Sustainable Urban Development: A Conceptual Framework and Its Application

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THE term "sustainable city" was coined in 1990. Since then, international programs, projects, and forums on the topic have proliferated. Yet there is little agreement about what the term means for urban design or how to "translate" the term into actions.

The Earth Summit in Rio de Janeiro in 1992 placed the challenge of sustainable development at the core of global change and economic development. "Agenda 21," the international program of action established in Rio, contains suggestions about social and economic developments, the protection of fragile ecosystems, and the preservation of natural resources. It also stresses the need for all major groups of an affected area to participate in the planning for the implementation of any changes. Yet, despite these recommendations, international commissions, as well as national and local groups, continue to conceive of sustainability almost exclusively in terms of the protection of the natural environment and the preservation of non-renewable natural resources.

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Local "Agenda 21" projects in European cities, for instance, address primarily issues of energy saving and storage, waste handling, water and air pollution, urban space and transportation planning, and utilization. When social issues, such as questions of poverty, discrimination, and disintegration, enter the discussion of sustainable development, strategies to address these problems remain largely

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disconnected from questions of planning of urban space, resource management, and the protection and revitalization of ecosystems within the urban context. This, we suspect, is rooted partly in the difficulty researchers have in conceiving of cities as complex systems made up of intricate webs of interrelationships.

This might change. Recently, the European Community's Expert Group on the Urban Environment Sustainable Cities Project concluded: EC Expert Group

> There is increasing agreement about the content of a "green" (that is ecological) agenda for urban planning (e.g., support of public transportation systems, recycling and reduction of waste, energy saving measures, measures to improve water and air quality, integrated planning, etc.). The gap between public declarations and concepts on the one hand, and concrete measures taken on the other hand, remains large in most cities. What appears to be missing is "process know-how," that is, practical relevant knowledge pertaining to the following questions:
>
> - How can projects in different areas of intervention be integrated?
> - How can social problems be addressed in conjunction with issues of economic development and sustainable change?
> - How can successful partnerships and collaborations among the private, public and the non-profit sectors be designed and promoted?

In its report, the Expert Group argued for a variety of different, multi-disciplinary local experiments that are evaluated not only in terms of their outcomes and effects, but also in terms of their processes of implementation and collaboration.

The Zürich Sustainable Urban Development Research Project

Responding to this call, the Swiss Federal Institute of Technology and the city of Zürich funded a research project to address some of the questions posed by the EC Expert Group. The main goals of the project were: to link ecological sustainability to the psychological, social, economic, and cultural aspects of urban development and planning; to outline the preconditions, contexts, and processes that characterize successful partnerships among the public, private, and non-profit sectors; and to link planning theory with planning practice. One of the project's unique features was the collaboration of the

research team with a task force consisting of representatives from nearly every department of the Zürich city government.

The research began by selecting six projects that were undertaken in Zürich within the last ten years. The projects selected were a mix of public, private, and non-profit sector initiatives; were successfully completed or were far enough along so that they could be evaluated; and were involved with issues of sustainable development. Also, each project chosen emphasized a different aspect of urban development (i.e., housing, neighborhood revitalization, energy consumption, emissions reduction, job creation, etc.).

Urban development and other changes in a city are usually made to respond to some problem that requires action (e.g., air/water/soil pollution, traffic) in response to some articulated interests (economic development projects, etc.). Rarely are such endeavors undertaken solely to make a city more sustainable. Zürich is no different. In the case studies, we attempted to assess in what ways the goals and implementation processes of projects contributed to or detracted from sustainable developments. In this paper, we define sustainable development, explain the theoretical framework created to evaluate these projects, and recount the evaluation of one of the projects.

