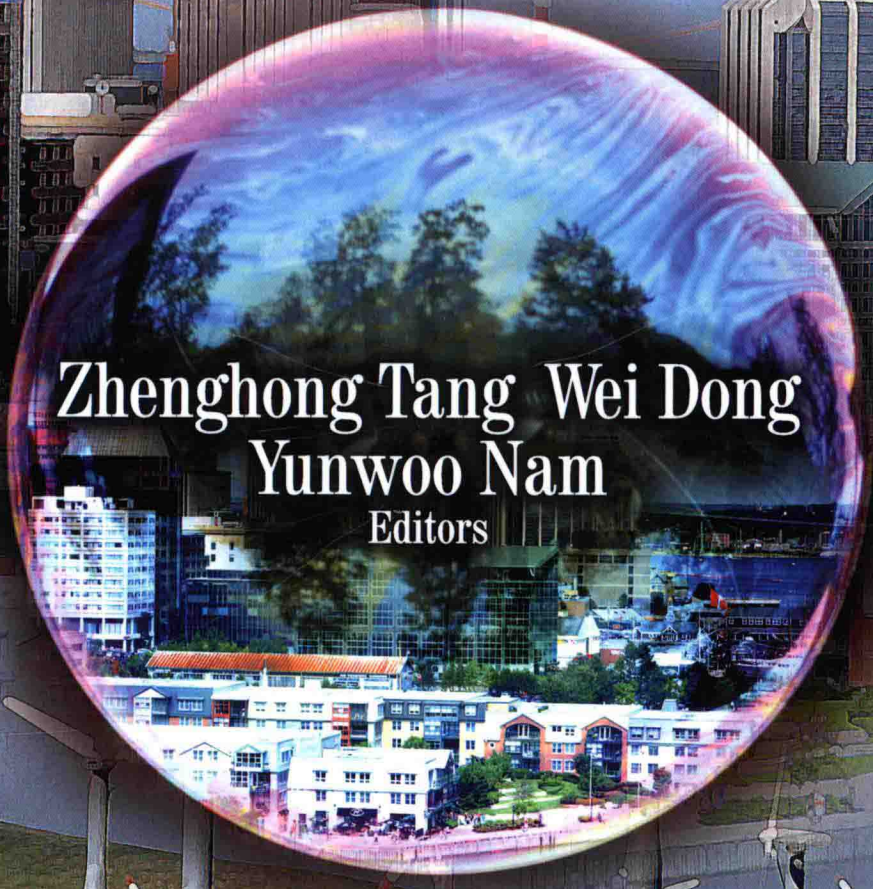
Towards Green Growth and Low-Carbon Urban Development



Zhenghong Tang Wei Dong
Yunwoo Nam
Editors

URBAN DEVELOPMENT AND INFRASTRUCTURE

NOVA

URBAN DEVELOPMENT AND INFRASTRUCTURE

TOWARDS GREEN GROWTH AND LOW-CARBON URBAN DEVELOPMENT

ZHENGHONG TANG
WEI DONG
AND
YUNSUOO NAM
EDITORS

nova publishers
New York

Library of Congress Cataloging-in-Publication Data

Towards green growth and low-carbon urban development / editors: Zhenghong Tang, Wei Dong, and Yunwoo Nam (Community and Regional Planning Program, University of Nebraska-Lincoln, Lincoln, NE, USA, and others).
pages cm
Includes index.
ISBN: 978-1-62417-858-0 (hardcover)
1. City planning--Environmental aspects. 2. Urban ecology (Sociology) I. Tang, Zhenghong editor of compilation. II. Dong, Wei editor of compilation. III. Nam, Yunwoo editor of compilation.
HT166.T6266 2013
307.1'216--dc23

2013008994

Published by Nova Science Publishers, Inc. † New York

URBAN DEVELOPMENT AND INFRASTRUCTURE

TOWARDS GREEN GROWTH AND LOW-CARBON URBAN DEVELOPMENT

URBAN DEVELOPMENT AND INFRASTRUCTURE

Additional books in this series can be found on Nova's website under the Series tab.

