ELSEVIER

Technology in Society 28 (2006) 477–488

Technology In Society

www.elsevier.com/locate/techsoc

"Connectivity" in urban rivers: Conflict and convergence between ecology and design

Rachel May*

Office of Environment and Society, Syracuse University, 431 Crouse-Hinds, Syracuse, NY 13244, USA

Abstract

"Connectivity" is a key concept for riparian and landscape ecologists and hydrologists, who use it as a measure of natural integrity in a river ecosystem. Urban designers and politicians use the same term to promote human access to riverfronts. Effective riverfront restoration requires reconciliation of these opposing definitions. A solution is to draw upon abstract and symbolic sources, or "cognitive connectivity," to raise awareness of the complexity of urban river ecosystems and to provide cues for appropriate use of those systems. Examples of effective cognitive connectivity include restoration plans with strong pedagogical components, water museums, and artistic interventions that reveal ecological processes (eco-revelatory design). The use of visual and conceptual connectivity offers hope for harnessing human creative energy in the interest of ecosystem integrity.
© 2006 Elsevier Ltd. All rights reserved.

Keywords: Urban ecology; Urban rivers; Ecological design; Connectivity; Environmental education

1. Introduction

Hurricane Katrina brought to everyone's attention the extraordinarily delicate relationship between cities and their waterfronts, and it also brought into the open the tension between ecology and culture in urban rivers. Many of the world's great cities are located in fragile river deltas because those locations offer optimal access for trade and transportation, ample fresh water, fish, and game, and fertile agricultural land. Over time the waterfronts in these cities take on not only commercial significance but important

*Tel.: +1 315 443 9726; fax: +1 315 443 3363.
E-mail address: enspire@syr.edu.

0160-791X/$ - see front matter © 2006 Elsevier Ltd. All rights reserved.
doi:10.1016/j.techsoc.2006.09.004

cultural roles as well. When engineers and architects work to shore up the flood-prone river banks (as in St. Petersburg, New Orleans, or London), they create embankment or levee structures that define the city's character and frame its vistas while also providing public space. These structural changes transform the ecological relationship between river and city in ways that may support a day-to-day sense of stability but that, over time, can exacerbate the threat and magnify the consequences of severe floods. In the debate about whether and how to rebuild the city of New Orleans, we see a direct clash between ecological and cultural arguments: ecologists and engineers predictably lean toward relocating the city above sea level and restoring the wetlands so that they can control flooding naturally, while others contend that the city's cultural heritage and historic significance are too great to abandon. Although the arguments may not ultimately be reconcilable, it is timely to consider how to bring the parties to a single table so they can try to resolve the ecological and cultural issues simultaneously. In research on urban rivers, one of the terms that comes up most frequently is "connectivity," but the term has very different, even conflicting connotations in the context, say, of river ecology or of urban waterfront planning. This essay explores the possibilities for finding common ground between them through the pursuit of "cognitive connectivity," or educational and aesthetic interventions that allow urban dwellers to experience their place in the urban watershed in ways that do not jeopardize its ecological systems.

Ecologists use the term connectivity as an important indicator of the health of river ecosystems and as a key to managing landscapes for biological diversity. Urban planners and community activists apply the term to efforts to integrate the life of the city with its riverfront. Even environmental philosophers talk of connectivity in describing the way we come to understand the place of individual organisms and species—particularly humans—within their environmental context. These different connotations overlap in some ways, but in others they come into conflict. In the interest of fostering deeper connections between different disciplinary approaches to urban rivers, it is worth investigating the relationship between these multiple uses of the term connectivity and efforts to bring them into constructive dialogue with each other. By making cognitive connections between different disciplinary understandings of connectivity, we may be able to achieve the kind of healthy integration of built and natural systems that is the goal of most people who approach urban sustainability from any disciplinary perspective.

