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Green Infrastructure in New York City: The case of the Bronx River

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Abstract

The research presented analyzes initiatives and actions carried out and developed in New York City to improve environmental conditions through the wider diffusion of green infrastructure. The effectiveness of mechanisms related to bottom-up approaches are evaluated, considering initiatives implemented by local community organizations, grassroots associations, and citizen groups in the field of green infrastructure. To investigate these aspects and the relationships between the policies of public bodies at the Federal, State and City government levels and local communities (i.e. bottom-up and top-down approaches), the case of the Bronx River was analyzed. The Bronx River is an urban river located in the South Bronx, a low income, polluted neighborhood in the northern part of NYC that has long been characterized by its many environmental and social inequities. From the 1970s, many restoration measures have been directly implemented or pushed by the local community; today, local community organizations and NYC Departments work together to improve the environmental and social conditions of the neighborhood to reduce ecological imbalances of the River, which is surrounded by a greenway and parks, and is maintained with the efforts of citizen volunteers.

Keywords: Green Infrastructure, local community, policies, urban river, sustainability, urban design

Introduction

The majority of the world's population today lives in urban areas (Luederitz et al., 2013) and is responsible for 70% of global carbon emissions and nearly 70% of energy consumption – an increasing trend for both (International Energy Agency, 2008) with land converted to urban areas projected to triple by 2030 (Seto et al., 2012; United Nations, 2012). Furthermore, global greenhouse gas (GHG) emissions have increased 70% in the last 40 years (Rogner et al., 2007) and environmental problems within cities have significant consequences for human health, citizens' quality of life, and urban economic performance (Commission of the European Communities, 2005). This is due in large part to urban areas' high vulnerability to climate change related flooding and heat waves (Commission of the

European Communities, 2005). As also stated by Grimm et al. (2008), while human lifestyles, consumerism, and unsustainable material production lead to alterations at multiple scales in urban systems, they also generate negative effects in residents' everyday lives.

Owen (2010) states that, in the United States, people living in cities consume less energy compared to people living in suburbs or rural areas; also according to Hamin and Gurran (2009), a denser urban environment could reduce the emissions connected to transportation needs and building energy use, and consequently their impact on climate change (Ewing et al., 2008); compact development add population to already developed places, concentrating human related activities and helping to protect underdeveloped and sensitive lands and maintaining viable habitats in the remainder (Farr, 2008). Therefore, through sustainable urban design, the negative effects of anthropic activities on the environment can be reduced, and environmental issues for human health and quality of life can be mitigated.

Vegetation can restore the environmental quality of dense urban areas by reducing the Urban Heat Island (UHI) effect, improving air quality and energy performance of buildings, and fostering biodiversity (Dunnett and Kingsbury, 2008; Farr, 2008; Ottelé et al., 2010; Taha, 1997). Green infrastructure (GI) includes natural, semi-natural, and artificial networks of multifunctional ecological systems within, around, and between urban areas (Sandstrom, 2002; Tzoulas et al., 2007). This includes waterways, wetlands, woodlands, wildlife habitats, greenways, parks, and other natural areas that support native species, maintain natural ecological processes, sustain air and water resources, and contribute to the health and quality of life for communities and people (Benedict and McMahon, 2001; European Commission, 2010). Today, more than 40% of the total land in urban areas is covered by impervious surfaces as roads, parking, and buildings (Benedict et al., 2006). Green infrastructure at city scale is therefore important to improve environmental conditions. When green infrastructure is proactively planned, developed, and maintained, it can guide urban development by providing a framework for economic growth and nature conservation integrating urban development, nature conservation, and public health promotion (Schrijnen, 2000; Tzoulas et al., 2007; Van der Ryn, 1996; Walmsley, 2006).

European environmental policies so far have achieved important results at both Member State level and internationally. The normative framework of Member States can vary significantly, greatly impacting the effectiveness and flexibility of territorial management tools (Giachetta, 2013). The United States has a different approach to Europe in this field; with a less prescriptive normative framework (e.g. five states have not yet adopted the Department of Energy's Building Energy Codes Program; U.S. Department of Energy, 2014), several associations, organizations and public bodies work to improve environmental conditions in dense urban areas through the integration of green infrastructure. This community involvement can play a very important role in the field as many initiatives to improve ecological conditions of cities depend on the participation of urban citizens (Francis and Lorimer, 2011).

