Elissa Rosenberg
Associate Professor, Faculty of Architecture and Town Planning,
Technion – Israel Institute of Technology
Technion City, Haifa, Israel 32000
elissabrosenberg@gmail.com

ABSTRACT

Public open spaces have taken on an increasingly complex role in the city. In addition to their social role as the site of urban public life, they are now considered part of the city's "green infrastructure," expected to provide a broad array of ecosystem services such as microclimate regulation, air pollution and noise reduction and water management (Bolund and Hunhammar, 1999). Additional goals include adaptation to climate change and linking natural areas to counter fragmentation and preserve biodiversity (Sylwester 2009). This approach to the planning and design of public open space (POS) has been adopted as urban policy by many cities, often within a suite of related policies. Some of the most prominent examples of green infrastructure guidance include New York City Department of Parks and Recreation's "High Performance Landscape Guidelines 21st Century Parks," (2010) and London's "All London Green Grid" (2011), a follow-up to the "East London Green Grid" (2008).

Green infrastructure is based on the goals of "protecting, restoring and interconnecting the city's ecological structure" (Girling 2005). The GI approach has three defining characteristics. First, the systems approach implicit in the concept of infrastructure stresses the interconnectedness of open spaces to achieve ecological functionality (Benedict and McMahon, 2006). Second, the emphasis on performance suggests that POS must be multifunctional rather than single-purpose, and third, they must be planned to function as a network at multiple, nested scales-- from the region to the neighborhood.

How do these characteristics of spatial distribution, multifunctionality and scale change the conception of POS and suggest new typologies of open space—introducing new forms, configurations and uses? This paper will focus on the relationship of sustainable urban water management (stormwater management, flood control, water supply and waste) to POS in the city.

Keywords: green infrastructure, sustainable water management, water sensitive design, public open space

Introduction: Infrastructure and Public Open Space

In 1904 the Olmsted Brothers produced a new park plan for Baltimore. Their sweeping proposal was to create a new valley park and parkway system along the stream valleys of Jones and Gwynns Fall, connected by parkways to be laid out in the lateral channels. The 1904 report is full of detailed photographs of Baltimore's rolling piedmont landscape, documenting each natural stream valley and noting their subtle differences -- their varied topographies and unique vegetation. (Olmsted Bros. 1904)

Bottomlands are typically the forgotten spaces of the city- wet, unbuilt, neglected, often inaccessible. The Olmsted Brothers' far-reaching recognition of the topographic and hydrological systems as an urban armature recognized the significance of urban stream valleys as a resource at a time when other cities were filling their ravines and culverting their streams in order to build new housing and transportation systems. Their approach represented a prescient floodplain protection strategy, but it also effected a fundamental change in the perception and experience of the city (Olson 1995). The park plan proposal transformed the stream valleys from inaccessible, neglected urban leftovers to unique and valued landscapes, inverting the topographic reading of the city, which, until then, had privileged the hilltops where its landmark buildings were located, and rendered the stream valleys invisible.

The Olmsted Brothers' park plan provides an early example of a hydrologically based urbanism. The management of water has always played a key role in the development and form of cities, whether for the supply of fresh water, the provision of drainage or protection against flooding. This basic relationship between water systems and urban form was eroded in the modern city. Modern water technologies are no longer legible; the visible elements that were once centers of social life—wells and cisterns, street fountains, and aqueducts—have been replaced by invisible systems, either remote or underground. The relationship between urban functions and the natural environment has become opaque. This is a result of a profound cultural change. If once engineering and urban design were intimately connected, became increasingly autonomous with the rise of professional specialization in the 20th century. Functionalism and efficiency were seen as ends in themselves, divorced from civic meaning. The planning and production of infrastructure has become increasingly technocratic and standardized, losing its connection to the environment (Shannon 2010).