An Attempt to Define Sustainable Development

Using the declaration of the Rio Summit as the basis for an operational definition, we can say that sustainable development needs to address the interrelationship between three equally important dimensions: *economic* (the optimal utilization of all resources), *ecological* (the limit of the use of non-renewable resources), and *social* (the balance of the distribution of all resources). In this context, "resources" encompasses the sum of *natural capital* (natural resources, biodiversity, etc.), the sum of *reproducible (man-made) capital* (i.e., machines, the built environment, etc.) and the sum of *human capital* (individual and social qualities and competencies).

Cities are usually only perceived as physical structures. By contrast, we propose to view cities as multi-dimensional integrated systems that are composed of qualitatively different and semi-autonomous processes on the physical/chemical, biological, psychological, social, economic, and cultural levels. In this view, sustainable urban development encompasses the care for and continuing development of the psychological, social, and cultural systems of a city or urban region as well as for the physical systems. Assessing the degree to which urban development and change move toward sustainability or away from it, thus requires a framework that not only includes issues of

how interventions affect the preservation of natural resources (air, water, and soil), but also how they affect the population of the city, that is how they meet the needs of their inhabitants and help the functioning of the multitudes of social systems that make up city life.

Based on this perspective, developments are sustainable if:

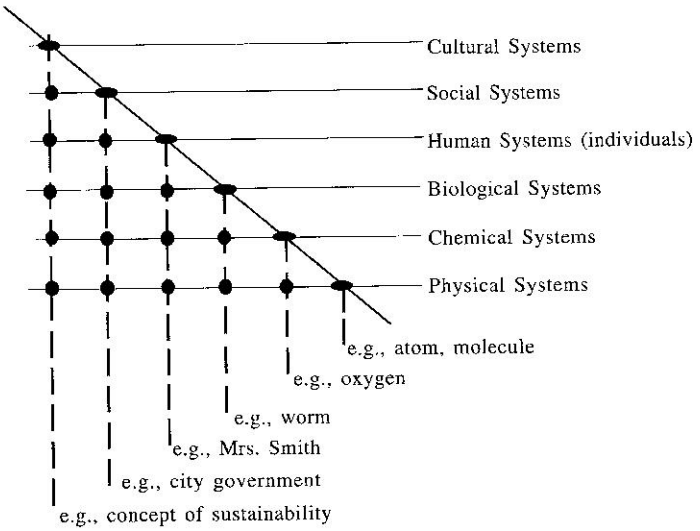
- they integrate the economic, the ecological, and the social dimensions of city life
- they appropriately take into account the specific characteristics of the affected systems (cultural, social, human, biological, chemical, and physical)
- they address human learning by including perceptual and behavioral changes.

A Conceptual Framework for Analysis

Theoretical Background

Most frameworks employed to address issues of sustainability include only the physical, chemical, and biological systems of a city. Our framework proposes to add to those the human (individual), social, and cultural systems. Each of these systems is characterized by different quantitative and qualitative properties. (See Figure 1.)

FIGURE 1
The Six Levels of Systems



The emergence of each of the higher systems is contingent upon the prior existence of the lower systems. In other words, each higher system also contains the preceding system. For example, individual human beings are also biological systems; social systems are composed of individuals, and the emergence of culture requires the existence of social systems.

Qualitative differences between different systems encompass both emergent, new characteristics as well as submerged characteristics of lower systems. For example, instinctive behavior is submerged in human beings (compared to other biological systems such as animals); social systems, though composed of human beings, lack a central nervous system and the quality of self-awareness. Table 1 shows some examples of important emergent and submerged characteristics.

TABLE 1
Emergent and Submerged Characteristics of Different Systems

Systems	*Emergent Characteristics*	*Submerged Characteristics*
Cultural	language systems philosophies science technology art religions norms/values	???
Social	Exchange relationships *1. Levels* individuals, households, communities, regions, nations *2. Functions* division of labor in households, communities, in the economy *3. Stratification* distribution, allocation, utilization of material and non-material resources *4. Territories* neighborhood community, city, country, etc.	ability to learn ability to sense/experience self-awareness central nervous system
Human (Individual)	self-awareness self-reflexivity thinking, feeling, acting motivations, goals, plans central nervous system	instinct
Biological	ability to learn ability to sense instinct DNA	unlimited duration
Chemical/Physical	unlimited duration molecules electro quarks	???