The main objective of this research is to study and analyze initiatives and actions carried out and developed to help improve environmental conditions in cities; it considers especially

bottom-up approaches and the relationships between the policies of public bodies at the Federal, State and City government levels and local communities (i.e. bottom-up and top-down approaches). The case study of the Bronx River in New York City is analyzed to investigate these aspects.

Rivers and streams are critical to almost any green infrastructure systems (Benedict and McMahon, 2001); urban waters take on large amounts of pollution from a variety of sources (e.g. industrial discharges, wastewater, trash, and polluted stormwater runoff), creating public and environmental health hazards (Office of Water, 2014). The Bronx River is an urban river located in the South Bronx, a low income, polluted neighbourhood in the northern part of NYC that has long been characterized by its many environmental and social inequities (Loria, 2009; Maantay, 2000). From the 1970s, many restoration measures have been directly implemented or pushed by the local community; today, local community organizations and NYC Departments work together to improve the environmental and social conditions of the neighbourhood to reduce ecological imbalances of the River, which is surrounded by a greenway and parks, and is maintained with the efforts of citizen volunteers.

The presented research includes a broad survey of local newspapers dating to the 1970s was carried out, as was bibliographic analysis and research on plans released by local community organizations and NYC Departments over the past 40 years. All the aspects analyzed in this research have also been deepened thanks to consultation with several experts in the field and referents from community groups, among others.

The river and the neighborhood

In this paper the case of the Bronx River is presented. The Bronx River runs through the New York City (NYC) borough of the Bronx and southern Westchester County in New York State; this corridor begins near Valhalla, N.Y., and flows south for 23 miles through Westchester and Bronx Counties before emptying into the East River (Bronx River Alliance, 2006; www.bronxriver.org).

The Bronx River has been used for human activities since at least the time of the Mohegan Indians, who inhabited the mainland peninsula that came to be called the Bronx, and used its numerous freshwater waterways for drinking water, food, transportation, waste removal, and recreation (Kadt, 2011). It was in the 1840s that railroad construction turned the valley into an industrial corridor (New York City Dep. of Environmental Protection, 2010) and, with industrialization, power was turned to the production of tobacco, paint, cotton, rubber products, and the River to flushing away waste and providing water for industrial processing (Kadt, 2011). Mills operating along the River decreased its water quality, and dams harnessing the River's power impeded the ability of anadromous fish to spawn upstream. When mills started to close, the Bronx River's water quality became more of a concern, however, the combined sewer and stormwater infrastructure (combined sewer overflow, or CSO) continues to be usable to transfer all the sewage to treatment plants, especially when it rains, causing water pollution to this day. In addition, in the last decades the Bronx River had become "hidden" behind small industry, apartment buildings, roads, and junk (Kadt,

2011). The Bronx River went from a flourishing and beautiful resource to a contaminated conduit for industrial and residential wastes. As it will be shown, thanks to the efforts of the Bronx community that, in the 1970s, started to work to improve the river and the neighborhood conditions, this trend has changed (DEP, 2010).

The Bronx River winds through areas with different land use and physical characteristics. Neighborhood and community around the River are characterized by industries to the south and residential and parkland uses in the central and northern segments (DEP, 2010). The southern portion of the Bronx River has undergone an important makeover in recent years, from an industrial no man's land to an increasingly people-friendly waterfront; however, there are still many accessibility problems due to the presence of a train line and an expressway, Amtrak line and the Sheridan Expressway (DNAinfo.com New York, 2012). The central section of the Bronx River area is dominated by Bronx Park, an extensive parkland that includes the New York Botanical Garden and the Bronx Zoo, and the northern segment is mostly residential (New York City Dep. of Environmental Protection, 2010). In summation, the densely populated section of the Bronx River that passes through industrial areas shows a range of problems typical of urban rivers, while the northern part that passes though Bronx Park is mostly naturalized and well vegetated.