With the increased scale and complexity of urban infrastructure projects, landscape architects have turned their attention to the reintegration of infrastructure with the city and its landscape in order to address ecological, functional, aesthetic and social concerns (Strang, 1992, Rosenberg 1996, Allen 1999, Raxworthy 2004, Belanger 2009, Shannon 2010, Hung 2011). The interest in infrastructure landscapes has emerged to reintegrate engineering and urbanism and "instill purpose, legibility and cohesiveness" (Hung 2011, 15) through site-specific solutions that are integrated into the landscape. This focus parallels the development of ecological design, as influenced by the new conceptual frameworks introduced by the subdiscipline of landscape ecology in the 1980s.[1] The relationship of ecology and infrastructure landscapes reframes landscape architecture by foregrounding two key ideas: landscape *performance,* and the conceptualization of the landscape as a *network.* Performance characterizes the landscape as working landscape that can be empirically evaluated for achieving specific goals: "As a nonisolated system, landscape infrastructure has the ability to adhere to a set of requirements and achieve measurable results" (Hung, 2011, 17). The network concept stresses that landscapes operates as systems, not as discrete "objects" or "scenes." **"**Infrastructure is a connective tissue that brings together disparate elements, instilling cohesion and purpose. The sheer scale and vast resources spent on network infrastructure present tremendous opportunities to leverage unrealized potential in the urban environments. ." (Hung, 2011, 18)

A parallel discourse has developed among planners around the concept of "green infrastructure." Green infrastructure is 'an interconnected network of green space that conserves natural ecosystem values and functions and provides associated benefits to human populations' (Benedict and McMahon, 2002,12). The GI approach is based on

[1] Ecologist Y. Haila writes: "Landscape ecology originated as a new research program in the 1980s, in a way as an amalgamation of all these theoretical developments (Wiens 1995b): a uniform Cartesian space was replaced with environmental heterogeneity; equilibrium assumptions were replaced with spatial and temporal variability driven by nonequilibrium processes in various scales; and an unquestioned search for universal regularities was replaced with the acknowledgment of spatial and temporal specificity of ecological processes. New hypotheses were suggested about non-equilibrium processes determining landscape dynamics." (Haila 2002, 349)

the goals of “protecting, restoring and interconnecting the city’s ecological structure” (Girling 2005). Although the term has a wide range of definitions (Sylwester 2009) it can be said to have three main defining characteristics. First, it is based on identifying and working with the city’s existing ecological structure. The systems approach implicit in the concept of infrastructure stresses the goal of interconnecting open spaces to achieve ecological functionality (Benedict and McMahon, 2006). Open space must be planned to function as a network at multiple, nested scales, from the region to the neighborhood. Second, the emphasis on performance suggests that POS must be multifunctional rather than single-purpose.

Public open spaces have taken on an increasingly complex role in the city. In addition to their social role as the site of urban public life, they are now considered part of the city’s green infrastructure, expected to provide a broad array of ecosystem services such as microclimate regulation, air pollution and noise reduction and water management (Bolund and Hunhammar, 1999). Additional goals include adaptation to climate change and linking natural areas to counter fragmentation and preserve biodiversity (Sylwester 2009). This approach to the planning and design of public open space (POS) has been adopted as urban policy by many cities, often within a suite of related policies[2]. This paper will discuss the emerging field of sustainable urban water management

[2] Some of the most prominent examples of green infrastructure guidance include New York City Department of Parks and Recreation’s “High Performance Landscape Guidelines 21st Century Parks,” (2010) and London’s “All London Green Grid” (2011), a follow-up to the “East London Green Grid” (2008).

(stormwater management, flood control, water supply and waste) in relation to the planning and design of urban POS. As distinct from conventional approaches, the integrative perspective of sustainable urban water management, which brings together engineering, hydrological, ecological and urbanistic perspectives, demands new holistic frames of analysis (Hill 2009). I will look at how sustainable urban water management suggests new planning and design approaches to POS using the central tenets of green infrastructure, with a focus on hydrological functionality. These tenets are based on the following concepts: 1) landscape structure and the principle of decentralized spatial distribution; and 2) multifunctionality. I will show how these sets of ideas suggest the ways in which hydrology can become an armature for urban form and POS, and how, in turn, POS may take new forms and suggest new configurations and uses.