2. Defining connectivity—biophysical approaches

From the perspective of landscape ecologists and conservation biologists, the landscape is made up of patches of different habitats with transition zones between them (ecotones). Connectivity is the strength of interactions across ecotones; it is "an ecological term that describes the natural habitat continuum throughout the landscape: the antithesis of fragmentation" [1]. Rivers and riverbanks are connecting elements (or landscape corridors) between patches. Rivers typically connect an upstream, forested area and a downstream wetland, and riverbanks serve as paths along which animals can move and plants can spread with ready access to water and nutrients. But riverbanks and floodplains are also ecotones between the river itself and the land habitats that surround it, allowing for passage of organisms and flotsam into and out of the water. At smaller scales, a river with a complex flow regime will have a variety of in-stream habitats (areas of faster or slower moving water, or warmer or colder water, of more or less nutrient-rich water), and there

will be ecotones between them. At all these different scales, connectivity "may be defined as the ease with which organisms, matter or energy traverse the ecotones between adjacent ecological units" [2]. By this definition, the highest degree of landscape and habitat connectivity in a riparian system would be achieved by periodic flooding alternating with dry periods. Such a pattern would share nutrients among aquatic and terrestrial habitats and create transition zones that would favor a diverse array of amphibious species and wetland plants.

River ecologists are concerned with similar issues, but they focus on the species in and properties of flowing water. They speak of lateral, longitudinal, and vertical connectivity in riparian systems [3]. Lateral connectivity (between the watershed and the river) includes the roles of plants and animals in the watershed, the geomorphology of sedimentation and channelization, and the delivery of nutrients, soil, debris, and organisms between the water and its shores. Longitudinal connectivity works from upstream to down and vice versa and includes issues of migration of aquatic species and delivery of organic and inorganic materials up and down the river. Vertical connectivity concerns exchanges between river and ground water, subsurface differentiation of habitats (such as surface vs. benthic or river-bottom environments), convection, and local differences in water quality, temperature, and turbidity. River ecologists recognize the importance of landscape connectivity not only along the riverbanks but throughout the watershed, since disturbances (such as paving, construction, logging or industrial activity) always affect the quality and flow regime of river water.

Hydrologists view riverbanks as regulators of and responders to flow regimes. They use the term connectivity to refer to the flow from upstream to down (and back), the ability of the riverbed to absorb changes in flow, the exchange of water and sediment between river and floodplain or between river and groundwater. Though their concerns are mainly with measuring and monitoring physical processes, there is an inevitable overlap with ecological concerns. According to Ward et al. [2], "Hydrological connectivity, the transfer of water between the river channel and the floodplain or between surface and subsurface compartments, has major implications for biodiversity patterns [and plays an important role in] structural succession patterns". Pringle [4] adds, "Hydrologic connectivity is essential to the ecological integrity of the landscape, and reduction or enhancement of this property by humans can have major negative environmental effects". Like river ecologists, hydrologists tend to take a watershed-level approach to riparian connectivity.

These three definitions of connectivity differ primarily in emphasis. Indeed, Pringle outlines the effect of ideas about landscape and ecological connectivity on the hydrological definitions, particularly in respect to the human dimensions of river connectivity, and advocates greater collaboration among these disciplines in defining and defending connectivity in river ecosystems. The most important similarity among landscape, ecological, and hydrological connectivity is their common defense of undisturbed river environments against fragmentation, impermeability, channelization, or excessive stratification [4]. As a rule, ecologists and hydrologists favor high connectivity for promoting biodiversity and reducing erosion and other damaging impacts of the built environment. (The exceptions are the hazards posed by the dispersion of exotic invasive species, pollutants, or diseases through highly connective landscapes or systems.) In general, the prescription for health and sustainability in a riparian ecosystem is to keep intact as much of the river bank or floodplain as possible to promote ecological and hydrological connectivity, including regular flooding, maintenance of natural vegetation, and minimal

disturbances in the watershed. A typical ecologically or hydrologically based river restoration plan will therefore call for removing hardscape (embankments, dams, roads or other pavement), restoring meanders, riffles, and vegetation, and creating buffers between the built environment and the river.

