Regenerative Cities

Making Cities work for people and planet

Background Paper

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Acknowledgements

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This report has been prepared by Professor Herbert Girardet

Contents

List of Figures

Introduction

200 years ago, in a world of villages and small towns, there was only one city of around one million people: London. Today there are thousands of cities of that size, and hundreds of multi-million cities, and dozens of mega-cities of over ten million people. And, for the first time in history, the majority of an ever-increasing world population now live in cities, a trend that is likely to further accelerate in the coming decades.

As ever larger cities emerge across the world, politicians, administrators and planners face significant new tasks: the sheer scale of modern cities poses unprecedented social, environmental and spatial challenges. But whilst officials are primarily tasked to deal with the 'inner workings' of cities, the wider impacts of cities and mega-cities on local rural landscapes, and on the world's ecosystems and farmlands now need to be addressed as a matter of great urgency. This is the age of the 'anthropocene', with cities and their resource use dominating human impacts on Planet Earth as never before.

Of course, it is not surprising that the primary responsibility of urban officials is with issues related to the urban *microcosm*: the well-being of city populations – local environmental issues, infrastructure, transport, housing, health, employment, education. That is what people rightly expect, that is what councillors are elected for, and that is what officials are appointed to do. But now cities also need address the fact that they are highly dependent systems: they are profoundly vulnerable to disruptions of resources supplies from beyond the urban territory. London, for instance, requires the energy equivalent of two super tankers of oil per week; and for its food supplies it requires farmland more than 50 times its own surface area, much of it located in distant territories.[1]

Cities today absorb the bulk of the world's natural resources, and their solid, liquid and gaseous wastes are often carelessly dumped somewhere in nature. But 'environmental boomerangs' are increasingly in evidence: In their own self-interest, cities urgently need to reduce their environmental impacts and ecological footprints, and to contribute towards regenerating damaged ecosystems.

This means that as the world urbanises, urban decision makers and populations need to expand their mental horizons; the *macrocosm* to which cities belong must become a major new focus for urban decision making: assuring sustainable resource supplies from closer by, as well as minimising discharges of pollutants into the local environment and the global commons. Self-interest, then, dictates a significant change in attitudes:

- Air pollution has become a major, very costly health problem in many cities;
- Sewage, fertiliser, pesticide and chemical pollution is affecting the health of people living near rivers and coastal waters;
- Polluted irrigation water is poisoning farmland in many places, affecting the quality of food supplies;
- In many rivers and coastal waters, plastic waste is clogging rivers to the detriment of aquatic creatures as well as local people;
- For cities located near the oceans, or in river valleys, impacts related to climate change – including coral reef destruction – could soon become existential threats.

We have responsibilities to local populations, to global environments on which we depend, and ultimately to future generations who have the right to inherit a healthy, liveable planet. We would be well advised to assure that cities develop a benign, regenerative relationship to the world's ecosystems.

The breakthroughs of the industrial revolution have provided the technical basis of the modern urban revolution, but ignorance and negligence of the environmental impacts connected to this now have to be vigorously addressed. Cities the world over need to recognise the huge benefits of a wide range of 'next generation' technologies that can transform the environmental performance of their cities and help them to stay within the sustainable carrying capacity of Planet Earth.

