# Sustainability and Cities: a landscape planning approach

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## Introduction

According to the United Nations, the world's population has recently become predominantly urban, and the world's urban population is projected to double by 2050 (United Nations Habitat 2006). This paper discusses the issues, challenges and best practices that are being conceived and applied by landscape and urban planners to bring sustainability and to build resilience capacity in cities. Landscape planning provides working/operational methods to address complex built and green urban environments with diverse resources, land uses and competing social needs and values. The theories behind landscape planning, landscape urbanism and new initiatives on sustainability and resilience will be reviewed and illustrated with selected international applications to urban planning and design. The concept of ecosystem services is used as a metric to assess the specific abiotic, biotic and cultural functions and processes in urban environments in support of sustainability.

## Background/Literature Review

**Landscape ecology/planning:** Through the interdisciplinary field of landscape ecology new methods have been proposed to apply the knowledge generated from landscape ecology to planning and design (Musacchio, 2009; Ndubisi, 2002; Leitão and Ahern, 2002). The pattern and process principal from landscape ecology is particularly relevant to planning – articulating the fundamental causal relationships among landscape pattern, process and scale (Wu and Hobbs, 2002; Forman, 1995). The principal explains how flows of species, information, resources and energy are influenced by the spatial composition and configuration of the unbuilt and built environment of cities, and how urban planning and design, in turn, influence these urban landscape patterns and processes. By making the links explicit between spatial pattern and landscape process the pattern:process principal provides a key scientific basis for planning and designing urban form to provide ecosystem services under a resilient and sustainable model. The form and process principal applies particularly well to link urban spatial form and configuration with urban water resources and hydrological processes (Marsalek et al, 2008).

**Ecosystem Services:** The ecosystem services concept was developed as an integral part of the United Nation's Millennium Ecosystem Assessment (2005) to explicitly articulate the full complement of provisioning, regulatory and cultural services provided by ecosystems by which humankind meets its needs. Ecosystem services, broadly defined to include cultural services (Figure 1), are appropriate as goals for sustainability planning because they are explicit and can be quantitatively measured and analyzed in a transdisciplinary process.

| Abiotic Services | Biotic Services | Cultural/Landscape Services |
|---|---|---|
| Maintain hydrological regime(s) | Habitat and movement routes for generalist and specialist species | Opportunity for active and passive outdoor recreation |
| Accommodate disturbance and adaptive response | Support metapopulation dynamics in fragmented landscapes | Context for social interaction |
| Support nutrient cycling, buffering, sequestration | Bio-remediation of wastes and toxics | Stimulus for aesthetic expression |
| Protection from floods | Maintenance of disturbance and successional regimes | Opportunity for environmental education |
| Stabilizing climate fluctuations | Biomass and food production | Reduce human stress |
| Filtering and improving air quality | Reservoir of genetic diversity | Supports economic activity (e.g. tourism) |
| Waste processing, digestion | Support flora:fauna interactions | Access to quiet/solitude |

**Figure 1. Selected examples ecosystem services organized in abiotic, biotic and cultural categories (ABC Functions)**

**Sustainability and resilience:** Since the sustainability principal was globally adopted in the late 20$^{th}$ Century, theorists and planners increasingly appreciate the profound role that change, dynamics, and uncertainty play in sustainability. Sustainability is now understood as an "inherently moving target". This new understanding of environmental change and dynamics has led to the concept of resilience and it has significantly influenced the global discussion of sustainability.

The prevailing paradigm of the 20$^{th}$ Century was developed around an equilibrium conception of nature, landscape, biological and technological systems. Certainly many of the great technological achievements of the 20$^{th}$ Century support and benefited from this equilibrium conception of nature. Advances in scientific knowledge, medicine, technology and manufacturing supported a growing confidence that nature functions according to rules, or laws, and that by understanding these laws and rules, humans could manage or control nature and consequently would prosper and thrive. The motto of modernism was to design machines for living. The new paradigm of sustainability is to design living machines.

Under a non-equilibrium view, change and disturbance become accepted, even expected characteristics of the system or process being planned, in this case planning for urban sustainability. This raises the importance of resilience – the ability of a system to respond to change and disturbance without changing its state. Therefore, the real challenge for urban planning and design for sustainability and resilience is to plan for the infrequent, and the unexpected – while simultaneously planning for the routine, the familiar and the very real requirements and processes that define and operate 21st century cities (Pickett et al, 2004).