Additional e-books in this series can be found on Nova's website under the e-book tab.

ENVIRONMENTAL REMEDIATION TECHNOLOGIES, REGULATIONS AND SAFETY

Additional books in this series can be found on Nova's website under the Series tab.

Additional e-books in this series can be found on Nova's website under the e-book tab.

ACKNOWLEDGMENT

This research is supported by the Hyde Professorship Fund from the University of Nebraska-Lincoln and the funds from the Nebraska Department of Environmental Quality. The findings and opinions reported in this book are not necessarily endorsed by the funding organizations.

Zhenghong Tang

Lincoln, Nebraska, US
December 31, 2012

CONTENTS

In: Towards Green Growth ...
Editors: Zhenghong Tang, W. Dong and Y. Nam
ISBN: 978-1-62417-858-0

Chapter 1

CREATING ZERO WASTE CITIES THROUGH OPTIMISED MATERIAL FLOW, SUSTAINABLE DESIGN AND BEHAVIOUR CHANGE

Steffen Lehmann
School of Art, Architecture and Design,
University of South Australia, Australia

ABSTRACT

In this chapter I explore the notion of the zero waste city,which extends the concept of the sustainable city to include optimising all urban material flows. The aim is 100 per cent resource recovery and re-use of building components and materials. Cities need to be re-engineered with material flows in mind to become more sustainable and resilient. The construction sector, for example, uses a huge amount of raw materials and has high material and energy inefficiencies. What is also required is systemic, transformative change to promote sustainable consumption, shifting people from being merely consumers to responsible citizens. Therefore, I argue that influencing values and behaviour is an important but often neglected part of a low-carbon urban future. I discuss why we need zero waste cities and what needs to change at the level of cities, industries, individuals and households. This includes a transition phase of reduced, decoupled consumption, e.g. using products and buildings for longer, and producing more durable products that take advantage of prefabrication, modularity, adaptability and durability.

INTRODUCTION

By the year 2025, the world's population will reach 8 billion and almost 60 per cent of those people will live in cities. Around the globe, the urbanisation and growth in metropolitan areas is already affecting nature, biodiversity, food supply, the built environment and society in profound ways. However, the international community has made little progress over the last twenty years in restraining global CO_2 emissions, while now an increasing quantity of emissions is coming from large developing nations like China and India. Because of human

activity, the planet is reaching a potentially catastrophic tipping point, and several scientific studies indicate the estimated biodiversity decline between 1996 and 2011 to be around 12 per cent (Hooper et al., 2012). Studies over the last two decades have demonstrated that more biologically diverse ecosystems are more productive.

An increasing proportion of research in climate change mitigation and adaptation in certain disciplines focuses on the future of our cities and how we will design, build, operate, maintain and recycle products, buildings and city districts in a low-carbon urban future. Our research at the University of South Australia examines rapidly urbanising and changing cities, involving not only architects but also economists, planners, sociologists, psychologists, cultural studies researchers, health professionals, contractors, developers and engineers. While developed in Australia, the research findings have application worldwide. Such interdisciplinary research includes issues of sustainable design and behaviour change; it aims to rethink the way we deal with material flows, outlines why rapid urbanisation is a problem, and discusses possible solutions, new models and opportunities.

Many Asian cities have existed for a very long time and one can learn a great deal from their history; for instance, how cities have become resilient when facing extreme situations and challenges and how they have developed given the ecosystem's finite resources. Today we stand at a crossroads concerning the future of our cities. For instance, most cities in the Asia-Pacific region and in Latin America have experienced rapid urbanisation over the last two decades (while growth of cities in Europe and Northern America has slowed down, requiring a focus on urban renewal). Shanghai, for example, has transformed rapidly during this relatively short period, as have Bangkok, Hong Kong, Shenzen, Jakarta, Mexico City, Santiago de Chile, Sao Paulo and Campinas, just to name a few. But are these changes in the right direction? Are they part of the transition that we need to make towards a low-carbon world? I suggest not.