Source: Obrecht

The analytical framework we are here proposing defines no benchmarks for urban sustainability as do various indicators that have been devised by other researchers. Most of these indicators include targets or thresholds, referring to a defined, desirable state and measuring the progress toward it. Setting targets and benchmarks requires negotiation and cannot be prescribed by an analytical framework. Our framework, therefore, evaluates only the direction of change toward or away from desired states; it does not define benchmarks.

Questions to Assess Outcomes of Urban Developments

Because every urban development has some effect on one, or more often, several systems, our assessment questions are formulated in a general way, so they can be applied to any type of project. Following is an overview of the main questions that should be asked about any project of urban development.

Cultural System. In what ways does the project support or enhance the adherence to, or the promotion of, agreed-upon values and norms (national policies, international conventions, etc.)?

Social System. In what ways does the project sustain or improve the functioning of social systems and the development of social justice (within and between territories such as neighborhoods, communities, regions, nations)?

Human (individual) System. To what degree does the project sustain or enhance the satisfaction of basic human needs (biophysical, bio-psychological, and biosocial needs)?

Biological System. In what ways is the project environmentally sustainable? That is, how does it sustain and enhance bio-diversity and protection of natural habitats?

Chemical/Physical System. In what ways is the project environmentally sustainable? That is, how does it reduce emissions and the use of non-renewable natural resources?

These outcome-related questions can be used either to assess the potential impact of planned urban development projects or to evaluate the outcomes of completed projects.

Hypotheses to Guide the Evaluation of Urban Developments

In order to make urban development projects sustainable, there have to be changes in the systems we have listed. To make those changes, it is

necessary for interested parties to overcome traditional patterns of perception and to forge new alliances.

By studying successful projects, we hoped to identify the processes that led to success. Our research led us to propose a set of hypotheses drawn from a wide array of literature about individual learning and behavioral change, social systems change, and processes of innovation.

We grouped the hypotheses into those related to perceptual and behavioral change at the individual level, to change processes at the social systems level, and to urban planning design and implementation processes. These three areas obviously overlap, as urban planning processes occur within social systems, which, in turn, are made up of individuals. For analytical purposes, however, this categorization has proved useful. Following is an abbreviated list of our main hypotheses:

Promoting Behavioral and Perceptual Change on the Individual Level

Stimulation and challenge has to be in an area perceived as relevant to the interests of an individual.

Direct participation in the process of change supports learning and willingness to change.

Face-to-face contact along with perceptions and behavior of persons in one's own social network are more relevant than information transmitted via the media.

Key events or disasters can change perception and behavior, in particular if they are perceived as having an impact on one's everyday life.

Information about socially and ecologically sustainable behavior has to be translated from the "global" to the "local" level; the effects of one's own behavior have to be obvious and understandable in terms of cause-effect relationships.

Concrete examples (demonstration projects) have more "persuasion power" than books and lectures.

Sustainable behavior can be encouraged by creating incentives or imposing costs. Promoting change through creating positive incentives is preferable, as negatively perceived sanctions are likely to create resistance.

Socially and environmentally sustainable behavior is more likely to be adopted if it promises emotional benefits, that is, if it is connected with positive images. Appeals to reason have limited impact; stimulating positive emotions is more important.

The behavior of people viewed and accepted as role models supports individual change.

Promoting Change in Social Systems

The behavior of people in social systems to which individuals belong (family, neighborhood, workplace, etc.) needs to support changes made by an individual (reinforcement).

Change is more likely to be successful if it can be integrated into already ongoing developments by using the "judo principle" (directing existing forces towards the desired goals).

Bringing together motivated persons and groups supports successful change and the design and implementation of innovative projects (mutual reinforcement).