Sustainable Urban Water Management: WSUD/LID approaches

The growth of cities has had a dramatic impact on aquatic ecosystems. The substantial increase of impervious surfaces has had a direct effect on increasing urban runoff volumes, rates of discharge as well as overall affecting water quality. These three processes have in turn, decreased infiltration, caused erosion, sedimentation, and loss of aquatic habitats. Sustainable urban water management approaches have reoriented conventional engineering approaches to stormwater management from an almost exclusive emphasis on drainage and conveyance, aimed at flood prevention and protection of property, to broader set of goals based on ecological functionality of terrestrial and aquatic ecosystems. (Prince George's County, MD, 1999). Several approaches developed in parallel. Here I will refer to the techniques of Water Sensitive Urban Design (WSUD) which developed in Australia (Wong 2000, 2006) and Low Impact Development (LID) which developed in Prince George's County, MD, USA (Prince George's County, MD, 1999.) The goal of LID is not only to reduce the negative impacts of stormwater runoff, but to create an ecologically functional landscape that mimics natural hydrological functions (discharge, frequency, recharge and volume) and seeks to replicate predevelopment hydrology by designing hydrological functions into the site design. LID is based on small-scale, "source controls" of runoff dispersed in the landscape that minimize the need for storm drain piping and pond solutions. Additionally, it encourages multifunctional site design that maintains and restores terrestrial ecological processes necessary to protect the ecological integrity of the receiving waters—stream stability, habitat structure, base flows and water quality (Prince George's County, 1999, 5). WSUD emphasizes the integrative framework of stormwater management with the broader planning and design of the contributing urban area. (Wong, 2000): it "provides a common and unified method for integrating the interactions between the urban built form (including urban landscapes) and the urban water cycle." WSUD considers the water network as a whole, including potable water supply, stormwater and wastewater. In addition to treating stormwater, WSUD aims to reduce potable water demand and encourage treatment of wastewater to a standard suitable for re-use. (Wong, 2006).

Landscape structure and hydrological function -decentralized spatial distribution

Similar approaches to water management have developed contemporaneously in the US, UK, Australia, Japan and Israel (Carmon and Shamir, 2009). However, the planners, designers, and scientists involved in its application frequently do not share the same analytical frameworks (Hill, 2009). Each tend to use a distinct frame to guide practice: the "regulatory frame," in which social and legal structures are mapped and assessed; the "site frame," which is focused on the design of site-scaled best management practices, and the "geography-based frame" which stresses the water system as a network within a dynamic mosaic (Hill 2009). Hill notes that although these frames are not necessarily mutually exclusive, they are often applied as if they were. She proposes a landscape-based integrative framework that creates overlap across all three, based on hydrological function. The model identifies three kinds of sites: *upland* (where stormwater is first generated); *network* (linear concentrations of flows, such as streets) and *shoreline* (receiving waters). This model references the flow of water and adds directionality to the system. It also expands the sites of intervention and identifies sites according to their strategic locations in the watershed. For example, while most interventions now take place at the source (upland sites), network and shoreline sites may offer greater benefit due to their larger catchment areas and thus reduce downstream impact.

This model identifies the strategic relationships between the site scale and the overall watershed, recognizing the essential interconnectedness of interventions at multiple scales from the individual lot to the precinct, with regard to their corresponding scales of catchment: from micro-catchment to the watershed. This analytic frame also suggests that there may different kinds of design approaches to POS that correspond to the scale and location of each of the three types, with some being site-specific, one-off designs while others, such as the network type, may be more prototypic and system-wide. Examples of prototypic network applications in city streets are the Green Streets in Portland, and Street Edge Alternative (SEA) streets in Seattle, which began as a pilot project and has since been replicated and adapted throughout the city.