DEFINITIONS

In 2010 our research examined the concept of 'green urbanism', which is a principle-based step-by-step approach for urban transformation and retrofitting of existing cities towards sustainability (Lehmann, 2010a). This concept has now been developed further into the zero waste city model, which I outline in this chapter.

Urbanism is the academic discipline concerned with understanding the spatial organisation and dynamics of urban areas and with comparing, analysing, evaluating and inventing new ways to maintain the balance between public and private, the built and the un-built, and local and global perspectives. 'Green urbanism' is the holistic concept of urban systems that exist and change (grow or shrink) without impacting negatively on the ecosystem. Green urbanism is a particular form of urbanism concerned with a healthy balance between the city and its surrounding hinterland. It underpins practical action to shape the urban environment in a sustainable way. 'Zero waste city' takes the concept further and optimises all urban material flows towards 100 per cent resource recovery.

Waste is the material that leaves the human system for final discharge into the environment or landfills; it can be understood as 'a misallocated resource' (Lehmann, 2010b). Zero waste has become a worldwide movement; it considers the entire life cycle of products

and buildings, and the need to change industrial and societal systems and construction processes. It means that 100 per cent of waste is diverted from landfill, and all products, buildings and cities have been designed so that all resources can be recovered (and organic waste composted) without impacting negatively on the ecosystem. Today, raw materials are extracted and processed at an accelerated speed, and substances not directly useful to a factory become unwanted waste, polluting the air, rivers, landscape and soil. The alternative 'cradle-to-cradle' system seeks to build integrated, closed-loop systems, in which the by-products of one factory become the feedstock of another, so that there is no waste. Just as in the natural world, where one organism's 'waste' is another organism's opportunity (in a symbiotic relationship), the goal is zero waste.

Urban metabolism is a term used to describe and analyse the flows of materials and energy within cities. Abel Wolman first used it as an exploration and comparison modelling tool in his research 'The metabolism of cities' (Pomázi and Szabó, 2008). Urban metabolism may be defined as 'the sum total of the technical and socio-economic processes that occur in cities, resulting in growth, production of energy, and elimination of waste' (Kennedy et al. 2008, p. 45).

Cities are complex systems under stress. Clearly, the current development paradigm in most of the world's cities, based on ever-increasing consumption of resources, is unsustainable, and humanity has to find a new paradigm of urban development. In this chapter I will explore some linkages between material consumption, urban development and possibilities for resource recovery. I will suggest that zero waste principles can apply to both industrialising Asian cities and existing developed cities such as those in Australia.

There cannot be a unified definition of waste as each city has different circumstances and waste streams, and needs to identify its particular waste management solutions. Climate change is closely connected to waste production in cities, and the strategies I suggest in this chapter tackle both issues.

Reduce, Re-Use, Repair, Recycle: The Concept of ZeroWasteCities

To calculate the ecological footprint of a city we need to consider people's behaviour, lifestyles and values, policies and legal frameworks, the future of waste reduction, and resource recovery in households and urban settings. In *The principles of green urbanism* (Lehmann, 2010a) I defined the triple-zero framework for sustainable urban development as:

- zero fossil-fuel energy use;
- zero waste; and
- zero emissions.

Zero waste is an essential part of a holistic design framework that increases a city's capacity to absorb change (for instance, from climate change). Sustainable urban development towards zero waste includes three high-level, information-rich principles:

- increasing resilience;
- strengthening the interconnectivity of all systems and networks; and
- identifying particular localised solutions (shaped by the climate, context, site, etc.).

Wasteful consumption is defined as the purchase of goods or services that are not used at all, or are not used to their full potential, resulting in increased waste. Across the industrialised world, food and energy are the most common instances of wasteful consumption (for instance, in Australia over 40 per cent of food is not eaten; it is thrown out: Sharp et al., 2011). Over a third of energy used in Australia could be saved if we were more efficient. The concept of zero waste includes higher recycling rates (above 80 per cent) combined with legislation prohibiting all landfill and incineration, and advanced waste treatment so that resources incorporated in waste are fully recovered and looping material cycles are closed (Grosse, 2010; Lehmann, 2010b). Waste incineration produces toxic ash and air pollution, and burns the material resources (instead of recovering them), so should be minimised or avoided.