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[1] Girardet, H (2004 and 2008) Cities, People, Planet, Wiley, London
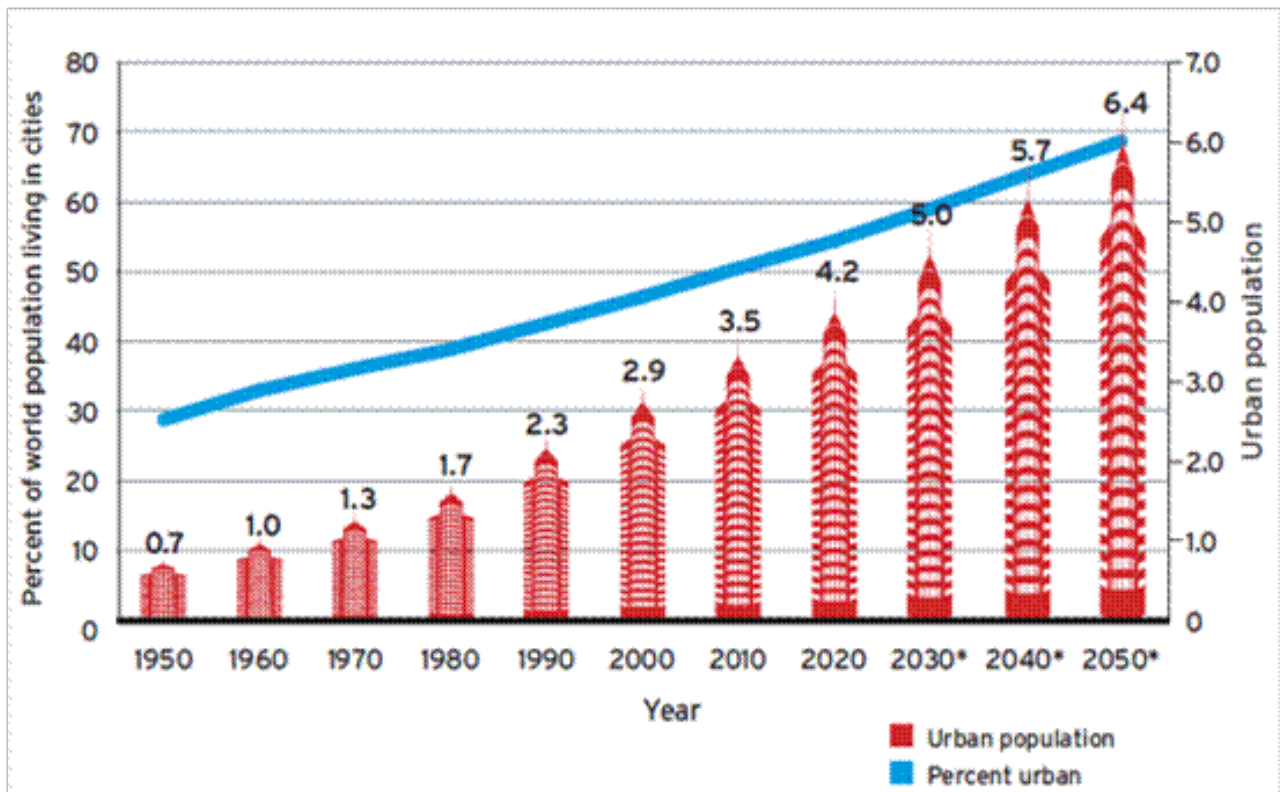
The making of the urban age

Under current trends, urban populations will grow nearly tenfold from 1950 to 2050, making up two thirds to three quarters of the human population. Source: UN Department of Economic & Social Affairs, Population Division

"Managing urban areas has become one of the most important development challenges of the 21st century. Our success or failure in building sustainable cities will be a major factor in the success of the post-2015 UN development agenda", says John Wilmoth, Director of UN DESA's Population Division.[2] In an urbanising world, then, we urgently need to answer some key questions:

- How can cities avoid local air pollution, noise and water contamination?
- How can they scale up their use of renewable resources?
- Could they thrive with a high degree of regional self-reliance?
- Could they actively protect and even regenerate the natural systems they depend on?

There is some divergence of views whether our actions should prioritise social, environmental, social or

greening the urban environment, on creating urban and peri-urban agriculture, on accelerating renewable energy systems, and on making effective use of organic and technical wastes can be a solid basis for creating new, green urban economies. An outline of how this may be achieved is given in my Adelaide/ South Australia case study at the end of this text.

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[2] UN World Urbanisation Prospects (2011), www.un.org/en/development/desa/news/population/world-urbanization-prospects.html

IPAT

There is much concern about ever growing human populations on Planet Earth. In the last 120 years, human numbers have increased fivefold to 7.5 billion, but urban populations have grown no less than 15-fold to nearly four billion. What are the environmental implications? In 1968 Paul Ehrlich, in his book 'The Population Bomb', developed the I = P × A × T equation: *Human impacts equal population numbers, times levels of affluence, times uses of technology.* This formula is highly relevant to discussions on the relationship between cities and the global environment: they play a major role in human population growth, but they are centre stage in economic development and increasing human affluence.

"Cities have long been the world's economic dynamos, but today the speed and scale of their expansion are unprecedented. Through a combination of consumption and investment in physical capital, growing cities could inject up to $30 trillion a year into the world economy by 2025." [3]