The decentralized spatial distribution that defines sustainable water systems lends itself to retrofits in existing urban voids, creating new interstitial neighborhood POS that can provide social or productive functions such as play spaces or community agriculture.

Multifunctionality

The principle of multifunctionality calls for enrichment of urban space with multiple programs and purposes. In his discussion of urban parks, Michael Hough highlighted the need for "multifunctional, productive working landscapes": "Urban land as a whole will be required to assume environmental, productive and social roles in the design of cities, far out-weighing traditional park functions and civic values." (Hough 1995, 31). This hybrid conception of urban space allows for new combinatory programs and imagines a new kind of mixing in which open space serves multiple roles. Thus, in addition to providing storm water management, open space may also serve social, cultural, environmental and economic roles, by creating habitat and increasing biodiversity, controlling microclimate and contributing to community revitalization. (Wiggering 2003, Hung 2011).

Village Homes in Davis, CA, designed by Michael and Judy Corbett in the early 1970s, is an interesting early example of a sustainable community that was designed to promote energy conservation and use of solar energy, walking and bicycling, neighborhood agriculture and natural drainage. The community consists of 242 single- and multifamily residences on sixty acres. (Francis, 2002). There are several types of open space, including including private gardens, common areas, agricultural lands, and sports turf that incorporate the use of native or edible plants. All stormwater is managed in an open system as surface flows that allow for infiltration. The surface stormwater system structures the overall plan of the housing and open space network, providing pedestrian circulation and a continuous network of public open space. In the dry months this area doubles as children's play spaces (Francis, 2002). Other playgrounds use permeable surfaces (sand), and are intended to double as stormwater storage areas. Close to $200,000 in development costs were saved by eliminating conventional storm sewers, which covered most of the landscape costs (Francis, 2002). In addition, the planners fought hard to narrow the streets from the accepted standard widths of 44 ft. (13.4 m) down to 23 ft. (7 m.) in order to minimize impervious paved surfaces. Road surfaces amount to a total of 15% of the overall area, as compared to 22% average in the surrounding area. The multifunctional approach to stormwater management allowed the system to provide an armature of POS to the community.

Conclusions

By approaching the design of water as an integral element of urban design , it can be reintegrated into the visual and spatial experience of the city. In this way, water infrastructure can once again become a source of civic meaning instead of being relegated to a separated functional realm: expressive, sensate, present. The return to the design of the utilitarian landscape celebrates the interrelationship between natural systems and everyday urban life.

References

Allen, S. 1999. Points + Lines. Diagrams and Projects for the City. NY and Princeton: Princeton Architectural Press.

Bélanger, P. 2009. Landscape as infrastructure. Landscape Journal 28, pp. 79-95.

__________ 2010. Redefining infrastructure, in Mostafavi. M and G. Doherty eds. Ecological Urbanism. Baden, Sweden: Lars Müller Publishers, pp 332-349.

Benedict, M. and McMahon, E., 2006. Green infrastructure. Washington: Island Press.

Bolund, P. and S. Hunhammar, 1999. Ecosystem services in urban areas. Ecological Economics 29, pp. 293–301.

Carmon. N. and Shamir, U. Water-sensitive planning: integration water considerations in to urban and regional planning. Water and Environment Journal 24, pp. 181-191.

Costanza, R. et al., 1997. The value of the world's ecosystem services and natural capital. Nature 387, pp. 253-260.

Department of Environmental Resources, Prince George's County, MD. 1999. Low Impact Development Design Strategies: an integrated design approach.

_____________________. 1999. Low Impact Development Hydrologic Analysis.

Francis, M., 2002. Village Homes: A case study in community design. Landscape Journal 21(1), pp. 23-41.

Fry, G., 2001. Multifunctional landscapes—Towards transdisciplinary research. Landscape and Urban Planning 57, pp. 159–168

Girling, C., 2005. Skinny streets and green neighborhoods. Washington: Island Press.