Zero waste cities require transition strategies for change in the construction sector as well as in consumers' behaviour. Implementing material efficiency in the construction sector requires a change in how materials are approached throughout the supply chain. The appropriate selection and use of materials for construction has a significant ecological and financial impact on the construction industry: Santamouris (2001) estimates that each year over three billion tons of raw materials are used worldwide to produce construction materials, which represents almost 40 per cent of the total flow into the global economy, while the building sector is responsible for 50 per cent of material resources taken from nature. Research by Harland (1993) and Tucker and Treloar (1994) has shown that a high proportion of this material is wasted during the construction phase. Harland has calculated that about 20 per cent of the total material is wasted as a result of damage or off-cutting at the installation stage, spoilage during transport or storage, and inaccuracies in ordering and specifying. Tucker and Treloar calculated that the embodied energy of construction materials in Australia accounts for 19.5 per cent of total energy use, meaning that a huge amount of energy that went into these construction materials is wasted, sitting in landfill. Using less material by increasing material efficiency and using de-constructible (reversible) joint systems for easy re-use of entire construction components are promising strategies to achieve significant material, and hence emissions, savings in the construction industry.

The terms 'reduce, re-use, repair, recycle' describe a waste hierarchy that gives the highest priority to the most efficient strategy of minimisation: avoiding waste and material efficiency come first, followed by direct re-use and repair. This value system from waste management can be transferred into architecture and construction, reassessing the value of existing buildings: retrofitting and adaptive re-use of existing structures is seen as 'material re-use', where the smallest intervention with the least demolition and use of energy is the most sustainable process. It is no surprise that dealing with existing buildings and their embodied energy has become the most important task facing architects and planners in European cities today. For instance, the conversion, refurbishment and adaptive re-use of postwar projects on a vast scale demands a complete revaluation not only of the structures themselves but also the social and historical implications of their contained resources (materials, energy, water, CO_2, etc.). The same logic can be applied in setting up a new value

system to address not only existing structures, but also the way we design, construct, operate and maintain new buildings and cities (see Figure 1).

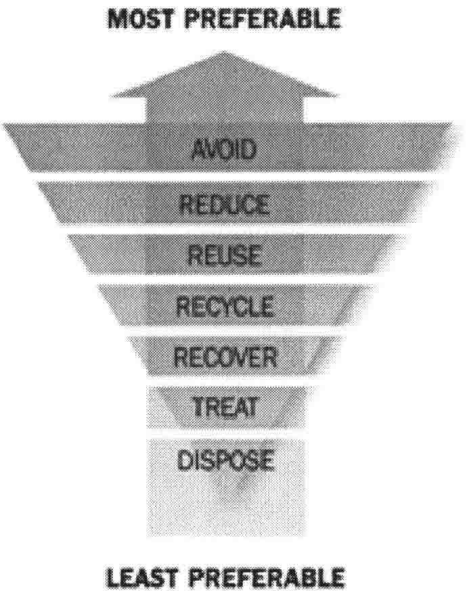


Figure 1. The waste hierarchy, which gives the highest priority to waste avoidance ('avoid/reduce') and to adaptive re-use ('re-use/repair'), can be transferred into urban planning and architecture. Principles of design for recycling and design for disassembly are the outcome. (Diagram: the author, 2006).

WHY THE CONCEPT OF THE ZERO WASTE CITY IS IMPORTANT?

While there have been major changes to the way society manages waste streams in the last two decades and recycling rates have increased, we are still generating more waste per person each year (EPHC and DEWHA, 2010). Zero waste is therefore a timely and necessary goal. Materials and resources are being depleted at an accelerating speed, and rising consumption trends across the globe have placed material efficiency, waste avoidance and recycling at the centre of many governments' policy agendas. Resource recovery and the optimisation of material flows can only be achieved alongside and through behaviour change to reduce both the creation of material waste and wasteful consumption.

