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The Sustainable City —Challenge for the 21st Century

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Climate will be decided in the cities!

This is the key message of the State of the World 2007 report, recently published by the World Watch Institute based in Washington, D.C.¹ The message came as a surprise to the majority of architects, urban planners and experts on climate change. However, what was particularly surprising is that the proclamation was issued not by a "green" research organisation, but by one of the world's leading institutes for future science. The report concludes that modern cities and settlement structures are one of the central causes of global warming, climate change, and the exponential increase of man-made environmental disasters, as well as of attendant and equally grave social problems, most especially within developing nations.

The message itself is not new. Indeed, it was a central theme of the new field of urban ecology in the 1970s and 1980s. The author was one of the pioneers of this new research field.² However, these research findings were largely neglected for decades. Only in recent years has a change been underway.

The international consensus among scientists is that a sustainable future will be possible only if global warming does not exceed two degrees by the end of this century. This target has now gained widespread acceptance within the sphere of national and international politics.³ Operating under the premise that all humans have an equal right to make use of environmental resources and generate carbon dioxide emissions, this would mean that industrialised nations like Germany and Japan would be required to reduce carbon dioxide emissions and fossil fuel consumption by a factor of 10 by the mid-21st century.⁴ However, carbon dioxide emissions are only one reason for climate change. The situation is even more critical if we consider that carbon dioxide is only the tip of the iceberg.

Why the cities?

Modern societies are becoming increasingly urbanised. It is projected that more than eighty percent of the world's population will live in cities, urban agglomerations and mega-cities by mid-century. Indeed, more than eighty percent of the global flow of materials is already today directed toward cities. However, the increasing global urbanisation process is in itself not the sole cause of global warming and other environmental crises. Rather, this outcome is the result of the specific manner in which the urbanisation process has taken place.

Key to this modern process of urbanisation is the fateful rejection of the principles of the sustainable *cyclic household economy* that characterised most pre-industrial societies for thousands of years. In its place arose a new exploitation and exchange economy that paid little heed to ecological consequences, and ultimately resulted in paradigmatic change within urban and settlement structures. The largely cyclically-organised supply and disposal systems of pre-industrial cities were replaced by increasingly open and lin-

ear urban systems and new industrial "end-of-pipe" technologies. Systems that provided solar and renewable energy were replaced by the fossil economy. Modern urbanisation was also combined with increasing consumption of ecologically valuable land, resulting in damage to the natural and sustainable water balance and natural cooling systems. Cities became heat islands, which damaged the functions of natural climate balance essential to sustainable urban development.

Modern urbanism led to a permanent increase of irreversible matter loss, which required compensation via increasing dependence on imports and other inefficiencies. Cities and urban agglomerations have become aggregates in which valuable resources are transformed into hazardous wastes, climate-endangering gases, and environmental contaminants. It is beyond question that there is no future for this form of urbanism. The side effects



- Cities are the built form, the materialised copy of the relationship between society and nature.
- In dependence of the specific kind of this relationship and its physical and structural materialisation in urban and spatial structures societies can be sustainable or not sustainable.
- Modern cities have turned out as being not sustainable, they are one of the main causes of climate change and other man-made environmental dead alleys.
- To create sustainable cities is one of key challenges for the 21st century.

Figure 1

¹World Watch Institute, *State of the World 2007* (New York & London, 2007).

²E. Hahn, "Siedlungsökologie" (Frankfurt a.M., New York, 1982); E. Hahn "Ökologischer Stadtbau – Paradigmenwechsel in der Stadtentwicklung" (Berlin, 1986); E. Hahn "Ökologischer Stadtbau – konzeptionelle Grundlegung" (Frankfurt, 1992).

³IPCC Report, 2007.

⁴F. Schmidt-Bleek, *Das MIPS-Konzept* (Munich, 1998).

and consequences of modern urban development have created problems and risks of previously unknown magnitude and dimension. An ecological and social development has taken root in modern cities and mega-cities that increasingly is destroying the basis of existence of both current and future generations.