Haila, Y. 2002. A conceptual genealogy of fragmentation research: from island biogeography to landscape ecology. Ecological Applications, 12(2), pp. 321–334

Hill, K. 2009. Urban design and urban water ecosystems. In: L. Baker, ed., The water environment of cities. Boston: Springer.

Hough, M., 1995. Cities and natural process. New York: Routledge.

Hoyer, J., Dickhaut, W. and Kronawitter, B.W., 2011 Water Sensitive Urban Design, Principles and Inspiration for Sustainable Stormwater Management in the City of the Future, Berlin: Jovis Verlag GmbH.

Hung, Ying-Yu, 2011. Landscape Infrastructure, Case Studies by SWA Basel, Berlin, Boston: Birkhäuser Verlag für Architektur.

Melosi, Martin. 2000. The Sanitary City: Urban Infrastructure in America from Colonial Times to the Present Baltimore: John Hopkins University Press.

Nassauer, J.I., and Opdam, P., 2008. Design in science: extending the landscape ecology paradigm. Landscape Ecology 23, pp. 633–644

Nassauer, J.I, 2012. Landscape as medium and method for synthesis in urban ecological design. Landscape and Urban Planning (in press).

Olmsted Brothers, [1904] 1987. Report upon the Development of Public Grounds for Greater Baltimore. Baltimore: Friends of Maryland's Olmsted Parks and Landscapes.

Olson, S., 1997. Baltimore: the Building of an American City.

Peterson, J.A., 1979. The impact of sanitary reform upon American urban planning, 1840-1890. Journal of Social History

Portland Green Streets Program http://www.portlandonline.com/bes/index.cfm?c=44407 [accessed 10.5.2012]

Raxworthy, J. and Blood. J., 2004. The Mesh Book: Landscape/Infrastructure. Melbourne: RMIT Press.

Rosenberg, E. 1996. Public Works and Public Space: Rethinking the Urban Park. Journal of Architectural Education. 50 (2), pp. 89-103.

Ruhnke, A., 2011. Stormwater management: designing urban hydrological systems as infrascapes. Journal of Biourbanism 1, pp. 59-

Shannon, K and Smets, M. 2010. The landscape of contemporary infrastructure. Rotterdam: NAi Publishers.

Spirn, A., 1984. A Granite Garden. NY: Basic Books.

________ 2005. Restoring Mill Creek: landscape literacy, environmental justice and city planning and design. Landscape Research 30 (3), pp. 395 – 413.

Schultz S. and McShane, C., 1978. To Engineer the Metropolis: Sewers, Sanitation, and City Planning in Late Nineteenth-Century America. Journal of American History 65 pp. 389-411

Strang, G. 1992. Infrastructure as Landscape. in Rosenberg, E. ed., Design + Values, CELA: 1992, Charlottesville, VA: University of Virginia, pp. 93-102.

Street Edge Alternatives, Seattle http://www.seattle.gov/util/About_SPU/Drainage_&_Sewer_System/GreenStormwaterInfrastructure/NaturalDrainageProjects/StreetEdgeAlternatives/
[accessed 10.5.2012]

Sylwester, A., 2009. Green Infrastructure- supporting connectivity, maintaining sustainability. European Commission, DG Environment.

Tzoulas, K. et al, 2007. Promoting ecosystem and human health in urban areas using green infrastructure: a literature review. Landscape and Urban Planning 81, pp 167–178.

Wiggering, H. et al. 2003. The concept of multifunctionality in sustainable land development. In K Helming and H. Wiggering, eds. Sustainable Development of Multifunctional Landscapes. Berlin: Springer-Verlag, pp. 3-18

Wong, T.H.F., Eadie, M.L., 2000, Water sensitive urban design - A paradigm shift in urban design, *Xth World Water Congress*, Melbourne VIC, 12-16 March 2000, Organising Cttee, Xth World Water Congress, Melbourne Vic Australia
.

Wong, T.H.F., 2006, An Overview of Water Sensitive Urban Design Practices in Australia, *Water Practice and Technology [E]*, vol 1, issue 1, IWA Publishing
2006.

.