Human activities implemented over 400 years along the Bronx River have had a very high impact on the river ecology and on the environment. Below, a description of the main ecological and environmental imbalances, regarding stormwater management, biodiversity loss, invasive vegetation, and water quality, will be provided. The urbanization of the area around the Bronx River (which houses approximately 210,000 people) has resulted in an increase in annual stormwater runoff to the water body and has all but eliminated any natural response mechanisms (e.g. tidal marshes, buffer zones) that could helped absorb this hydraulic load (DEP, 2010). According to McDonnell and Larson (2004), impervious surfaces such as rooftops, parking lots, and roads cover more than 60% of the River's upland areas and inhibit the watershed's natural hydrological function. Due to stormwater runoff, water goes directly into the River through sewers and drains and is not be intercepted by vegetation or absorbed by soil (Dunnett and Kingsbury, 2008). This results in disturbed flow patterns within the river channel that cause flash floods, erosion, low habitat value, high water temperatures, low base flow, and excessive sedimentation(Bronx River Alliance, 2006a). This is not the only problem related to human activities; other examples including dams located in the Bronx Park section that work as barriers to fish passage, floating waste as debris, and sewage, inputs of which lower dissolved oxygen (DO) levels and limit the growth and survival of aquatic organisms. Habitat degradation, the result of riparian management, channel degradation, and poor hydrology and water quality, prevents diverse flora and fauna from establishing and, as poor water quality violates health standards, these waters are also unsuitable for public recreation: during storm events, combined sewer overflows discharge untreated sewage, stormwater, and other pollutants into the River, which results in poor water quality conditions in this section of the River (Bronx River Alliance, 2006a). Combined sewer systems are designed to collect rainwater runoff, domestic sewage, and industrial wastewater in the same pipe. During periods of heavy rainfall or snow melt, if the wastewater volume in a combined sewer system exceeds the capacity of the sewer system or treatment plant, excess wastewater can be discharged

directly to nearby streams, rivers, or other water bodies (http://cfpub.epa.gov/npdes/home.cfm?program_id=5).

Another important aspect is the presence of invasive vegetation, which limits the diversity of the vegetative community, contributes to bank instability, and excludes trees from the riverbank, thus limiting the supply of large woody debris necessary to create certain habitats (Bronx River Alliance, 2006a).

The ecological restoration and the greenway

The ecological restoration of the Bronx River started in the 1970s. What described below (i.e. the Bronx River restoration timing) is the result of the broad survey of local newspapers (e.g. the Bronx Press Review, Bronx Beat, Bronx Times), carried out for the research. Thomas Angotti, Professor of Urban Affairs and Planning at Hunter College and the Graduate Center, City University of New York, and Robin Kriesberg of the Bronx River Alliance ware consulted to comment the relation between politics and the trend identified by the survey.

In 1974, in response to the poor conditions of the Bronx River, local residents formed the Bronx River Restoration Project, Inc. (BXRR) and removed debris from the shoreline of the Bronx River (New York City Dep. of Environmental Protection, 2010). According to Angotti (personal communication, December 13, 2013), this trend can be related to Federal and local politics. «During the [administration of President Richard] Nixon (1969-1974) and the crisis [of] near bankruptcy of New York City in 1975, the South Bronx was written off by local and national policies as a declining area that was not worth the investment. However, the community-based efforts to improve and restore housing and communities have created a viable Bronx, which is attracting new investments for development resulting also in gentrification processes».

The first plan released by BXRR (Bronx River Restoration Plan, 1977) was sent to the White House care of the Democratic President Jimmy Carter (1977-1981). «A direct appeal to President Jimmy Carter for his aid in expediting the Bronx River Restoration program has been sent to the White House. [...] We need your help in two ways': to identify the channels through which the program can receive Federal funding and to help expedite such procedure. With your indicated interest, BXRR can become a symbol of self help to which your administration can point with satisfaction and justification [...]» (Bronx Press Review, 1977). Just a few years after the community started to work on the Bronx River, the important involvement of New York City municipality was formalized by the release, in 1979, of “Restoring the Bronx River” (Bronx Press Review, 1979).

In the 1970s, among the most important initiatives implemented to restore of the Bronx River are simple communication and community outreach. Seminars conducted by a team of ecological experts of the City University of New York examined the reasons for the current condition of the River and set long range plans for its restoration, and were organized already in 1974 by Bronx Community College (Bronx Press Review, 1974). Fairs, exhibitions, and festivals were also organized in the following years (Bronx Press Review, 1975), and the Bronx River Rehabilitation Exhibit was made (Bronx Press Review, 1977).