3. Defining connectivity—cultural and design approaches

Those whose concern is primarily with human institutions and the built environment also place a high positive value on connectivity, but they define the term in a way that places paramount emphasis on connecting humans to the river. For urban planners concerned with riverfronts, the main issues are making the river accessible to people from the most densely used or occupied parts of the city (pedestrian paths and bridges, transit linkages), linking the river visually and conceptually to the city (greenways, parks, attractive riverfront destinations, integrated design elements, vista points, identifiable images and logos), and providing social and cultural attractions along the riverfront. For example, the Buffalo Bayou Master Plan (2002) in Houston, Texas, calls for "conscientious planning for land connectivity, for urban connectivity through space networks and centers, and social connectivity through lively and interactive gathering places, both built and natural" [5]. Urban planners conceive of sustainability on the urban river as a matter of making the city attractive and livable to a wide range of residents, thereby reducing their need to drive out of the city for fresh air and recreation.

The concept of connectivity, though not necessarily the term, also permeates the work of cultural historians of urban rivers. In part, this is due to the role of rivers in cities as physical connectors to trade routes and travel. May et al. discuss the many interactions among biophysical and human connectivity at a river junction in the north of Russia. Ecological connectivity attracts human settlement; hydrological connectivity subsequently ensures interchange among ethnic groups; and changing political realities dictate a range of propagandistic uses for the junction, from promoting trade and assimilation to defining territorial borders and, ultimately, forging symbolic connections between this geographically marginal but historically vital site and the heart of the Russian state [6]. Historians of St. Petersburg point out that the city was designed explicitly to perform connective functions, as a gateway between the Russian state and the Western world, and, for Peter the Great, as a way to force his subjects out of their landlocked mindset and onto the water [7].

Other urban historians, such as Ari Kelman for New Orleans [8], Karl Haglund for Boston [9], Philip Lopate for New York [10], and Dale Porter for London [11], take up a different aspect of connectivity, in the way riverfronts become established (and are later defended) as public spaces. Riverfronts connect urban dwellers to the natural processes that are generally hidden in the built environment, to the history of their cities, and to each other across class lines and other divisions. These different types of connectivity may be incompatible, as Porter [11] writes about the construction of high retaining walls along the Thames in Victorian London:

> Before the Embankment was built, the metropolitan Thames supported lives and livelihoods in physical proximity to its water and mud and wooden pilings. The great brick and granite walls sealed off that kind of relationship. By 1900, the river was virtually closed to casual boaters, to scavengers, and to other marginal characters

> who had no legal or bureaucratic right to work on it. It was no longer a working thoroughfare but an object of engineering reports and water quality surveys. It had ceased to be a frightening source of disease and social disorder, but it was also shut off from the life of the nearby streets.... Having exploited and despoiled London's natural and economic lifeline, the Victorians built a wall around it, channeled the worst of their pollution out of sight, and created a public esplanade along the river's edge. From that vantage point, they could enjoy the Thames as a cultural amenity, discerning in its waters a reflection of themselves and their improved, respectable city.

The Embankment, then, was designed specifically to interrupt ecological connectivity (with the primary purpose of preventing transmission of disease). This interruption, in turn, leads to the loss of traditional river occupations but creates new types of cultural and symbolic connections between urban dwellers and their river. Porter implies that many Londoners actually felt more connected to the river when they no longer had physical access to it.

Most contemporary cultural and design approaches to urban river connectivity are almost diametrically opposed to the ecological and hydrological notions, because they promote human interaction with the waterfront, controlled and mediated by the built environment. Such interaction necessarily disrupts biophysical connectivity along the river and between river and shore, because it depends on crossing the banks with roads and bridges, shoring them up to prevent flooding, and landscaping for recreation, not wildlife. Designers often look for inspiration to the famous urban riverfronts of the world, such as those in Amsterdam, St. Petersburg or San Antonio, Texas. From the ecological perspective, these are poor models, being entirely artificial constructions based on channelized riverbeds, in which the hydrology and ecology of the original river have been altered to suit the economic and aesthetic values of the city. When ecological connections are made in these places, the context is usually negative, as with the floods and outbreaks of water-borne diseases in St. Petersburg and the annual need to drain the "river" in San Antonio to dredge out the mud. Furthermore, as the authors of the definitive report on "Ecological Riverfront Design" from the advocacy organization American Rivers point out, each urban river is a unique place with a unique conjunction of ecological and cultural demands, and models from one city do not readily adapt to another [12].

