http://www.sustainability.ac.t.gov.au/sus_reps/vol3_content/Vol3_chap1.pdf) (25 August 2004)
- (8) *Sustainable development. London's ecological footprint.* URL: [http://www.london.gov.uk/mayor/sustainable-development/susdevcomm\\_footprint.jsp](http://www.london.gov.uk/mayor/sustainable-development/susdevcomm_footprint.jsp) (30 August 2004)
- (9) *Agenda 21, Chapter 7: Promoting Sustainable Human Settlement Development.* URL: <http://iompa.spiralwave.co.uk/faq/agenda21/chapter07.htm> (17 December 2002)
- (10) Ravetz, J.: *City Region 2020. Integrated Planning for a Sustainable Environment,* Earthscan Publications, London, pp.39, 2000
- (11) Girardet, H.: *Cities, People, Planet.,* Liverpool (UK) Schumacher Lectures, pp.7, 2000.