Activities implemented to improve the River and the neighborhood saw an interruption in the 1980s, however, but regained momentum at the end of the century. When asked about the slowing down of restoration activities near the Bronx River during the 1980s, Angotti links the trend specifically to the Federal politics: «Most political scientists would agree that [the administration of President Ronald] Reagan (1981-1989) was a real turning point in government policies away from welfare state to neoliberal state» (Angotti, 2013).

The 1990s were dynamic years for the Bronx River, going back to the1992 Bronx River Trailway Plan to create a greenway all the way along the River (New York Times, 1992). The greenway was conceived not only as a pedestrian and bicycle route, but as a linear park that would serve a population long deprived of green open space and waterfront access (Bronx River Alliance, 2006b). In this period, several groups and programs, involving both local community groups and NYC Departments, were created, including the Partnerships for Parks, a joint program of City Parks Foundation and NYC Parks founded by local activist in 1995 (Bronx River Alliance, 2006b). In 1997, the Bronx River Working Group was formed by grassroots organizations, made up of local activists who embraced the reclamation of the River and joining with Partnerships for Parks and other units of NYC Parks to draft the Bronx River Action Plan (Bronx River Alliance, 2006b).

The presidential administration of Bill Clinton (1993-2001, following 12 years of Republican Presidents Ronald Reagan and George H. Bush) and the mayoral administration of Rudolph Giuliani (994-2001) played a part in Bronx River restoration initiatives as well, explained Angotti, but not as much as the environmental justice activists in the South Bronx (T. Angotti, personal communication, December 13, 2013).

The work to restore the Bronx River was also made possible by grants and funds from NYC Parks and the Federal Government, which also funded a reconnaissance study examining flood control and the potential to restore the damaged ecosystem of the Bronx River (Norwood News, 1999; Bronx Beat, 2000).

In 2001, the Bronx River Working Group formed the Bronx River Alliance as an independent non-profit organization, working in close partnership with NYC Parks to protect, improve, and restore the Bronx River corridor to be a healthy ecological, recreational, educational, and economic resource (DEP, 2010), and to coordinate and track the implementation of the Bronx River Greenway (New York City portion, (Bronx River Alliance, 2006b). The Bronx River Alliance consists of 74 community-based and other non-governmental organizations as partners and supporters, the Federal Government (i.e. the Environmental Protection Agency (EPA)), State and local government (Bronx River Alliance, 2006a). According to Robin Kriesberg of the Bronx River Alliance, a bottom-up approach allows the community to remain involved. «Everything started from a branch of smaller groups in the area that were interested in cleaning up the river that was neglected – there was lot of dumping and it was not accessible from the community. They formed some working groups trying to address some of the issues and problems, got some funding and worked together to clean up (pulling out cars, washing machines, trash) and got the City to buy some land around the river to build public parks. From that original work, they formed the Bronx River Alliance». (personal communication, November 18, 2013).

Since the Alliance works a lot with volunteers due to a lack of money to hire so many people, they try different ways of training and involving (R. Kriesberg, personal communication, November 18, 2013). Thanks to these efforts local community organizations (as Sustainable South Bronx, http://www.ssbx.org/) coordinate volunteer activities working together with the Bronx River Alliance, planting trees, maintaining green areas, etc.