4. Connecting the connectivities: a cognitive approach

Can urban designers and ecologists find common ground in their approach to riverfronts? The solution is not simply to exclude humans from the river ecosystem, tempting as this may seem to scientific purists. Humans are, after all, the dominant species in urban ecosystems, so connectivity of all kinds must include a connection to us, and from us to the system as a whole. If the values of ecological and hydrological connectivity do not fit into our established ideas of how cities engage with rivers, then what is needed is a new way of communicating and understanding those values. Many recent urban river restoration projects recognize this need, and they can serve as models for a new cognitive connectivity between cities and rivers. Ironically, the Thames Embankment project is indicative of this possibility, for it shows that riverfront design can increase people's symbolic connection to the river even as it separates them physically from the river. The

human capacity for abstract understanding offers hope for more ecologically sound relationships between cities and rivers. Instead of putting our engineering and aesthetic energies into controlling rivers and framing them as beautiful objects, as previous riverfront projects tended to do, we can work to integrate the complexity of river ecosystems into the public image of our cities.

Cognitive connectivity, the acknowledgment that humans are integral components of ecosystems, has its roots in environmental philosophy, where it is the basis for ecological understanding in general. Philosophical connectivity demands that we comprehend our place in the local and global ecosystems and acknowledge the far-flung consequences of our actions. "The new ecology starts with this fundamental assertion: that the unit of survival is not the individual or the species, but is the organism-and-its-environment… Connectivity ultimately allows no free riding. The concept of the global is deeply significant in providing a context for the understanding that consequences displaced are really just consequences deferred" [13]. The application of this idea to specific issues of urban rivers involves a strong educational component, both through explicit pedagogical materials (such as exhibits in riverfront museums) and through more subtle, "eco-revelatory" design that allows people to see and understand ecological processes. It also draws connections between global and regional ecological concepts and the residents' understanding of and fondness for local places. "[E]cologically designed urban landscapes should communicate cultural 'cues' for sustainable behavior; these landscapes should be implemented in partnership with ecological education efforts; and the cultural meanings and ecological place values created over time will be fundamentally local" [14].

There are many admirable examples of sensitive river restoration, incorporating both urban design connectivity and ecological connectivity (see [12] for numerous case studies). Most, however, incorporate cognitive connections only in the planning stage, through collaborative and participatory design procedures; the completed projects do not engage the public in conscious interaction with ecological processes. Hey (1994) describes the Des Plaines River wetlands restoration project as an outgrowth of greater public consciousness about ecological processes: "Today, our values are different. We are more aware of the cause-and-effect relationship between our actions and the fragile environment in which we live" [15]. But the restoration project itself takes place in a strip of land between a highway and a railroad line where little direct human interaction could be expected.

By contrast, three types of recent design interventions in urban riverfronts stand out for their ability to draw cognitive connections between the ecosystems and the daily lives of urban residents. The first comprises river restoration plans that incorporate pedagogical elements into the landscape. The second group consists of increasingly popular water museums that provide virtual or conceptual tours of the riverfront without exacerbating the human impact on the riverbanks themselves. And the third type of intervention consists of works of art that facilitate and call attention to natural processes [16]. In all three cases, the goal is to reverse the historical pattern of asserting human dominance over river ecosystems by making people aware of the complexity and interdependence of all parts of those systems.

4.1. Pedagogical restoration plans

The Don River Restoration plan (Toronto, Ont.): This plan is the subject of Michael Hough's classic book, *Cities and Natural Process* [17]. Hough describes the experience of moving from the marsh and delta of the Portlands area of Toronto, to a more linear

section of river formally landscaped for urban recreational use, to a floodplain of marshes and meadows, and then to a system of "narrow forested ravine tributaries," as a way of learning about the complexities of river systems. Explicit educational components of the plan include a research station where "people would learn about how the river works throughout the watershed [and] how changes to river hydrology can create new and more complex habitats for wildlife." Organizers of the project recently held an exhibition of historic photographs entitled, "Reconnecting with the Don" designed to enhance the emotional and historical sense of connectivity between residents and the river [18].