In Europe, America and Australia, cities have been centers of affluence for a long time. Now China is catching up: whilst it has had only limited population growth in recent decades, it has experienced massive economic and urban growth, powered primarily by coal-based energy technology. Hundreds of millions of people have moved to the country's ever larger cities. Ever-growing levels of urban affluence inevitably result in an ever-larger global eco-footprint, way beyond the country's own territory. And what has been happening in China is now being repeated in India, Indonesia and in other developing countries. Critical planetary boundaries are upon us, and the mega-urbanisation of the planet makes new perspectives on the local, regional and global impacts of cities a crucial necessity. As we create a primarily urban world, we urgently need new tools for understanding how cities function as complex systems.
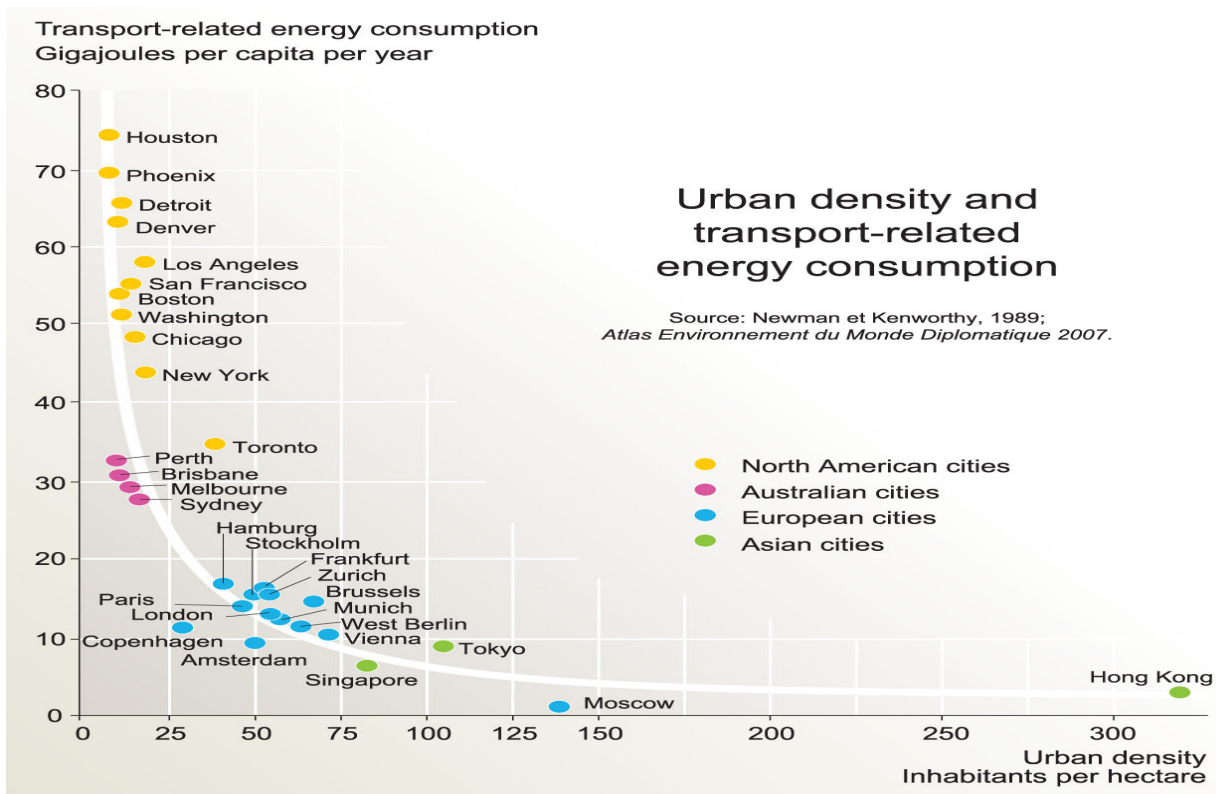
Transport related energy consumption

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[3] McKinsey (2015) Meeting the Demographics Challenges in Cities, www.mckinsey.com/global.../urban-world-meeting-the-demographic-challenge-in-cities

This famous diagram (Figure 2) by Peter Newman and Jeff Kenworthy, based on the meticulous collection of data over many years, shows the correlation between urban density and the transport related fossil fuel-based energy consumption of cities in the most eloquent way. It shows conclusively that compact cities are more efficient in terms of transport energy use. [4] We now need data collection and the development of similar diagrams to show the correlation between the resource consumption of different types of cities and their ecological footprints. Will increased resource productivity and new eco-technologies assure a significant reduction in global urban environmental impacts, as conceptualised in the IPAT equation?

Energy use in urban transport systems are certainly a useful start: Since the 1950s we have seen the rise of 'autophilic' cities, meant here as a term for cities where the automobile has become the favourite mode of transportation. More commonly, 'autophilia' is a term used to describe a form of narcissism, and this is relevant in this context as well: we live in cities that are self-obsessed, and that have virtually declared their independence from nature.

(Whilst we should strive towards creating compact cities, where pedestrianisation, cycling and public transport are prioritised over private motor vehicles, the significance of new transport options in lower density cities, where electric vehicles are powered by locally produced renewable energy, should not be understated.)

Autophilic, biophilic, ecophilic …

Partly in response to concerns about the proliferation of the 'autophilic city' across the world, the concept of the 'biophilic city' has emerged in recent years. Here we see a very different emphasis: "Biophilic Cities are cities that contain abundant nature; they are cities that care about, seek to protect, restore and grow this nature, and that strive to foster deep connections and daily contact with the natural world. Nature is not something optional, but absolutely essential to living a happy, healthy and meaningful life." [5]

The biophilic city movement has greatly gained in momentum in many countries. But the argument in this paper is that we need to go one step further and embrace the concept of the 'ecophilic city': a place where urban administrations and populations are fully conversant with the need to help create a symbiotic, life enhancing relationship between cities, their local environments and the world's ecosystems beyond.