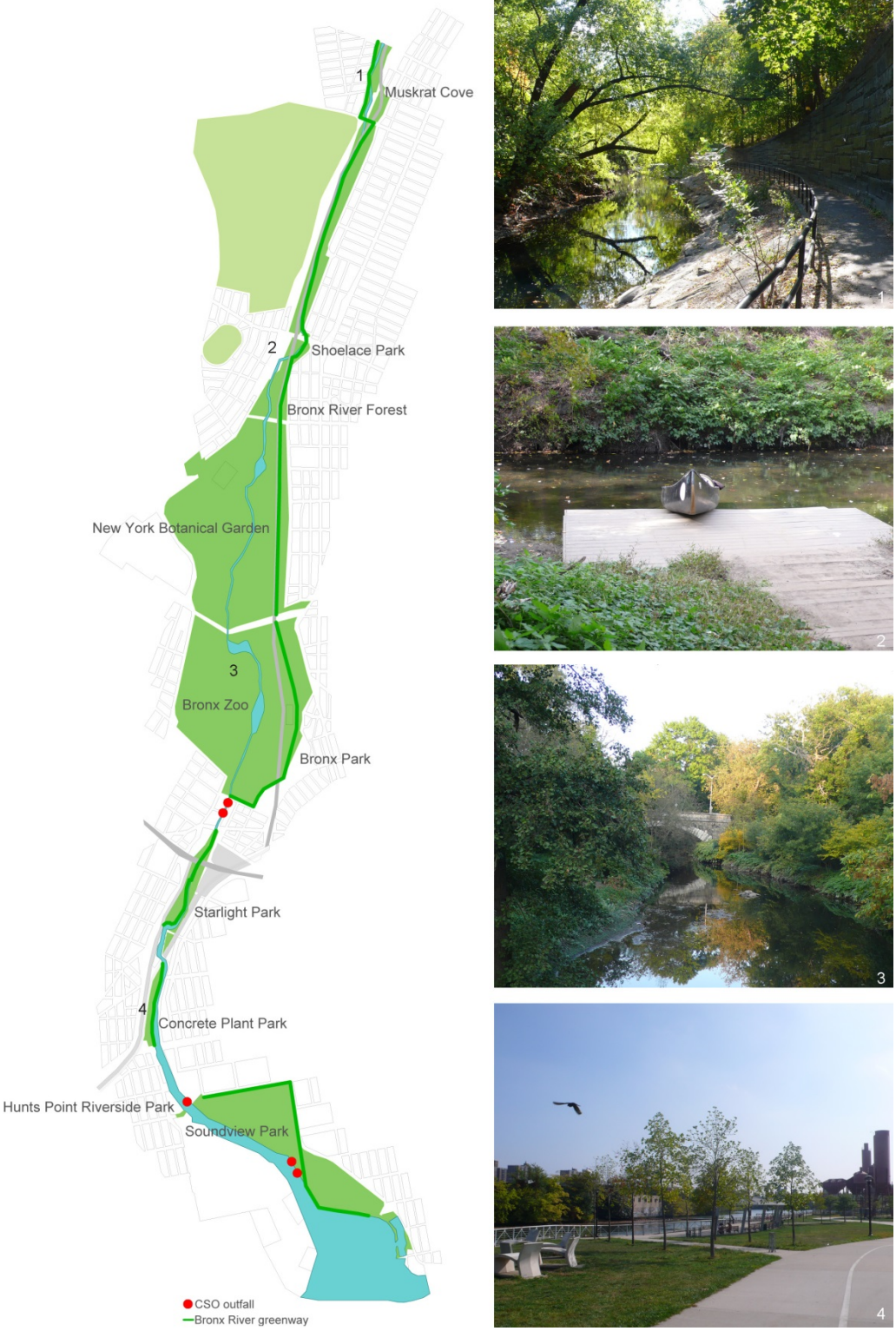
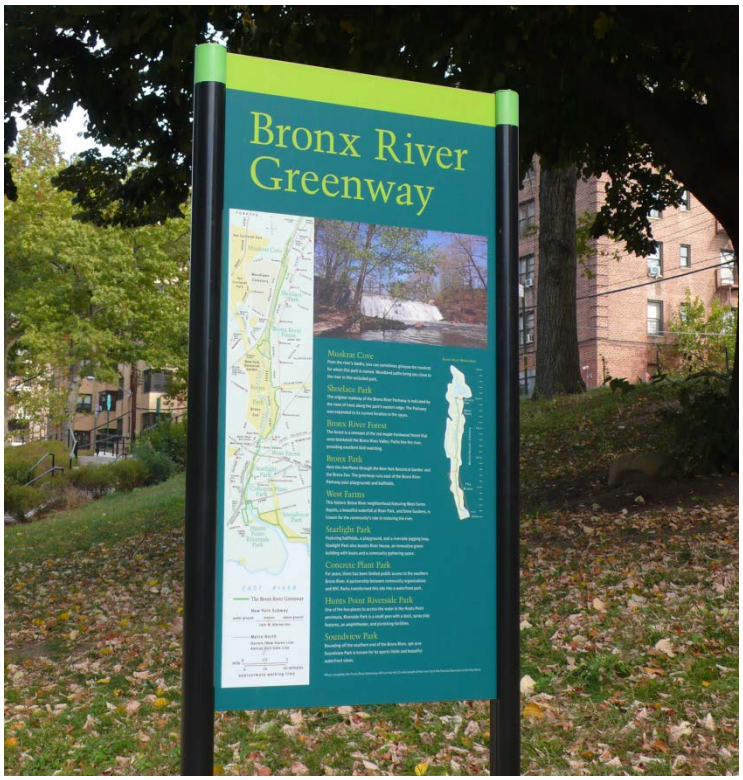