I propose a suite of 5 urban planning and design strategies for building urban resilience: multifunctionality, (bio)diversity, multi-scale networks, redundancy and modularization, and adaptive capacity (Figure 2). These strategies are intended to build resilience capacity to addresses the inherent uncertainty of cities. They also represent a somewhat radical rethinking about sustainability and change. The paradox of sustainability relates to the intrinsic need for stability and security while simultaneously accepting the existence and the need for change in all systems. To resolve, or confront the paradox of sustainability requires strategic thinking, which addresses the forces and drivers of change, and seeks opportunities to influence these forces proactively, rather than reactively responding to the inevitable unexpected "surprises" characteristic of any urban environment over time.

Resilience is defined as the ability of a system to experience disturbance and still retain its basic function and structure (Walker and Salt, 2006). Understanding resilience is central to understanding sustainability since sustainability addresses the need for a long-term, multi-generational view, and under a non-equilibrium view all systems will change in unpredictable ways, especially over the long-term. Resilience theory is at the frontier of contemporary urban planning and design – serving as a robust platform for shaping and articulating the regenerative work of landscape architects, planners and architects in volatile times.

| Strategies | Attributes/Characteristics | Examples |
|---|---|---|
| A) Practice Multi-functionality | Spatially efficient<br>Economically efficient<br>Builds a constituency of social/political support | Green Streets, Portland Oregon<br>Stormwater wetlands |
| B) Practice Redundancy and Modularization | Risk-spreading<br>Back-up functionality<br>Meta-systems<br>Decentralized, adaptable<br>Can "contain" disturbance<br>Flexibility, adaptability<br>Spatial segregation | Created wetlands in Green Wedges,<br>Green Infrastructure<br>Watersheds and "neighbor-sheds"<br>Greywater recycling systems |
| C) Promote (Bio)Diversity and heterogeneity | Differential response to disturbance, stress and opportunity<br>Bio-library of memory/knowledge<br>Complementarity of resource requirements | Urban bioreserves<br>Conventional, ecosystem-based, and hybrid functional types |
| D) Build and restore Networks and Connectivity | Meta-systems<br>Circuitry and redundancy, risk-spreading<br>Design for functions and flows | Bluebelt, Staten Island New York City<br>Ecological Networks |
| E) Build Adaptive Capacity | Actions as opportunities for experimentation and innovation<br>"Learn-by-doing", "Safe-to-fail" design experiments" | SEA Street, Seattle |

**Figure 2: Strategies, attributes/characteristics and examples for building urban resilience capacity.**

The proposed planning method proposed (Figure 3) addresses resilience explicitly – as a necessary condition of sustainability. The planning process begins by determining, or reviewing, ecosystem service goals, in the context of resilience factors – which are the trends and drivers of change. In planning to meet specific ecosystem service goals, resilience planning strategies are considered in the context of the public will, the economic climate, and existing urban conditions. Spatial concepts are used to design alternative scenarios to explore possible futures, including the means to their realization. With expert and stakeholder participation (transdisciplinarity), the scenarios are evaluated and ultimately revised or modified as an urban resilience sustainability plan. The plan is adaptively implemented, with monitoring of key indicators recommended to yield new knowledge and to continuously inform and (re)direct the planning process. While the method is shown as a linear process, in application it is cyclical, iterative, and may be entered or initiated at any point.