Cities are the material form of the human-nature relationship (figure 1)

These issues are only symptoms of the problem. To develop concepts and plans of action towards a sustainable post-modern urbanism and society, we first require a deeper understanding of how these environmental calamities came about. To arrive at this understanding, we must first realise that cities are the immediate expression of the human-nature relationship within a specific social era. Urban and settlement structures are the material form and the built map of this relationship. The human-nature relationship thus includes the level of development of productive forces for the appropriation of natural resources, urban supply and disposal systems, and the lifestyles and social structures realised within them. The human-nature relationship also encompasses the materialisation of a society's value system both generally and with respect to nature and the environment.

Moreover, we must realise that the materialisation of the human-nature relationship within the built environment, particularly in cities and settlement structures, holds the key to the developmental sustainability of a society. Examples of both sustainable and unsustainable relationships exist within human history. The majority of societies with unsustainable human-nature relationships have vanished or declined, leaving behind deserts and profoundly ruined landscapes. Examples include the early urban cultures of South America, Persia, Mesopotamia, and urban cultures which arouse around the historic Silk Road. Many other pre-industrial urban cultures survived, often becoming the leading impetus behind the evolutionary process of social and cultural development and change.

Human ethology – biology of human behaviour

“A problem well-stated is a problem half-solved.” (John Dewey)

The science of human ethology, or the biology of human behaviour⁵, provides valuable insight on the relationship between modern climate change and other ecological crises and their social causes and origins. One of the core findings of human ethology is that particular behavioural patterns have emerged over the course of millions of years of human evolutionary progress within the natural environment. These behavioural constants are substantially resistant to change and adapt only slowly over long periods. They have a potentially decisive effect on the sustainability of social processes.

These behavioural constants may be assigned to three different categories. The first category is largely neutral with respect to sustainability, and includes the instinct for play, curiosity, and for discovery; the desire to explore the unknown; the desire to master the world; and the search for a better world. The second category is characterized by a high potential for conflict, and includes exploitative behaviour and the focus on short-term goals; selective perception; a tendency toward the overuse of common resources; and the desire to overcome dependence on nature and the environment. The third category tends to promote sustainable development and has a stabilizing effect: the desire for security, the preservation of the human species; the desire for contact with nature; pleasure in the experience of the elemental; a preference for water and transitional biotopes; the desire for the aesthetic and the symbolic and orientation; and the search for higher meaning and spirituality.

The manner in which a society physically and socially organizes its basic living conditions may serve to strengthen or weaken specific constellations of behavioural constants and thus influence the sustainability of social developments. A society's conditions and value systems may promote either the

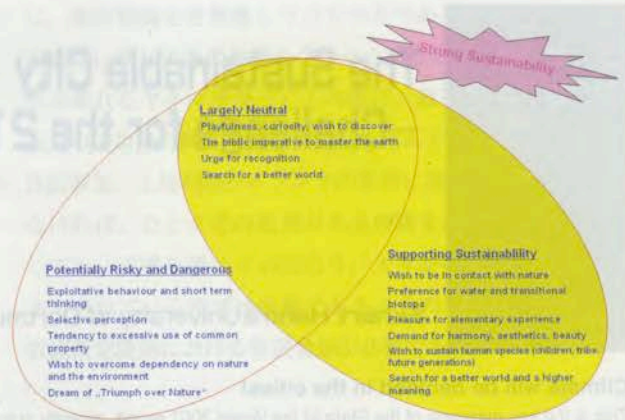


Figure 2

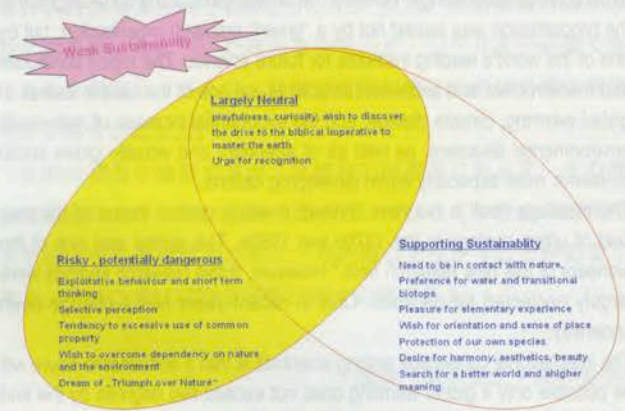


Figure 3

high-risk category of behaviour constants or the behavioural constants that promote sustainable development. The combination of categories one and two results in a high potential for dangerous and unsustainable development (figure 2), whereas the combination of categories one and three promotes sustainable development (figure 3).