Innovations often start as small-scale pilot projects. Promotion and replication on a larger scale and in different contexts support the diffusion.

Ongoing process and outcome evaluation of successful projects helps identify key factors to success, thus supporting further (horizontal) diffusion.

Successful diffusion of innovation often includes the integration of the innovation at the level of legislation, policy guidelines, etc. (vertical diffusion). Interventions aimed at perceptual and behavioral change in social systems should include multi-level strategies: e.g., attractively designed and transmitted information, direct involvement of the persons affected (through action-oriented events, incentives, appeals to values, feedback about successes, etc.).

Change strategies, laws, and policies should address the sources of problems (rather than focus on damage control), that is, focus should be placed on where the biggest benefit/effect can be expected.

Promoting Sustainable Urban Planning/Design and Implementation

Conduct open planning processes.

Address different system levels (cultural, social, human/psychological, biological, physical/chemical).

Involve the collaboration of decision makers across different disciplines and areas of expertise.

Involve interest groups and individuals affected by the project as early as possible in the process.

Make goals, strategy, development, and decision-making processes "transparent."

Create an ongoing assessment of learning, information, communication, and interaction processes.

Involve a marketing strategy to communicate successes a) to give credit to the initiating, planning, and implementing groups and individuals, b) to promote the idea of sustainability, and c) to encourage diffusion and adoption by others.

Require new roles of planners and modify ways in which they operate. Planners should learn to become mediators between governments, markets, and citizens; they must view themselves as participants in a process of social learning and they must no longer view plans and organization structures as starting or end points, but now they should view them as static elements in a dynamic process.

Urban Brook Revitalization: An Application of the Framework

Background

The city of Zürich is surrounded by hills with numerous springs that form smaller or larger brooks flowing into the city. During the last 130 years of city development and construction, roughly 100 km of these previously open waters disappeared from the surface. Road construction, risk of flooding and pollution of these brooks prior to the construction of area-wide sewage treatment systems were the main reasons why these water flows were channeled into large underground pipes. As a result, the city's two water treatment plants historically had to deal with large amounts of "clean" runoff which increased operational costs and diminished the efficiency of the water treatment process.

Revisions of the Swiss water protection law in 1991 stipulated that clean runoff and unpolluted rainwater should seep directly into the ground or, where this is not possible, should be diverted into a drainage system separate from the pipes carrying the waste water. In 1985 a city engineer together with a city landscape architect took the initiative to develop the "brook concept" containing guidelines and recommendations for the opening or revitalization of 50 brooks on city grounds. The first project was realized in 1985. Since then, 34 brooks with a total length of 12 kilometers have been re-constructed.

The "brook concept," approved by the Zürich city government in 1988, aimed to achieve the following objectives: 1) to improve the recreational qualities of urban neighborhoods and thus make them more habitable and attractive, 2) to restore lost habitat for plants, insects and small animals, enhancing the relationship between city residents and their natural environment, and 3) to reduce the amount of "clean" water flowing through the waste water treatment plants and thus improve the quality and the efficiency of the treatment process.

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Evaluation

The following summary of results is based on the analysis of documents as well as on interviews with project initiators (city planners), external experts on urban design, representatives of different neighborhood groups as well as citizens involved in the implementation phase of a brook revitalization in one neighborhood. (See Figures 2a and 2b.)