**A Transdisciplinary Method for Spatial Planning of Resilient - Sustainable Cities**

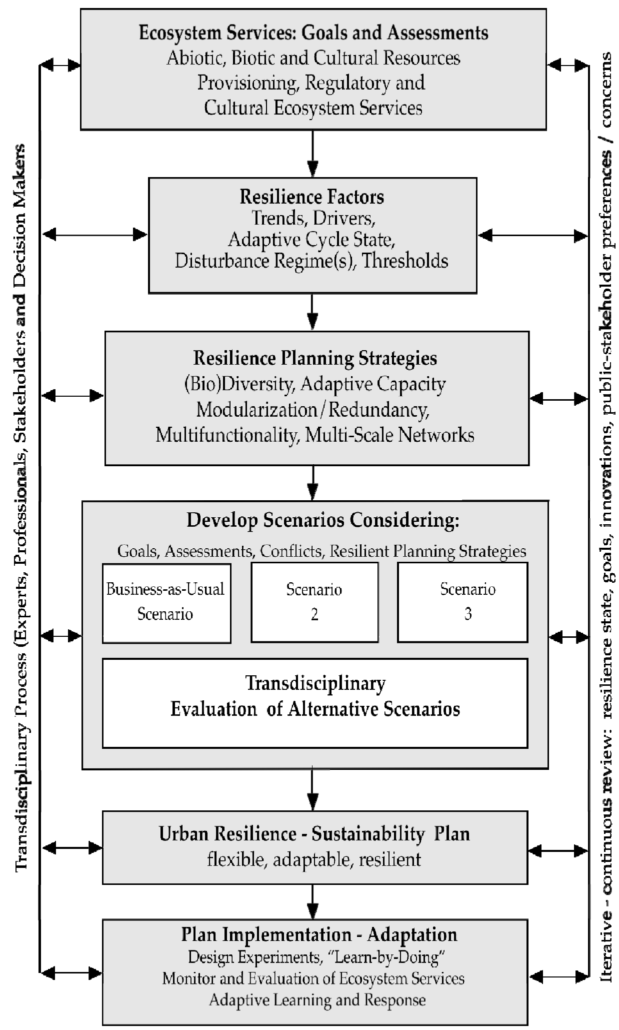


**Figure 3. Landscape/Urban Planning method for sustainability and resilience**

**Examples of Urban Sustainability and Resilience:** The Staten Island Bluebelt is an example of green infrastructure that provides multiple functions and ecosystem services in support of sustainability and to build resilience. Staten Island is the least populated borough of New York City and was the last part of New York city to provide storm and sanitary sewer service. Parts of Staten Island have a history of drainage problems and septic system failures due to low topographic relief, high water table and soils with low permeability. Staten Island also has the largest and last concentration of freshwater wetlands in New York City, a motivation for considering an alternative to an engineered stormwater system. Since 1997 New York City Department of Environmental Protection has been building an alternative stormwater management system that uses sewers to convey stormwater to detention areas employing created wetlands, settling ponds, and sand filters (NYCDEP, 2005). The effluent from this wetland treatment is discharged into natural wetlands and watercourses to provide conveyance, storage and filtration of stormwater. The overall system, known as the Staten Island Bluebelt services 11 watersheds with a drainage area of some 5000 hectares. The system was built at a cost savings of over $50 million in comparison with a conventional separated stormwater system – including the cost of land acquisition (Eisenman, 2005). The Bluebelt was planned to protect, salvage and maintain the native flora to sustain ecological and hydrological functions, making a significant contribution to local urban biodiversity.

The Bluebelt system has been proven to be effective to reduce peak stormwater flows, to increase groundwater recharge, and to remove contaminants from stormwater. Importantly, the bluebelt is recognized for providing additional functions including: recreation, wildlife habit, historic preservation, and neighborhood beautification. The Bluebelt has been integrated with public parks and trails in Staten Island. Anecdotal evidence shows that proximity to the Bluebelt adds to real estate property value. By providing functional ecosystems as well as urban drainage systems, the Bluebelt builds resilience capacity and contributes to the sustainability of multiple urban watersheds.

**Malmö, Sweden's Western Harbor** is an eco-city built on a former shipyard and industrial site on Malmö's waterfront. Malmö's shipbuilding industries suffered economically in the 1970's and were abandoned, leaving a contaminated post-industrial landscape. The Western Harbor is part of Malmö's strategic transition from an industrial to a knowledge-based service economy. The Western Harbor is planned for a total area of 160 ha, eventually to support 10,000 residents and 20,000 workers and students.

The goal of the Western Harbor project was to create a model ecologically-sustainable city, combining aesthetics, ecology and high technology as part of Malmo's Ekostaden program. It has 1000 housing units on 25 ha (40 units/ha). To prepare the contaminated site for development, 6000 $m^3$ of contaminated soil was removed for treatment and replaced with 2m of clean soil.