The Rouge River Gateway Plan (Detroit, Michigan) [19]: The stated goal of this plan is to "restore relationships between the Rouge and its natural and social systems" [20]. The planners have divided the river into a linked series of land-use zones (not unlike those Hough identified on the Don). Interpretive materials acknowledge and call attention to the difference and the connection between less compromised sections of the river and historically industrialized or urbanized areas. Hydrological interventions include restoration of an oxbow and partial removal of a concrete channel; ecological interventions include renaturalizing the river banks and converting industrial sites to green purposes, and city connections include a public greenway and riverboat taxi to link the various usage zones in the popular image of the river. Because these different zones and their functions will be made explicit in the design, the planners claim that "[t]he Rouge River will be both a magnet for community activity and a way for residents to better understand their unique role as stewards of this riparian ecosystem" [20].

Harriet Island (St. Paul, Minnesota): The city center of St. Paul stands on high bluffs above a large oxbow in the upper Mississippi River. The downtown has long faced away from the river, but, as is the case in many American cities, there has been a major shift in recent years to re-engage architecturally and culturally with the riverfront. One of the linchpins of this effort involved developing Harriet Island, directly below the downtown, into a recreational site. But because the island routinely floods when the Mississippi is high, the park was designed as an "outdoor classroom" "for the exploration of river dynamics, river ecology, and the ecology of the flood plain" [21].

Long Beach Riverlink (Long Beach, California): This community design project is explicit about making connections along a number of axes. The project website states, "Most Westside neighborhoods suffer from severed connections to downtown amenities and the Los Angeles River, as well as a lack of a strong sense of community identity. Residents lack a connection to the natural environment of the surrounding area, and the existing park spaces are viewed as unsafe" [22]. The Riverlink aims simultaneously to connect communities to each other and to the river. There is even a vertical connection built into the design, one between land and air. Riverlink promotional materials emphasize the value of the park project in mitigating air pollution and the urban heat island effect, two issues that loom large in public concerns about the urban environment in Southern California.

All of these examples entail a combination of ecological restoration and urban design elements for connecting humans to the river, with symbolic and educational components that strive to make the two goals compatible.

4.2. Riverfront museums

Several major cities have recently opened waterworks museums that introduce visitors, especially school children, to essential concepts like watersheds, water quality, and water

cycle within the context of their own urban experience. They also bring into the open some normally hidden urban processes like wastewater treatment and the effect of impermeable materials on runoff and flooding. Because these museums include exhibits on both cultural and natural history of the city and its region, they have the potential to create strong cognitive connections between water processes and the daily lives of their visitors. And because the examples below are all located in significant architectural monuments with views of the water and the city, they create a symbolic link between the power of human creativity and engineering prowess and the majesty of the river.

World of Water Museum, *St. Petersburg*, *Russia*: This sophisticated museum, run by the urban water authority (Vodokanal), occupies an old brick water tower and offers exhibits on everything from how the water system was planned and built, to how waterworks officers heroically protected the supply of water during the German siege in World War II, to a history of bathroom fixture design, to a simulated tour of the underground sewer pipes. A popular multimedia show concludes the tour, including an impressive scale model of the city that illuminates the waterways with colored lights. The building, meanwhile, provides magnificent views of the Neva River and some remarkable contemporary fountains. Since St. Petersburg's granite embankments are an integral part of the city's historic architectural ensemble, there is very little that can be done in the way of restoring ecological or hydrological connectivity, so this museum plays an extremely important role in creating cognitive connectivity between residents and their watershed. The appeal to patriotic sentiments in the World War II exhibit is also an effective way to drive home the importance of preserving the city's water system, since Russians still strongly identify with heroes of the "Great Patriotic War." Altogether, the combination of old and new in the architecture, the simultaneous appeal to scientific, aesthetic, historical, and local concerns, and the fact that visitors can get a close-up sense of what goes on underneath their streets and buildings make this a highly effective installation.