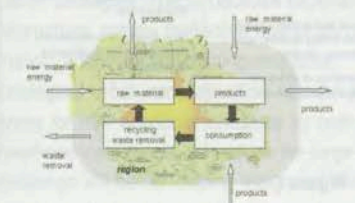
Pre-industrial cities (figure 4)

The earliest cities and urban cultures emerged with the Neolithic revolution approximately eight thousand years ago. None survive today. Some of these cities and urban cultures disappeared after only a few hundred years, while others survived several thousand years. However, there has been little systematic and comprehensive research on the reasons why these urban cultures disappeared. In addition to military conflict, there is substantial evidence that ignorance towards the principles of natural sustainability or lack of knowledge contributed to the disappearance of these early urban cultures. Over the long term, these cities and cultures were virtually doomed to fail. Natural sustainability was always crucial to sustainable urban development. Within the history of urban cultures, a number of basic planning principles for sustainable urban development have emerged that follow the laws of natural sustainability. These principles are the same as those which substantially influence the success of evolutionary development in nature as a whole. Some of the basic planning principles governing the sustainability of urban development include:

- independence from foreign energy imports, with energy needs instead being met by solar and renewable sources;
- successful conservation of limited material resources via short and efficient water, material and feeding cycles;

⁵1. Eibl-Eibesfeld, Die Biologie des menschlichen Verhaltens (Munich, 1995).

The preindustrial City



- Minimalization of material losses
- Minimalization of irreversible processes
- Improve system efficiencies
- Coming back to system couplings
- Reduction of foreign energy consumption
- Compensatory climatic functions

Sustainable constants of behaviour are embodied in

- in habits and lifestyles
- in religions
- in the Consciousness of the people

Figure 4

- reduction of pollution and emissions within the system in accordance with the load capacity of the local and regional ecosystem;
- successful preservation of natural cooling systems by efficient and integrated vegetation and water systems; and
- efficient supply and disposal systems designed to close matter cycles by minimizing irreversible matter losses.

A second category of essential planning principles may also be derived from an analysis of successful pre-industrial urban development. These principles are related to social issues, and help support sustainable behavioural constants while restricting unsustainable behavioural constants (figures 2 and 3). Successful pre-industrial urban development was thus characterised by a number of factors:

- First, technical urban systems were sensually experienceable by city dwellers in their daily life (versus black box technologies).
- City dwellers played an active role in running technical systems. (An example might be a sailboat, where the crew sets sail, plots the course, and makes decisions by carefully observing nature, a process not dissimilar to managing a household.)
- Successes and failures in the sustainability of technological systems and human behaviour were immediately and locally noticed via a direct relationship between cause and effect.
- A central design principle optimized efficient interaction between nature, humans and technology (for example, the traditional Japanese house).
- The urban grid and technological systems were designed in accordance with a human scale and employed short distances.
- Finally, the sustainable relationship between humans, nature, and the environment was conceived as a life-enhancing system, and formed an integral component of mental, cultural and spiritual life.

Within pre-industrial societies, a commitment to these principles did not rest upon a voluntary high moral or ethical standard, but rather upon a strong dependence on local and regional resources and natural conditions. When these principles were ignored, this generally resulted in immediate and serious consequences for the prosperity, welfare, and living conditions of urban inhabitants. The negative consequences led to significant restrictions upon the lifestyle, personal freedom and liberty of pre-industrial peoples. Thus, daily life entailed a constant monitoring and active engagement with nature.