We need to work towards -

- an environmentally enhancing, restorative relationship between cities and the natural systems they depend on;
- the mainstreaming of efficient, renewable energy systems for human settlements across the world; and
- new lifestyle choices and economic opportunities which will encourage people to participate in this transformation process.

Social priorities

The United Nations tends to prioritise the social and health problems posed by large scale urbanisation, and sustainability is, first and foremost, defined as a social issue, most recently expressed in the 17 Sustainable Development Goals.[6] The primary challenges are seen as addressing urban poverty, homelessness, slums and disease problems. And this is not really surprising since half the populations of many cities in developing countries live in slum conditions or worse.

This focus has a long history. It goes back to the concerns of social reformers working in the aftermath of the industrial revolution in Europe and the USA when millions of people were forced to live in unhygienic, overcrowded slums. Today, of course, vast numbers of people continue to flock to urban centres as new economic opportunities beckon. But wherever haphazard, uncoordinated growth takes places, planners invariably make proposals for better, more liveable urban environments.

Various urban planning movements sprang up in the early 20th century: in the UK, the Garden Cities movement aimed to provide new habitats for people living in the country's overcrowded industrial cities; and across Europe after 1945, the Modernist movement came up with austere and cost-effective urban development concepts suitable for rebuilding and replacing cities damaged by the war.

In recent years, there has been much emphasis on creating improved, liveable urban environments within cities. Perhaps most innovative in this context is the work of Danish architect and designer Jan Gehl. His

[4] Newman, P., and Kenworthy, J. (1999) Sustainability and Cities, Island Press Washington DC
[5] Beatley, T. (2012) Biophilic Cities, Integrating Nature into Urban Design and Planning, Island Press, Washington DC; also www.biophiliccities.org

[6] UN Sustainable Development Goals, www.un.org/sustainabledevelopment/sustainable-development-goals

seminal book 'Life between Buildings' advocates gradual but significant improvements to the quality of urban life by re-orienting city design towards pedestrians and cyclists. Gehl has had great successes in many cities across the world. [7]

All the urban planning movements of the 20th century have focussed in their various ways on creating 'liveable cities', aiming to assure the well-being of their inhabitants. But the wider dimensions, regarding the regional and global impacts of the consumption and waste disposal patterns of increasingly affluent cities, are still largely ignored.

Natural disasters and urban sprawl
Another important issue that needs much more attention is that cities in many regions can be vulnerable to sudden natural disasters such as earthquakes, tsunamis, high tides and floods. And then we need to start raising awareness of the potential impacts of climate change: In some parts of the world, droughts are becoming an existential threat to cities. And for those located in river valleys and coastal areas, floods and rising water levels are becoming causes for concern.

The world's most expensive real estate is found in coastal regions: For instance, of the 25 most densely populated U.S. counties, 23 are in coastal locations. Many major city regions are vulnerable to sea level rises of one metre widely forecast by climate scientists by 2100: They include New York, Newark, Miami, San Francisco, Boston, Amsterdam, Hamburg, Bremen, Venice, London, Hong Kong, Shanghai, The Nile River Delta, Dhaka, Hanoi and Ho Chi Minh City. This existential problem is still treated primarily as a local issue: in many places adaptation measures in the form of huge investments in sea defences are being envisaged to deal with likely sea level rises and ever more intense rainfall and floods.

For urban planning this means that building in areas of significant risk should be avoided wherever possible. The 'room for river' concept, as adopted in 16th century Japan and in today's Netherlands, is an excellent precedent. And in existing urban areas, the height needed for effective sea or river dykes needs to be clearly established.

But we need to face another problem: Even in countries where populations are stable or even declining, and where there is little economic growth, cities are often still expanding as families want to live away from dense,

noisy, built-up areas. But the resulting sprawl requires large infrastructure investments and it wastes both land and fossil fuel resources.

It is apparent that land use, transport infrastructure and disaster prevention measures need to be well integrated. And in rapidly aging societies, the future needs for infrastructure and urban space also have to be carefully considered: Systems that seem useful today may not be appropriate in future. We have to acknowledge that we may burden future generations with maintaining costly urban infrastructures: they may face ever larger bills whilst having ever smaller budgets available to pay for them. All this means that there is an urgent need for greater clarity about long term perspectives in urban planning.