Fairmount Water Works Interpretive Center (FWWIC), *Philadelphia*, *Pennsylvania*: The Water Works is a magnificent complex of neoclassical buildings that once housed the steam engines and waterwheels—and, later, turbines—that carried water from the Schuylkill River up to a reservoir on Faire Mount. The Water Works were a wonder of engineering and design that attracted tourists to the buildings and to the extensive Fairmount Park above them, one of the world's largest urban parks that was designed as a pioneering effort to protect the city's watershed while providing recreation for the city. The buildings have gone through a number of uses over two centuries, and now they have been revamped to showcase the engineering and ecological aspects of providing water to an urban population. Hands-on exhibits encourage visitors to become familiar with watersheds and what can go wrong with them (in imaginary "Pollutionopolis"), but the most compelling aspects of this museum are the building itself and its location. Visitors can look inside the real workings of the massive machinery and, through the small porthole-like windows see the powerful river rushing by outside. The low-lying structures flood when water levels rise, and the exhibits are designed to be submersible or easily removed in anticipation of high water. The FWWIC enhances its educational materials by reminding visitors viscerally that they are really inside the watershed.

Biosphère, *Montreal*, *Quebec*: The famous glass geodesic dome created by Buckminster Fuller for the American Pavilion at Expo '67 now houses Environment Canada's center for environmental education about water, climate change, and the Great Lakes–St. Lawrence ecosystem. Here, too, there is a deft combination of general information about water

processes and climate science, on the one hand, and materials that draw specific connections between visitors and their local or regional watersheds. In addition to hands-on games and models about water processes in the St. Lawrence, there are films and exhibitions highlighting the beauty of the region. This museum is less focused on urban issues than the other two, because it takes a more regional and global perspective, but its prominent location in a Montreal landmark and its views of the city and river from Île Ste. Hélène draw the connections between the city and its larger context.

4.3. *"Eco-revelatory" design*

Working outside the confines of museums and often at a smaller scale, environmental artists are finding ways to redesign the infrastructure of the built environment so as to remind its users of their day-to-day role in ecological processes. The term "ecovention" has been coined for artistic interventions that seek to serve ecological ends, whether restorative or symbolic [16]. Listed below are a few such interventions that forge new physical and aesthetic links between cities and their hydrological systems.

Living Water Garden: In the center of Chengdu, China, a water quality education park and green space hugs the banks of the Fu and Nan rivers. These rivers are central to the culture of the city but are also severely compromised by industrial pollution. Created by installation artist Betsy Damon and her Keepers of the Waters foundation, the constructed wetlands, artistic fountains, and "flow forms" of the Living Water Garden provide beauty and recreation while demonstrating low-technology water treatment methods [23].

Gift of Water: Jackie Brookner calls her work "biosculpture" or "sculpted ecosystems" that incorporate mosses, wetland plants, and bacteria on sculpted stone forms. Her Gift of Water installation near Dresden, Germany, "is part of a constructed wetland that provides the only filtration for a huge municipal swimming pool that is used by up to 1500 people a day in the summer… The sculpture, with its cupped hands tenderly holding water, acts as a link for people, and they start asking questions" [24].

Beckoning Cistern: In Seattle, sculptor Buster Simpson has created a downspout in the form of a giant hand that feeds rainwater from the roof of an apartment building to a cistern that, in turn, waters gardens along the street. It is part of a local project known as "Growing Vine Street" that has engaged the community, under the leadership of architect Carolyn Geise, in conceptualizing the neighborhood "based upon bioregional principles and celebrating water" [25]. Poet Michael Godfried invokes the project in terms of connectivity:

> There is a street in the city,
> that seeks once again to connect
> earth to sky
> to keep the water
> above ground
> to trace the serpentine
> running path
> of water:
> roof-top
> gutter
> cistern

back into the wetland
and
Splash!
Into Elliot Bay below.
…

Knitting a human experience

A vivacity of community
Into the exposed fabric of nature
In the city.