Humanity has borrowed from the planet for a long time, exceeding the planet's carrying capacity; if our societies and the global economy are not transformed, we risk further depletion of virgin materials and even descent into unhealthy urban conditions (Meadows et al., 1972; Callenbach, 1975; Von Weizaecker, Lovins and Lovins, 1997). Unfortunately, our current model of economic and urban growth is driving this unhealthy system, and, as a consequence, we have now passed the limits of our planet's capacity to support us (Wackernagel and Rees, 1996; Brown, 2009; Lovelock, 2009). If we continue on our current trajectory of population growth and increasing resource consumption, then there will be an even greater disparity in resource availability between rich and poor. Over the last 20 years, for example, the amount of waste Australians produce has more than doubled, and it is likely that it will double again between 2011 and 2020 because the amount of waste generated in

Australia grows by around 6 to 7 per cent per annum, becoming unmanageable. Only around 52 per cent of all waste in Australia is currently recycled and 48 per cent becomes landfill (EPHC and DEWHA, 2010). The situation in Chinese cities is now becoming similar as they are using the industrialised world's model of high consumption to drive their GDP growth (McKinsey and Company, 2009).

In *State of the world 2010: transforming cultures from consumerism to sustainability*, the Worldwatch Institute (2010) lists many of the environmental and social problems we face today as symptoms of a deeper systemic failing – a dominant cultural paradigm that encourages living in ways that are often directly counter to the realities of our planet's finite resources. Consumerism has spread around the world and 'hyper-consumerism' (an extreme form of over-consumption) has led to ever more unsustainable consumption levels. The institute's report states that if this pattern spreads further, to rapidly developing and urbanising societies in China, Vietnam and India, there will be little possibility of solving climate change or any of the other environmental problems that are poised to disrupt human civilisation. The Worldwatch Institute's program director, Eric Assadourian, notes: 'It will take a sustained, long-term effort to redirect the traditions, social movements and institutions that shape consumer cultures towards becoming cultures of sustainability' (Worldwatch Institute, 2010, p. 34).

We are recycling more waste per person, but we are also producing more waste. Increasing consumption is not always visible because 'The increase in recycling and the reduction of waste sent to landfill can hide our increased levels of consumption and waste generation' (Zero Waste SA, 2010). Recycling is a very important part of waste management, but it is far better to avoid waste creation, reduce resource and material usage, and re-use components and materials for remanufacturing. Far too much toxic e-waste still ends up in our soil and rivers, potentially polluting our drinking water, soil and air; and organic waste ends up in landfill, emitting methane (EPHC and DEWHA, 2010).

In 1974 Californian environmentalist Paul Palmer coined the notion of 'zero waste'; and in 1996 the German philosopher and urban planner Karl Ganser came up with the concept of 'change and prosperity without growth', something still unimaginable today for most politicians and economists (Hannemann, 2000). But so far, hyper-consumption continues. Passing sustainable limits has consequences, as we see in increasing global warming and changing weather patterns, declining availability of natural resources, loss of biodiversity and increased desertification. Things have to change.

We must make every effort to future-proof the built environment by designing and building more resilience into urban systems. By doing so, we will learn from nature's complex ecosystems and natural ordering principles (i.e. nature knows no waste); redefining our industrial ecology to change the way we produce, manufacture, package, transport, and re-use products and materials. We are involved in a green revolution, which has already started to transform our society, economy, energy and transport systems, waste management systems, and our design of more modular products and buildings, which can be more easily disassembled at their end of life and re-used. New strategies for reorganising the urban landscape are emerging, and the logical next step is to go further and rethink industrial systems, production processes and construction methods.

Waste recycling alone is insufficient. Sustainable consumption, waste avoidance and resource recovery are needed to allow material wellbeing as well as environmental quality (UN-Habitat, 2008; Grosse, 2010). Changes at the cultural and behavioural level – beyond the

usual emphasis on technology and efficiency – should help develop less materialistic values to support people's lifestyles without reducing our living standards.