The metabolism of cities
A recent publication by the German Government Scientific Council on Global Environmental Change delves into these issues in much detail. Its 2016 report on the 'transformative power of cities' states that urbanisation poses local as well as global sustainability challenges. It is not just a problem that cities often grow on some of a country's most productive farmland, effectively sealing it and rendering it infertile, but that they make huge demands on a wide range of global resources as well: Fuels, food, timber and metals prominently among them.[8]

This issue was first addressed by the American urbanist Abel Wolman in his 1965 paper 'The metabolism of cities'. The model he developed estimates the inflow and outflow rates of resources of a hypothetical American city of one million people. The benefits of this approach are now widely understood: They enable a clear understanding of urban 'system's boundaries', explaining how cities interact with the natural world. By integrating biophysical and social sciences, Wolman helped to clarify policy and technology options.[9]

In my own writing, I have addressed this issue in a number of publications: Modern cities have an essentially linear metabolism, with resources flowing through the urban system without much concern about their origin, or about the destination of wastes. Inputs and outputs are treated as largely unconnected. Fossil fuels are extracted from rock strata, refined and burned, and the waste gases are discharged into the atmosphere. Raw materials are extracted, combined and

[7] Jan Gehl (2011) Life Between Buildings, Island Press, Washington DC

[8] WBGU (2016) Humanity on the move: Unlocking the transformative power of *cities*, German Advisory Council on Global Change, Berlin
[9] https://en.wikipedia.org/wiki/Abel_Wolman

processed into consumer goods that ultimately end up as trash which cannot be beneficially reabsorbed into living nature. In distant forests, trees are felled for their timber or pulp, but all too often forests are not replenished.

Similar processes apply to the urban food system: nutrients and carbon are removed from farmland as crops are harvested and eaten. The resulting sewage, with or without treatment, ends up in rivers and coastal waters and the plant nutrients it contains are usually not returned to farmland. Rivers and coastal waters all over the world are 'enriched' by a potent mix of urban sewage and toxic effluents, as well as the run-off of mineral fertiliser and pesticides applied to the farmland used for feeding cities.

We need to make strenuous efforts to move from a linear to a circular urban metabolism — returning plant nutrients (nitrogen, phosphates and potassium) – back to the farmland, storing carbon in soils and forests,

reviving urban and peri-urban agriculture, powering human settlements efficiently by renewable energy, and reconnecting cities to the regional hinterland. These measures can significantly contribute to creating viable new economies at a time when globalisation has been causing economic dislocation in many cities.

For their long-term sustenance, cities should adopt strategies connecting food production to organic waste management. Some European cities, such as Milan, have implemented urban food strategies aiming to close the loop between urban food production and organic waste output. Whilst food is traded commercially by private companies, city authorities can take active measures to link urban food supplies with the utilisation of organic wastes by local farmers. At a conference in Milan in 2015, 138 cities from across the world came together to sign an 'urban food policy pact' concerned with implementing such measures at the local level. Similar initiatives have been implemented in Adelaide, as listed below. [10]
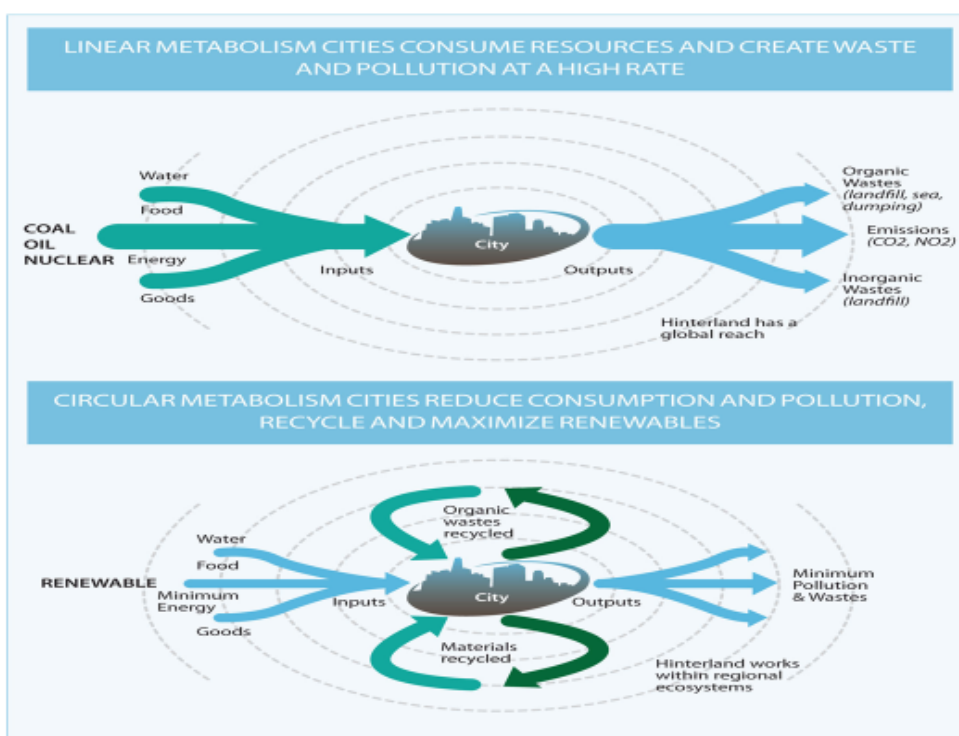
Credit: Herbert Girardet.