5. Conclusion

These examples suggest that direct river restoration plans are insufficient for achieving the goal of restoring ecological and hydrological connectivity, since the urban river differs fundamentally from rivers in their natural state by its connection to human processes. Furthermore, as Godfried eloquently suggests, most human activity connects to the river not through riverfront vistas but through the "exposed fabric of nature" that is all around us. Roof-tops, gutters, roads, factories, swimming pools, and waste treatment plants are necessary parts of the urban water cycle. The first step toward healthy urban rivers, then, is to restore connectivity between human behavior and the very idea of natural hydrological processes, around our homes, on our streets, in our parks. Given the vast ingenuity humans have put into taming and controlling rivers over the past millennia, the possibilities are enormous if people can now become inspired to find equally creative ways to coexist with river systems [26]. The better we can "connect earth to sky," the more likely it is that human interventions in urban rivers will become a strength, rather than a liability, of the system.

New Orleans is an extreme example, in which connectivity between the city and its surrounding water bodies is a matter not just of aesthetics or long-term ecosystem health but of immediate survival. As engineers scramble to restore the levees that separate the city from the water, politicians and devoted New Orleanians are hoping to return to a state of stable distinctions between river (or lake) and city. But the cognitive connection has been seared into public consciousness and will not easily recede. No doubt there will be efforts to construct memorials to those who lost their lives in the tragedy of Hurricane Katrina. The most fitting memorial would be a redesign of basic urban infrastructure to keep that cognitive connectivity alive, such as eye-catching drainage and stormwater systems, beautiful detention basins and constructed wetlands, homes and walkways designed with flooding in mind (submersible ground floors, elevated access routes, lifeboats), and a waterfront that does not just stand in mute defiance against the elements but that teaches about the cultural and ecological dynamics of the Mississippi Delta.

Acknowledgments

I am grateful to Robert Frodeman and Carl Mitcham at New Directions: Science, Humanities, Policy for the opportunity to pursue truly interdisciplinary research and

collaborative investigations of urban rivers. This essay originated as a lecture given under the auspices of the Great Lakes Research Consortium Seminar series.