FIGURE 2a
Zürich Neighborhood before the Brook Revitalization

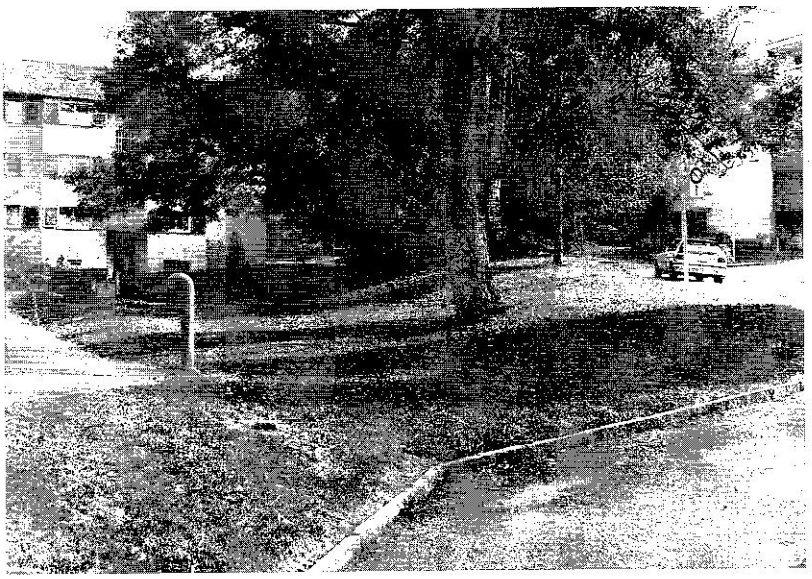
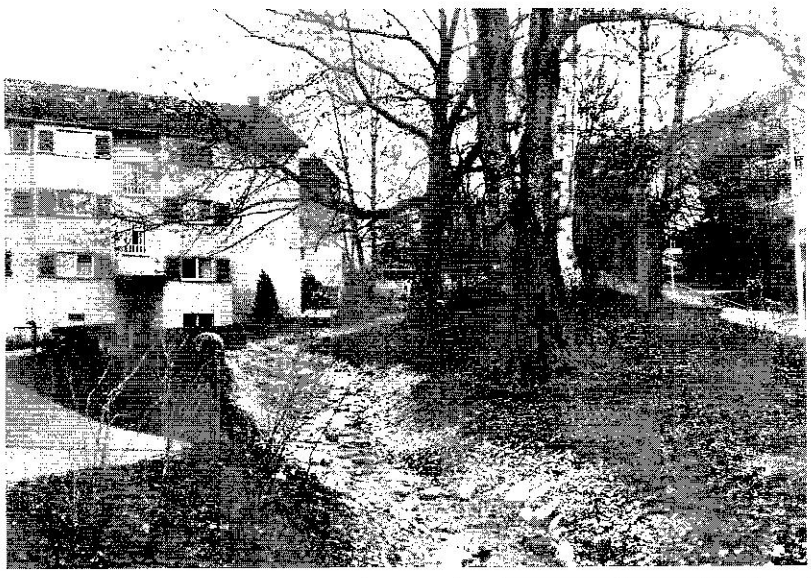


FIGURE 2b
Zürich Neighborhood after the Brook Revitalization



The goal of the case study was to assess the way in which project outcomes indicated developments moving toward or away from sustainability in the different systems affected, teasing out the important process aspects that led to the project's success.

Analysis of the Process: The project is an example of a very successful process of urban change and development. The planners/initiators successfully overcame resistance within their own and other departments of city government, preserved the quality of the original concept and allayed fears of neighborhood residents and property owners by convincing them of the value of revitalized brooks in their neighborhood.

Some of the ways they accomplished this are summarized below.

Overcame resistance in city government by:

- using the judo principle: i.e., using the planned revision of the water protection law (prescribing the separation of clean water runoffs) to argue for the brook revitalizations
- having a strong commitment to the original project and being able to work well together and complement each others' skills
- gaining the support of their superiors
- locating the project in a technical department of city government (water treatment), which supported arguing for the brooks on technical and cost-savings grounds
- forming the "brook group"—an interdepartmental task force that helped overcome resistance within the city administration
- enlisting support at the state level and involving other expert groups such as the nature protection commission.

Preserved the quality of the original concept by:

- developing the "brook concept" that contained specific guidelines for the planning and implementation of brook revitalization projects
- forming an interdisciplinary project group for each revitalization project (engineers, landscape architects, biologists, etc.).