The metabolism of cities

Modern cities function as linear systems, taking resources from nature without much concern about their origin and the destination of wastes. To be sustainable in the long term, cities need to adopt a circular metabolism instead.[11]

[10] Milan Urban Food Policy Pact 2015, www.milanurbanfoodpolicypact.org
[11] Girardet, H. (1999) Creating Sustainable Cities, Green Books, Totnes

LOW CARBON LIVING
CRC

We need to think not just about sustaining the world's badly damaged ecosystems in an increasingly degraded condition, but about making strenuous efforts to regenerate them.

But with the huge scale of urbanisation now occurring across the world, these challenges are still barely understood.

Well managed cities offer good opportunities for economic development, and for easy access to basic services, such as health care and education. And in compact cities it tends to be more cost effective to provide good public transport, housing, electricity, water and sanitation than in low density regions.

But now we also need to broaden our perspectives: economists have started to assess the financial costs and benefits of ecosystem services underpinning urban systems. And among ecologists there is also much discussion about this topic. They stress that to acknowledge financially measurable benefits doesn't tell the whole story: nature's benefits can't only be valued in cash terms. Whereas economists are not greatly interested in biodiversity, with its myriad of interdependent species, ecologists would argue that cities exist as part of a vast, interactive web of life on earth of which urban life must be a beneficial part, or not at all.

From Petropolis to Ecopolis

As an ecologist I would argue that we need to take a close look at the problems associated with the systemic dependence of cities on the ubiquitous use of fossil fuel energy. I call this type of city *'Petropolis'*:

Fossil fuel energy has made the modern city possible more than any other factor, largely determining both urban form and function. But we are faced with the unavoidable realisation that oil, gas and coal are finite and that their ubiquitous use is inevitably results in climate change, of which cities are both the cause and the unfortunate victim. The huge challenge of our time is to transform *'Petropolis'* into a new model of the city that I call *'Ecopolis',* the regenerative city. Most urgently we need to answer a key question: can modern, energy hungry cities be converted to efficient use of renewable energy instead of fossil fuels.

In the age of the 'anthropocene' we need to look at the big picture. Cities need to familiarise themselves with the four laws of ecology, as defined by Professor Barry Commoner:

1. Everything is connected to everything else. There is one ecosphere for all living organisms and what affects one affects all.
2. Everything must go somewhere. There is no 'waste' in nature and there is no 'away' to which it can be thrown.
3. Nature knows best. The absence of a particular substance from nature is often a sign that it is incompatible with the chemistry of life.
4. Nothing comes from nothing. Exploitation of nature always carries ecological costs and these costs are significant.[12]

A really fortunate aspect of nature's economy is that it is defined by great abundance. The vast variety of living organisms is engaged in an exuberant, never-ending give and take. Nutrients and energy circulate within fluid boundaries, powered by solar energy. The challenge for an urbanising humanity is to learn living in unison with the living Earth.

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[12] Commoner, B. (1971) The Closing Circle - Nature, Man, and Technology, Knopf, New York

"Petropolis"

- Central city
- Navigable river
- Air imports/exports
- Road imports/exports
- Rail imports/exports
- Sea imports/exports
- Global communications
- Oil imports
- Food imports
- Motorway links

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Petropolis

The 'Petropolis' model of modern cities. The diagram shows the systemic dependence of cities on fossil fuel energy for all aspects of their existence. Reliance on local resources has increasingly given way to global supply chains.

'Petropolis' is no longer a viable habitat for humanity and needs to be replaced by this new urban model, 'Ecopolis' (another term that is widely used is 'Ecocity'). In Europe many small to medium-sized cities and city regions are now undertaking this kind of transformation process. They are engaged in -