References

[1] Harrison S. Connectivity. Prince George Forest Region Forest Resources and Practices Team, B.C. Ministry of Forests, Forest Research Note 1996; PG-03.
[2] Ward JV, Tockner K, Schiemer F. Biodiversity of floodplain river ecosystems: ecotones and connectivity. Regul Rivers-Res Manage 1999;15.1–3:125–39.
[3] Naiman RJ, Bilby RE. River ecology and management: lessons from the Pacific coastal ecoregion. New York: Springer; 1998.
[4] Pringle C. What is hydrologic connectivity and why is it ecologically important? Hydrol Process 2003;17:2685–9 Available from: 〈www.interscience.wiley.com〉.
[5] Buffalo Bayou Partnership. Buffalo Bayou and Beyond: visions, actions, strategies for the 21st century; 2001. Available from: 〈http://www.buffalobayou.org/pdf/BBB_Summary.pdf〉.
[6] May R, Klein J. Kashchenko Ust-Izhora: historical, political, and ecological connectivity at a river junction, "Cities and Rivers" workshop web site; 2004. Available from: 〈http://enspire.syr.edu/Nevaworkshop/Ust-izhoraRM.htm〉.
[7] Ageeva OG. "Velichaishii I slavneishii bolee vsekh gradov v svete"—Grad sviatogo Petra. Peterburg v russkom obshchestvennom soznanii nachala XVIII veka. ("The greatest and most glorious of all cities on earth"—The city of St. Peter: Petersburg in Russian social consciousness of the early 18th century.) St. Petersburg: Russko-Baltiiskii informatsionnyi tsentr BLITs; 1999.
[8] Kelman A. A river and its city: the nature of landscape in New Orleans. Berkeley: University of California Press; 2003.
[9] Haglund K. Inventing the Charles River. Cambridge and London: MIT Press; 2003.
[10] Lopate P. Waterfont: a journey around Manhattan. New York: Crown Publishers; 2004.
[11] Porter DH. The Thames Embankment. Environment, technology and society in Victorian London. Akron: University of Akron Press; 1998.
[12] Otto B, McCormick K, Leccese M. Ecological riverfront design: restoring rivers, connecting communities. Chicago and Washington, DC: American Rivers and the American Planning Association; 2004.
[13] Rose DB. The ecological humanities in action: an invitation. Aust Humanities Rev 2004:31–2.
[14] Eisenstein W. Ecological design, urban places, and the culture of sustainability. San Francisco Planning and Urban Research (SPUR) Newsletter; 2001. Available from: 〈http://www.spur.org/documents/010901_article_02.shtm〉.
[15] Hey DL. The Des Plaines River Wetland demonstration project. In: Rowntree RR, Platt RH, Muick PC, editors. The Ecological City, Amherst: University of Massachusetts Press; 1994.
[16] Spaid S. Ecovention: current art to transform ecologies. Cincinnati: Cincinnati Contemporary Art Center; 2002.
[17] Hough M. Cities and natural process. London and New York: Routledge; 1995.
[18] The Market Gallery 2004 Exhibits and Events. Reconnecting with the Don: balancing the valley. Available from: 〈http://www.stlawrencemarket.com/gallery/ex2004.html〉.
[19] Wayne County Rouge River National Wet Weather Demonstration Project. Rouge River Gateway Ecosystem Restoration Project. Wayne County, Michigan, 2003. Available from: 〈http://www.rougeriver.com/pdfs/overview/gate-00.pdf〉.
[20] Cave KA, Murray J, Bagale E, Loval S, Andrews N, Johnson C. Rouge River Gateway Project: Restoration of an urban river. Detroit: Wayne County Department of Environment; 2000. Available from: 〈http://www.rougeriver.com/pdfs/wetlands/WATERSHED2002-02.pdf〉.
[21] Mississippi National River and Recreation Area. Comprehensive management plan. St. Paul: National Park Service; 2004. Available from: 〈http://www.nps.gov/miss/info/cmp/amendment/outdoor.html〉.
[22] City of Long Beach. Long Beach RiverLink: Connecting city to river…envisioning possibilities. Long Beach, CA: City of Long Beach; 2003. Available from: 〈http://www.longbeach.gov/park/facilities/context.asp〉.
[23] Keepers of the Waters, Visions and Solutions. Model projects—living water garden. Available from: 〈http://www.keepersofthewaters.org/lwg.cfm〉.
[24] Spiess K. Parts reflecting the whole: an interview with Jackie Brookner. Land Views 2003; Summer. Available from: 〈http://www.landviews.org/la2003/parts-jb.html〉.

[25] Geise C. Denny Regrade to Belltown: an ongoing community journey. In: Bloom B, Bromberg A, editors. Belltown paradise/making their own plans. Chicago: University of Chicago Press; 2005.
[26] May R. On the role of the humanities in urban ecology: the case of St. Petersburg. Urban Ecosyst 2004;7.1:7–15.

Rachel May directs the Office of Environment and Society at Syracuse University and the SUNY College of Environmental Science and Forestry. Her research concerns the role of humanistic values, aesthetics and inspiration in shaping urban ecosystems. She developed the collaborative Neva Project (http://enspire.syr.edu/nevaproject/) to investigate the relationship between the Neva River and the city of St. Petersburg, Russia. This work, supported by the New Directions Initiative, resulted in an interdisciplinary "Cities and Rivers" workshop in St. Petersburg in 2004. Dr. May is also working on academic–government–NGO partnerships for promoting sustainability in Syracuse, New York. She holds a PhD in Slavic Languages and Literatures from Stanford University and a Master's degree in Environmental Studies from SUNY-ESF. She previously taught Russian language and literature at SUNY, Stony Brook and Macalester College and is the author of books and articles on translation studies and Russian nature writing as well as urban ecology.