Transformative Change at the Systemic Level Towards Sustainable Consumption: From Consumers to Citizens

Over the last two decades, a transformation has taken place, as hundreds of millions of people move from a rural existence to an urban and increasingly globalised one, causing a fast rise in consumption. This transformation combined with the growth of the global population, forecast to reach 9 billion by 2050, has led to an increasing scarcity of some natural resources and escalating global warming. Today, humanity's ecological footprint is in ecological overshoot: it is 50 per cent greater than earth's capacity to support it, and is predicted to rise by a further third by 2030.

How can sustainable consumption be achieved? A rethinking of the idea of seemingly 'endless growth' began in 1972 with the Club of Rome's report *The limits to growth* (Meadows et al., 1972), which emphasised the creation of value and well-being rather than urban development and lifestyle. Now, transformative, systemic change is needed to shift the global population from consumers to citizens who are fully aware of their choices and their ability to contribute to a less consumptive future. The theoretical concept of *decoupling* consumption and GDP growth (with material throughputs as the sole measures of economic progress) from the use of natural resources and its broader environmental impacts has been understood for some time; however, its real implementation has proved difficult and too slow (see Figure 2).

The question is: will we be able to *decouple* fast enough the rising levels of affluence and lifestyle consumption from the waste of materials and products? It is well documented that higher levels of extraction, processing and use of materials has led to increasing levels of environmental degradation. Yet, the pace of environmental change has been too slow to keep up with growing consumption levels and to curb the escalating use of natural resources and rising tide of environmental degradation, which we are now facing. Some businesses and industries have already moved to more resource-efficient production processes with whole life cycle approaches (including extended producer responsibility), improved transparency and more sustainable supply chain management (and sourcing decisions), but the transformation is still too slow and the increase in consumption levels in the developing world is too fast.

This is why it is time to accelerate and scale up sustainable consumption, including empowering consumers to become citizens and to change public policy. To achieve this, we need to change our approach to start catalysing the transformation needed. Values and behaviours are relatively hard to change, as they are often instilled in childhood, including through early education systems. Implementing sustainable consumption will require a shift in focus in the following areas:

- shifting from defining and analysing the case for 'sustainable consumption' to identifying and accelerating the sets of policies needed to drive the change that is required;

- moving beyond the discussion of why sustainability is important, towards identifying leverage points that will allow us to tip the global economy as a whole towards sustainable consumption (while eliminating the 'rebound effect');
- integrating the concept of sustainability into innovative business models and product design, creating new markets based on different models of value, identifying new ways to engage with consumers (e.g. providing incentives for environmentally preferable behaviour);
- influencing values and behaviour to reconsider what consumption means in a proactive way, starting a transition phase of reduced, decoupled consumption (e.g. using products and buildings for longer, producing more durable products: modularity, adaptability, durability);
- implementing public policy with incentives for sustainability that will help to transform the context of consumers' decision making;
- influencing industry and business to transform their practice and to improve investor accountability, measuring broader outcomes than pure financial shareholder return; and
- encouraging a new generation of products and buildings that are made for resource recovery: designing for modularity and disassembly, re-use and zero waste, closing recycling loops, using less material to deliver the same products or services.

In *Designing for zero waste. Consumption, technologies and the built environment* (Lehmann and Crocker, 2012, Introduction), I discussed the need to fundamentally change the way we consume, by designing for human experience rather than acquisition. This is about re-conceptualising the consumer as citizen. Usually, after our fundamental needs have been met, the acquisition of more 'stuff' is unlikely to make us more satisfied or happy; ownership often brings more concern than happiness (hence the popularity of car-sharing services that do not require ownership). 'Consumption' has been described as a fundamental human cultural expression with a short time horizon, serving many goals or aspirations, whether for status, wealth, celebration or success (e.g. when the choice of a particular chosen product is visible to others). Yet, if the trend of growing consumption continues without any fundamental change in the way we consume, we face a very challenging future (McKenzie-Mohr and Smith, 1999; Cooper, 2010; UN-Habitat, 2010).