- creating an environmentally enhancing, restorative relationship between themselves and the natural systems they depend on;
- the mainstreaming of efficient, renewable energy systems; and
- offering new lifestyle choices and economic opportunities that encourage people to participate in this transformation process.
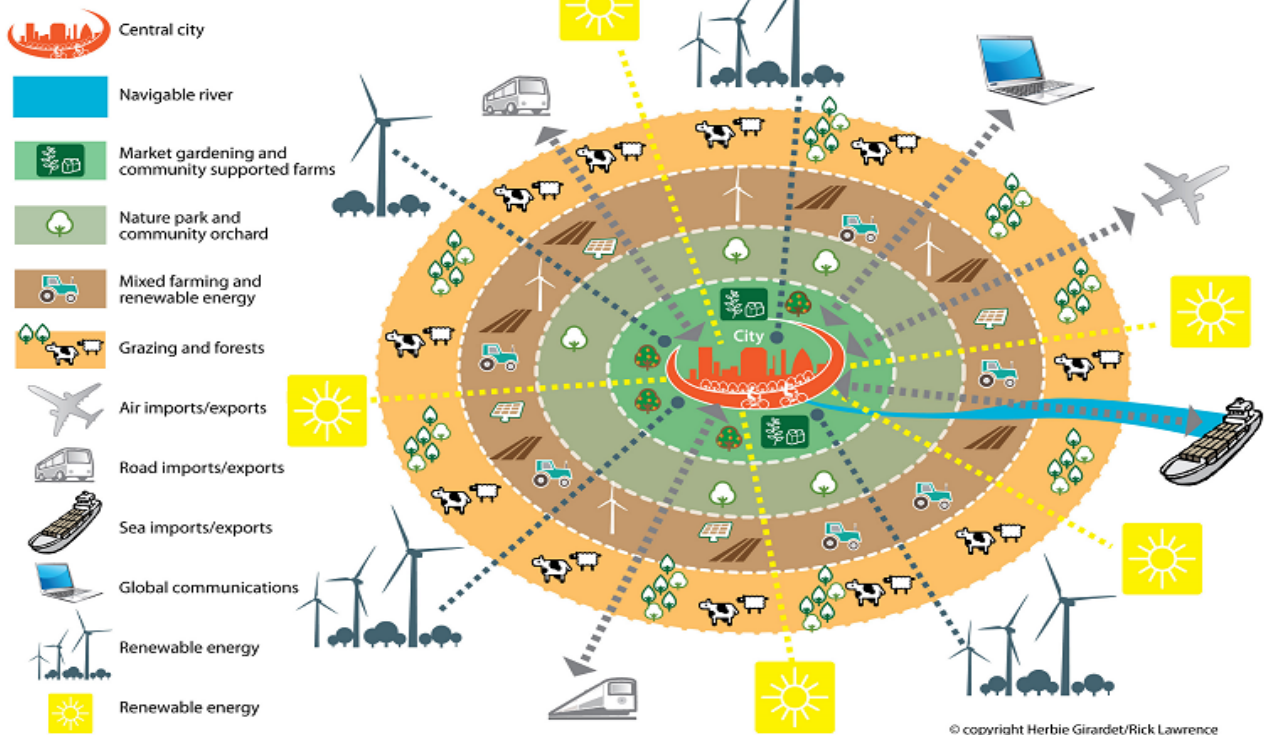
Urban creativity

It is in cities where human creativity is most vibrant, where new ideas are often generated, where NGOs are concentrated, and where most political, financial and economic decisions are taken. They are the places where solutions to the world's environmental and climate problems can be most effectively implemented [13].

The concept of regenerative urbanisation, then, is not just about greening the urban environment and protecting nature from physical urban expansion, but about city people taking positive steps towards creating regenerative urban systems of production, consumption, transportation and construction.

In recent years, there have been a great many *urban regeneration* projects in run-down cities of industrialised countries. These have greatly benefitted those immediately affected. But the concept of *regenerative cities* goes further: addressing the damage we have done to the world's ecosystems, and to initiate *regenerative* rather than just *sustainable* urban development.

[13] Mark Swilling et al. (2013) City-Level Decoupling, Urban resource flows and the governance of infrastructure transitions, UNEP, Nairobi

"Ecopolis"

- Central city
- Navigable river
- Market gardening and community supported farms
- Nature park and community orchard
- Mixed farming and renewable energy
- Grazing and forests
- Air imports/exports
- Road imports/exports
- Sea imports/exports
- Global communications
- Renewable energy
- Renewable energy

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Ecopolis

'Ecopolis' - the regenerative city, invites many typically rural activities back into the city region, such as market gardening, mixed farming and, most importantly, renewable energies. Fossil fuel dependence and transport intensity is thus greatly reduced.

We need to encourage city planners and politically active civil society groups to engage in a far reaching paradigm shift in the planning and management of cities.

Regenerative development is about *giving back* as well as *taking* – maintaining a proactive relationship between an urbanising humanity and the world's ecosystems, and nurturing nature's dynamism and abundance whilst drawing on its income.

The vision of regenerative cities is relevant for cities in many locations. Whilst in former industrial cities in the global North the 'brown agenda', of cleaning dirty industries is presently prioritised, regenerative 're-development' there too must also include a reinvigorated relationship with the local countryside, and its potential for supplying food and renewable energy. Development in the Ruhr region in Germany is strongly heading in this direction. [14]

So far, initiatives towards resource efficient, regenerative urban development are focussed, above all else, on 'eco-districts' in cities across Europe and the USA. Examples include 'urban the Solarsiedlung in Freiburg; the Beddington Zero Energy Development in Sutton; South London; eco-districts in Nancy; Hammarby Sjöstad in Stockholm; and Portland's Eco-District initiative. More often than not they were made possible by supportive national legislation. But there are also more ambitious projects that involve the retrofit of entire city regions. I have been involved in some of them, most notably, in Adelaide.