Modern cities (figure 5)

Modern cities embody the polar opposite of these pre-industrial principles of urban development. Indeed, the industrial revolution marked a paradigmatic shift in the human-nature relationship. Modern cities tend to promote the conflict-laden behavioural constants within modern urban lifestyles. This profound shift is the expression of the emancipatory hopes of industrial society, in which dependence upon the dictates of nature was to be overcome by sci-

entific and technical means. With their fully air-conditioned buildings, extensive traffic systems, globally organized supply and disposal structures, and detachment from the natural regional context and cycles of regeneration, modern urban and settlement structures have become the symbol and the built reflection of the supposed triumph over nature. The once sustainable relationship between humans and nature, which was highly spiritual and marked by great respect, has been replaced by the belief that an apparently unlimited scientific and technological progress can be harnessed to solve nearly any problem. Humans no longer experience themselves as part of nature. Rather, they now regard themselves as above nature, or indeed even as its master.

The apparently unlimited access to globally scarce resources, made possible by scientific and technological progress, has proven itself only too seductive. Modern societies have increasingly discounted and ignored the laws of scarcity, their dependence on the regenerative cycles of nature, and the capacity of nature to absorb emissions. Scientific and technological progress also proved itself able to externalize negative impacts, displacing negative consequences from their location of origin. This new independence from nature was celebrated as one of the main advantages of urbanism and modernity. The more independent cities and urban lifestyles became vis-à-vis nature and local conditions, the more modern and attractive they appeared.

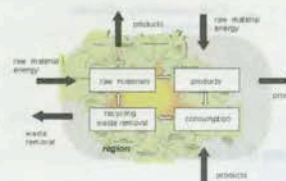
Paralleling the increasing separation of humans and nature, modern humans became desensitized to harmful innovation and negative development. Modern societies have lost sight of the reality that modern cities and urbanism are the most inefficient and destructive system to ever exist, a system that is one of the central causes of global warming, climate change, and an increase in man-made environmental disaster. Modern global and urban structures thus have become the key aggregate transforming valuable resources into hazardous waste, climate gases, and environmental contaminants.

The modern vision of the separation of humans from nature, as materialised within the built environment and modern cities in particular, has become a dead end. Indeed, one of the central proponents of modern risk assessment, Ulrich Beck, has argued that anyone who continues to speak of nature as something separate from the social (*Nichtgesellschaft*) remains mired in the categories of an earlier century, categories that no longer apply to our current reality.⁶ In the future, it will become impossible to conceive of nature apart from the social and the social as separate from nature.

An approach to sustainable post-industrial urbanism (figure 6)

The sustainable city of tomorrow will need to adhere to the age-old principles of sustainable development that also governed pre-industrial societies. However, these principles will need to be redefined to encompass the condi-

The modern City



- Constant increase of open urban systems and of foreign supply
- Multiplication of the irreversible net losses of the urban ecological systems (energy, water, materials)
- Ignoring respectively the destruction of vital climatic balance functions
- Connected with the climatic effective emission of various types of dust and gases
- Increasing dangers for water balance, vegetation and diversity of species

Figure 5

tions of advanced scientific and technological progress within modernity and emerging post-modernity. Within the framework of human ethology, this will entail the development of new urban structures as well as new planning concepts and technologies that promote sustainable behaviour constants and constrain risk-laden behavioural constants. The task will require the reestablishment of unity between nature and human society on an urban scale, and must be realisable and realistic for both small cities and for mega-cities across the globe.

Some of the fundamental technologies needed for sustainable urban and regional development are already partially available. Examples include solar, wind, and hydrogen energy technologies, new concepts for health-enhancing and ecological architecture, new concepts for ecological agriculture and forestry, and sustainable systems of cycle-oriented water and material management.

Globalisation will need to play a key role in this process. Globalisation offers a historically new potential for the rapid, cost-effective, and universally accessible distribution of information on sustainable concepts and technologies. This will enable advanced knowledge of sustainable technologies, methods, and instruments that will promote solutions adapted to local and regional conditions within a globalizing world. In Germany, for example, recent research results suggest by the year 2050, it could become feasible to achieve nearly eighty percent conversion to biogenic materials in the production of utility goods and to renewable energy, including wind, solar, and geothermic energy. The same results suggest that it could become feasible to achieve one-hundred percent conversion to ecological farming and forestry within that same timeframe.