Convinced the public by:

- holding meetings in neighborhoods early in the planning process in which planners showed three-dimensional models, and photo-reconstructions of what the open brook would look like
- using already-revitalized brooks as demonstration examples
- gaining support from informal neighborhood leaders to convince citizens
- negotiating with neighborhood groups and affected property owners to plan the details of the brook revitalization
- learning from and willingly compromising with citizens.

Analysis of the Outcome: Data analysis suggested that the brook revitalization projects led to sustainability-supporting effects in all systems with few measurable negative outcomes. It can thus be viewed as a successful contribution to urban development. Rather than specifying the sustainability relevant indicators for each system in advance, the data were analyzed according to the guiding questions already outlined. This allowed for the emergence of a more differentiated set of thematic outcome indicators for each system. (See Table 3.)

TABLE 3
Sustainability-Relevant Outcomes of Brook Revitalizations

Cultural Systems
–> reclamation/protection of the natural habitat for plants and animals
–> strengthening the relationship between humans and nature in urban neighborhoods
–> understanding for and care in dealing with nature
–> impetus for additional local initiatives to promote nature-enhancing neighborhood improvement projects
–> exemplary function/diffusion
–> restoring previously existing historical qualities to the urban life space
–> specific design characteristics of revitalized brooks and their surroundings

Social Systems
–> increased social interaction in the neighborhoods
–> citizen participation in the planning and implementation process
–>interdisciplinary cooperation across city government departments
–>involvement of all relevant groups affected by the projects
–>increased networking among neighborhood groups

Human (Individual) Systems
–>opportunities for regeneration in the immediate living environment (relaxation, recreation, feeling safe)
–>aesthetically pleasing shapes and sensory stimulation
–>sense of community and belonging
–> opportunities (for children) to play in, experiment with, and creatively use the immediate living environment

Biological Systems
–> increased diversity of plants and animals in urban neighborhoods
–> more linkages between natural habitats

Chemical/Physical Systems
–> energy savings in the waste water treatment process
–> reduction in the amount of sealed urban land
–> decreased need for various types of difficult-to-recycle construction materials
<– risk of flooding of urban neighborhoods in periods of heavy rain fall
•/<–risk of water pollution with toxic substances/chemicals

–> *Moving toward sustainability*
<– *Moving away from sustainability*
• *Inconclusive data*

Conclusions

Our experience indicates that our framework can, indeed, be used to examine whether urban projects support or hinder sustainable development. The framework can also identify the key aspects of successful planning and implementation processes. What it cannot do, and is not intended to accomplish, is set sustainability targets or measure exactly how sustainable a project is. It also cannot explain how to prioritize necessary interventions to make cities more sustainable, nor can it lessen the effects of overconsumption on cities and their environments. What the framework can do is provide a useful tool to experts in various fields, challenging them to overcome their "tunnel vision" and to consider, from a more encompassing, systemic perspective, the effects of the policies and interventions they promote. Creating sustainable cities, we believe, requires care for human, social, and cultural—as well as the natural—"environment."

Note

[1]The following case studies were selected:

- The revitalization of urban brooks (a city government initiative)
- Multiple measures to reduce/slow down car traffic in selected neighborhoods (a city government initiative)
- The revitalization of an urban neighborhood suffering from a concentration of drug dealing and drug use (a city government initiative in collaboration with neighborhood groups)
- A plan by the largest Swiss grocery chain to reduce CO_2 emissions by replacing truck deliveries of goods wherever possible by rail transportation (a private-sector initiative)
- A project by 18 large firms in Zürich to reduce their energy consumption by approximately 30 percent over a period of seven years (a private-sector initiative)
- The building of a housing complex, "Brahmshof," providing attractive and affordable housing for various groups (families, disabled persons, housing coop for adolescents) utilizing ecologically sound construction materials, preserving the natural environment, and providing neighborhood services (a private nonprofit initiative).

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