[14] Girardet, H. (2016) Creating Regenerative Cities, Routledge, Oxford

Adelaide

At the turn of the century the people of South Australia were getting concerned about dwindling water supplies from the Murray River. SA's Labour Premier Mike Rann decided it was time to explore wider sustainability issues in this city region of 1.3 million people. In 2003 I was invited to be a 'thinker in residence' in Adelaide to help trigger a discussion about options for combining environmental sustainability and new job creation initiatives.

During hundreds of seminars and lectures over a nine-week period, involving people from all sections of Adelaide society, many interconnected issues were explored. At the end of my residency I produced a 32-point plan to help transform the environmental performance of South Australia. [15] During Mike Rann's eight-year premiership, and in the five years since, much of this has been implemented:

45 per cent of electricity in South Australia is now provided from wind and solar technology; energy and water efficiency have become mandatory; all organic waste is recycled and returned to urban gardens and farmland on the edge of the city which is also irrigated with recycled wastewater; three million trees have been planted to counter erosion and air pollution; Lochiel Park Solar Village has been built as a model development; thousands of people are working in the city's new, green economy.

In addition to these initiatives, Adelaide has also done much to enhance the liveability of its inner-city region. Pedestrianisation and cycle lanes have transformed the inner city; new tramlines have been built; and much new housing has been made available in converted warehouses and former factories. Adelaide, with the famous Parklands at its centre, is now listed as one of the world's five most liveable cities.

Metropolitan Adelaide, then, has acquired many attributes of a regenerative city. This is a summary of the transformation that has occurred since 2003:

- 45 per cent of electricity produced by wind turbines and solar PV panels;
- photovoltaic roofs on 150,000 (of 600,000) houses, and on most public buildings;
- Tindo, the world's first bus running on solar energy;
- solar hot water systems mandated for new buildings;
- large scale building tune-up programmes across the city region;
- 60 per cent carbon emissions reduction by municipal buildings;
- 20 per cent reduction of CO_2 emissions in Greater Adelaide since 2003;
- construction of Lochiel Park Solar Village with 106 eco-homes;
- water sensitive urban development across the city region;
- three million trees planted on 2,000 hectares for CO_2 absorption and biodiversity;
- an zero-waste strategy driven by ambitious recycling incentives;
- 180,000 tonnes of compost a year made from urban organic waste;
- 20,000 hectares of land near Adelaide used for vegetable and fruit crops;
- reclaimed waste water and urban compost used to cultivate this land;
- thousands of new green jobs. [16]

[15] Girardet, H. (2003) Creating a Sustainable Adelaide, www.infosperber.ch/data/attachements/Girardet_Report.pdf

[16] Girardet, H. (2012) Regenerative Adelaide, Solutions Magazine, www.thesolutionsjournal.com/node/1153

Copenhagen

Copenhagen is another pioneering example of urban transformation. In the last 50 years Denmark's capital has done remarkable things towards becoming a liveable as well as a sustainable or even regenerative city. It all started the beginning of the 1960s when the heart of the was clogged by car traffic. It was decided to transform much of the inner city into a car-free, pedestrian zone. This has resulted in a 'Mediterranean-style' ambience in the city centre where markets, cafes and restaurants proliferate.

Walking has become a way of life in Copenhagen. Today, with a total length of 3.2 km Copenhagen has the largest inner-city pedestrian area in the world. Pedestrianisation was combined with a huge network of cycle routes and ambitious public transport schemes. But the city authorities did not stop there: They also introduced combined heat-and power schemes, comprehensive recycling projects and large scale wind-power development.

By 2025 Copenhagen wants to become the world's first carbon neutral capital city. It is now enacting a strategic climate action plan that combines 50 further initiatives in the field of pedestrian and electric transport, green architecture, renewable energy, a smart grid and waste reprocessing. Resource efficiency is becoming the basis of a green urban economy. [17]

Adelaide and Copenhagen are now used increasingly as models for the regenerative transformation of other cities. My book 'Creating Regenerative Cities' contains a further 18 case studies of urban innovations which combine local and global perspectives. There is no doubt that the challenges we face are vast, but so are the new opportunities.

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[17] As 14.

More information

The Co-operative Research Centre for Low Carbon Living works towards lowering carbon emissions in the built environment while driving competitive advantage for Australian industry. For more information see:
http://www.lowcarbonlivingcrc.com.au/

The Curtin University Sustainability Policy (CUSP) Institute is a research partner in the CRC LCL. CUSP are hosting the Regenerative Cities national forum for the CRC LCL. More information on CUSP can be found at:
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