Fields of action

Emerging from recent theoretical research and the findings of recent ecological restructuring pilot projects, we recently have seen the development of new fields of action and "building blocks" that attempt to mediate between the realities of sectoral planning, existing policy and administrative departments, and the need for integrated thought and action. Three fields of action have emerged as particularly important for integrated ecological urban restructuring: urban technology and urban design; grass-roots democracy and environmental communication; and urban economic and political administration (figure 7). The second and third fields of action suggest the importance of transformation of economic, social and political conditions. These transformations, in turn, will depend upon a new collective environmental consciousness and new environmental ethos.

The "building block" encompass new and established planning areas, policies, instruments and research proposals that are crucially important to eco-

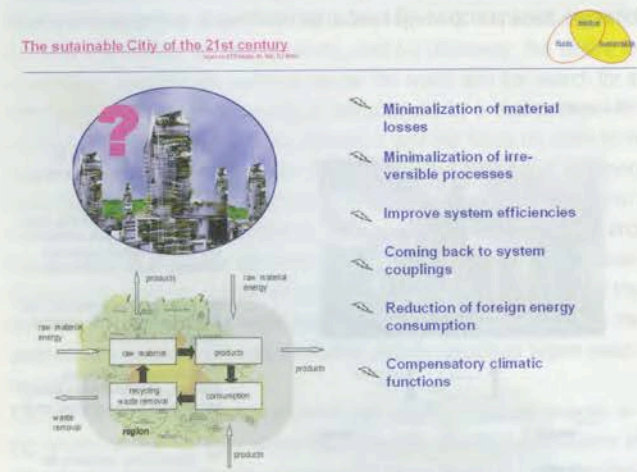


Figure 6

⁶U. Beck, Weltrisikogesellschaft, Frankfurt am Main 2007

Fields of Action / Building Bricks

Ecology (technique)	Social	Economy
Urban planning	„The first ecological law is participation and the inclusion of stakeholders...“	Economical transition economy and price systems
Architecture		Life-cycle- and true cost economy
Energy (heating, cooling, electricity, warmwater)	Participation concepts	Consumption-just billing
Water (freshwater, grey-water, stormwater, groundwater, surfacewater)	Ecological information, education and communication	Contracting systems
Soil, Soilmanagement	Social-ecological design	Resource- and emission tax
Climate	Integration of natural experience and ecology in daily life	Eco-technology, Eco-services, Eco-tourism
Mobility	Ecological behaviour stimuli (financial, living quality, user convenience, health)	New financial instruments (Bürgerfonds, Stattwerke Schönauf)
Area management		
Buildingmaterial	Consideration of different social and ethnic groups	
Material- und Wastemanagement		
Landscape, flora, fauna		
Indoor-climate		

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Figure 7

logical urban restructuring. Within these "building blocks", it becomes possible to identify the variety of individuals, organisations, and institutions that may develop into fruitful partners in a dialogue on a wide range of matters, including discussions on formulation of tasks, the implementation of strategy, the obstacles to successful realisation, and agreements on solutions. The term "building block" implies and illustrates that the function and potential of each building block only becomes effective in conjunction with other blocks. Thus the building block model is a framework that permits the recognition of suitable approaches for action within a specific project reality and within locally available possibilities and potentials.

Key levels of action

The main level where this important process will take place is the local and the regional level. This is where the conscious process of balancing economic activity with the ecological capacity of a specific region must be enacted. The hope is that this will initiate a lasting process of material and energetic sustainability that will strengthen regional identity and contribute toward sustainable urban and environmental development. To accomplish this goal, we must act on the most local level of the urban district and neighbourhood as well as on the peri-urban and urban level.

The urban district and neighbourhood

The urban district and neighbourhood is where people live and where their daily activities are most directly affected by growing environmental problems. The neighbourhood is where the causal relationship between an affected population and a problem can be most easily observed. It is here, also, where both apathy and "organised irresponsibility" can most fruitfully be comprehended and addressed. New ecological urban solutions must be developed within the concrete and comprehensible work and life circumstances of the neighbourhood and the district.

It will also become crucially necessary to reintegrate urban supply and waste removal systems as well as urban planning and structures in general, counteracting their current departmental isolation and reduction to technological and functional elementality. Neighbourhoods must also develop a new behavioural ethos based on emerging cooperative and participatory models to be enacted by locally affected individuals and groups.