The greatest potential lies therefore in the ability to transcend existing paradigms and to influence the values and consumption patterns of citizens, motivating a change in behaviour. Today, consumers have emerged as the key shapers of the global economy through their product choices, consumption patterns and engagement as members of communities. Setting social norms for sustainability and recognising the influence of context on decision making could offer a new way of unlocking transparent citizen engagement to reduce consumption.

Helpful strategies will include enforcing new environmental standards (regulations), and using public awareness campaigns to support environmentally friendly behaviour. Such campaigns have now become increasingly commonplace and can be highly successful. For instance, the amount of total waste recycled in the US increased by 24.4 per cent from 1995 to 2000 after the launch of a public awareness campaign, proposed by the NGO Environmental Defence (see www.adcouncil.org).

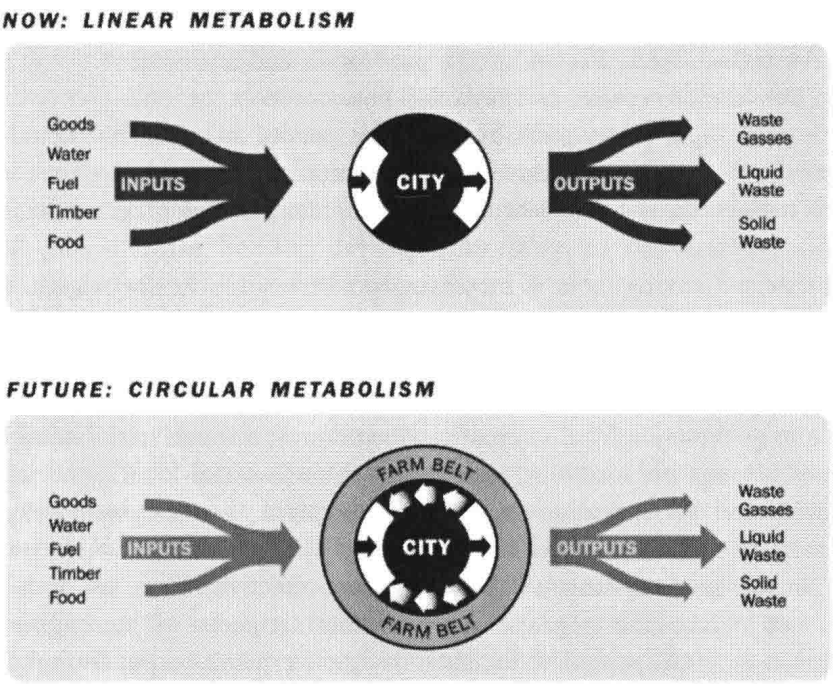


Figure 2. The city of tomorrow has to be transformed from unsustainable linear throughput of materials to a closed-loop circular metabolism, where materials, energy, water, food and other resources are fully recovered, continuously circulating for material gains and greenhouse gas reductions. The sd+b Centre is researching the transformation of existing cities from the neighbourhood scale to new models of low-carbon cities (diagram: the author).

Cities as the Solution: Urban Form, Inefficient Suburbs and Localised Waste Management Responses

The cities with the largest ecological footprints have a sprawling urban form, requiring vast tracts of land, high car dependency and massive energy consumption to maintain them. Living in distant suburbs far from workplaces is costly for residents, takes a health toll in daily traffic congestion, is inefficient for infrastructure provision, and eats up too much space and precious farmland. Investigations by my research centre suggest that suburbs often end up becoming social wastelands, where people are disconnected from neighbours and television becomes a substitute for personal interaction. Politicians should prioritise finding solutions to urban sprawl, and one important part of any program must be to revitalise their city's centre, while the existing suburbs will need to be transformed to more dense and mixed-use sub-centres.

Compact, mixed-use, transit-served infill development is proven to be much more sustainable and more likely to deliver social contacts. In fact, Australian cities are now witnessing more and more people moving from the suburbs to the centre (Mees, 2010). We know that the sprawling model of American urbanisation – which led to high car dependency, inefficiency and consumption of precious agricultural land – is not sustainable. Asian cities with higher densities, such as Singapore, Seoul and Hong Kong, can teach us about the