Western Harbor has a goal of renewable energy generation. The project's energy is provided 100% by locally-produced renewable energy including: 1400$m^2$ solar photovoltaic collectors, solar thermal panels, 2 megawatt wind turbines, and a geothermal heat system. Biogas is produced via collection of organic waste with a vacuum collection system and used to heat homes and power vehicles. Other waste is also collected, sorted and recycled or incinerated for energy to heat buildings. District heating supports heating and cooling distribution throughout the project. The project also uses an integrated electric grid to manage energy generation and use efficiently. Buildings are designed to minimize energy use through efficient insulation, and natural daylight.

The urban design of the Western Harbor neighborhood is modelled after the nearby medieval Swedish town of Lund with small interior streets and taller buildings on the waterfront to enclose the community space and block the very consistent and strong winds. The signature building of the project is renowned 45 story residential tower, the "Turning Torso" designed by Spanish architect Santiago Calatrava. To promote aesthetic diversity many architects were involved with building designs in the district.

The Western Harbor neighbourhood has an extensive sustainable urban drainage system including green roofs, open channels and swales, courtyard ponds, canals and a large stormwater pond. The drainage system is fully integrated with the neighborhood design at multiple scales – from community squares, blue-green open space canals and corridors to fine-scaled drainage details. Overall, the drainage system gives the project a distinct and attractive "sustainable design" identity. As part of the project's open space network, the drainage canals and corridors provide recreational opportunities and supports biodiversity with greenroofs and created wetlands.

Western Harbor employed a "Biotope Area Factor" (BAF) to ensure that the neighbourhood has a minimum amount of "green" associated with each building/ building block. This incentive-based tool has been used effectively to promote "greening" in Berlin Germany (Keely, 2007). The BAF requires a specific percentage of ecologically-effective land area that contributes to ecosystem functions by storing and infiltrating stormwater, and by creating wildlife habitat in all development parcels. Each plot needs to have a minimum green factor of 0.5. Developers have the choice of different "green" elements from a "menu" that can be combined in variable combinations to reach the minimum factor of 0.5 for the plot - for example: impervious surfaces rate 0.0, trees rate 0.4 and green roofs 0.8. The BAF also promotes wildlife habitat with native plantings and gardens.

Western Harbor is designed for sustainable transportation. All housing units are within 300m of a bus stop, with regular service. Public transportation will run on renewable biogas, generated, in part, from recycled organic waste from the district. Only 0.7 parking spaces per unit are provided. The center of the project is a pedestrian car-free zone – enhanced with well-designed promenades, bicycle paths, alleys, and squares.

The Western Harbor can be considered as a model of early $21^{st}$ Century sustainable urban living. The project is comprehensive in its commitment to sustainability in terms of: energy use, transportation, waste recycling, water (re)use and ecological integrity. The quality of the environment is evident in the design of buildings and landscape. The project clearly demonstrates the application of numerous resilience strategies and has succeeded in reaching its sustainability goals.

## Discussion and Conclusion

The urban planning and design disciplines are now engaged in a fundamental realignment of working methods, practices and goals to address the challenge for sustainability and resilience. This new planning and design paradigm accepts the 21st Century global urban demographic and the non-equilibrium view as axioms and prerequisites for urban sustainability. While recognizing that sustainability has multiple dimensions, or pillars - planners and designers address sustainability primarily through the spatial form of the built environment. And this focus on spatial form applied across a broad range of projects from the *de novo* urbanism of ecocities to the redesign and retrofitting of established neighborhoods and the re-conception of the structure and function of urban infrastructure. The new planning and design reality needs new methods and practices to address the profound challenges towards sustainable and resilient urbanism. The method proposed here, and the examples of the Staten Island Blue Belt and Malmo's Western harbor addresses these challenges through:

A focus on ecosystem services – articulating and specific abiotic, biotic and cultural functions and services that, in the aggregate, define sustainability.

A suite of planning and design strategies to build resilience (multifunctionality, modularization, (bio)diversity, networks, adaptive design).

An adaptive approach, in which planning and design actions are understood as "design experiments" to support "learning by doing" and promoting innovation.

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