Current discussions of urban ecology measures demonstrate that neighbourhoods are the most appropriate spatial and functional level in the city for the development and testing of new connections between old centralized and new decentralized urban systems. This is true for technological, political, social, and economic systems. Within the sphere of waste management, for example, this would entail the development of coordinated measures for waste reduction, collection of separated recyclables, toxic waste and other "refuse", and the collection and composting of organic waste.

A similar principle applies to coordinated measures to improve the quality of living environments and micro-climates; these could entail the creation of community gardens, neighbourhood parks and nurseries, re-clearing and planting soil, and roof and facade greening. Neighbourhood-level planning is also required to achieve decentralised water systems that incorporate rain-water, grey and ground water.

Although they have traditionally been oriented toward technological measures, the "building blocks" will also need to include environmental communication strategies. This is because experience has shown that technological alternatives remain ineffective unless accompanied by environmental information, education and training measures.

Ecological urban reconstruction has the potential to become a promising arena for new economic initiatives for both small- and medium scale neighbourhood operations, as well as for large entrepreneurial ventures. A key challenge will be developing integrated social, ecological, political and economic strategies on behalf of those neighbourhoods and cities most profoundly affected by social, employment and ecological crisis.

The urban and peri-urban level

As a rule, a region includes several municipalities and administrative districts, typically combining urban and rural elements. One of the first and paramount objectives of sustainable regional development is reducing the impact and flow of materials and environmental stress from outside the regional economic and social environment. A second objective is the reduction of material flow and environmental stress within the region.

Regions will need to play a key role in the conversion from industrial and chemical agriculture to ecological farming. This will include the development of local and regional processing facilities and the development of direct and regional marketing of locally and regionally produced foods. This will enable a substantial reduction in transportation and logistical costs, the reduction of chemical preservative use, and the reduction of pollutant and climate gas emission. At the same time, the regions will be supplied with fresher, more diverse, and healthier foods.

Conventional treatment plants entail the system-related loss of valuable nutrients, water and minerals. Sludge incineration and the discharge of valuable water and materials into the oceans via recipient watercourses result in the loss of valuable water and material resources. When these wastewaters cannot be locally recycled, a preferable alternative would be the discharge of nutrient-rich urban wastewater into managed wetlands in the urban environs. In the future, our supply of raw materials and energy will be increasingly derived from regenerative and regional sources, particularly from agriculture and forestry. In addition to food production, agriculture will need to generate basic biogenic materials like wood, sugar, cellulose, and lignin for construction and industry. These materials may be used to manufacture everyday and consumer goods, including packaging plastics and electronic and automotive components. According to current estimates, an efficient develop-

ment of regional wind and solar energy, geothermal and bioenergy could in many cases suffice to meet energy requirements over the short and even the medium term.

As is clearly apparent, these activities could provide an entirely new basis for the development of novel and sustainable regional economic structures, while at the same time serving to create new sectors of employment. Key in this respect will be the conscious shaping of exchange processes between the economy and the environment, based on the principles of ecological balance and current research knowledge of technological and economic viability and feasibility. A further result will be the reduction of imports to goods that are not available due to uneven geographic allocation. If this development and planning can be carried out in a timely and integrated fashion, coordinating these activities with an integrated concept of natural and landscape conservation will play a key role in the process of sustainable regional redefinition.

Finally, the need for action at the peri-urban and urban level also encompasses a series of continuing and related tasks. This includes both endogenous regional development, and making the achievements of specific regions more widely accessible. It will require a novel approach toward contents and methods, particularly within the raw materials and energy sectors, to enable the development and implementation of adequate indicators and strategies with a specific region. This will in turn promote a constant process of monitoring of ecologic space. This task will require horizontal networking among independent units, highly efficient organisation of substance-modifying processes, and the decentralization of decision-making. Ultimately these actions at the peri-urban and urban level should achieve the reduction of imports and export-oriented monocultures, the revitalization of bioregional diversity, and the promotion of self-regulation and control of environmental effects.

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