Figure 1. Bronx River Greenway, the Bronx, New York City.

Goals, strategies, projects, results

Goals and strategies implemented in and for the Bronx River address operation and maintenance procedures and related planning efforts to maximize capture of CSO and reduce contaminants in the combined sewer system for water quality. Green solutions are considered as control technologies and can be effective in restoring site hydrology to capture, infiltrate, evaporate, and detain stormwater runoff to reduce both its volume and peak overflow rate, and consequently the volume of stormwater entering the combined sewer system, while improving its quality (the "first flush" contains the highest concentration of nitrogen, other nutrients, and urban pollutants). Some common green solutions include bioretention (rain garden), vegetated buffers, grassed swales, green roofs, and increased tree cover (DEP, 2010).

In general, the main ecological goals of the Bronx River Alliance are the improvement of the Bronx River water quality via reduced direct and indirect sewage inputs and illegal discharges, and increased natural treatment of stormwater through infiltration thereby reducing direct releases from CSOs, and the improvement of hydrology in reducing erosion, sedimentation, and habitat disturbance. Biodiversity plays an important role too, with ecological goals including protecting and improving the aquatic and riparian plant and animal biological diversity and habitat through targeted removal of invasive vegetation, and increasing the connectivity between reaches and facilitating the passage of diadromous fish (Bronx River Alliance, 2006a).



Figures 2. The Bronx River greenway.

The Bronx River Greenway opened up new green space in neighborhoods and enhanced existing parks, connecting also some areas currently separated by highways, railroads, and other barriers (Bronx River Alliance, 2006b). The greenway design aims to follow ecological performance guidelines, related to landscape (e.g. increase ecological connectivity and habitat diversity, increase public amenities and quality of life, controlled invasive plant species), stormwater management, hardscape (e.g. increase smart access to the river, replace informal circulation networks with bike and pedestrian connections), streetscape, and sustainable maintenance practices. The Bronx River Greenway aims to be a sustainable transportation resource, a vehicle for the ecological restoration of the river and its banks, a catalyst for ecological restoration of the wider watershed and the revitalization of the communities along the river an educational resource, a "blueway" (a means of access to the river for boating), and a resource for a wide variety of recreation.

Through the work of local community organizations, NYC Departments, and especially of the Bronx River Alliance described above, many greened areas and a continuous, 23 miles greenway have been installed, with very important environmental, ecological, and social effects in the underserved neighborhood and on a formerly degraded River. The improvement in water quality and the actions carried out led to important results, such as a significant and measurable increase of biodiversity. In addition to ecological and environmental improvements, neighborhood conditions have also changed over the past few years, with the 2006 opening of the greenway affect[ing] land values in the watershed's neighborhoods (Bronx River Alliance, 2006b).

Although several connections along the greenway are still missing, forcing visitors to navigate crumbling sidewalks and busy roads on their way in and out, «the southern portion of the Bronx River has undergone an eye-catching makeover in recent years, from an industrial no-man's land to an increasingly people-friendly waterfront» (DNAinfo.com New York," 2012).

Conclusions

The case of the Bronx River demonstrates how effective a collaboration between local community organizations and public bodies can be in a low income community, [and] in a neighborhood with many social and environmental issues, while favorable conditions are important (e.g. the policies of President Bill Clinton and Rudolph Giuliani), the environmental justice activists of the South Bronx have played the most important role. Everything started with a branch of residents cleaning up the river 40 years ago, passing through protests of local community organizations, over time better organized, pushing the City and the State to work for the project. A long history of work, fights, plans, and efforts to involve the city for funds and grants, teaching, outreach activities, took where they are now: the Bronx River Alliance consists of 74 community-based and other non-governmental organizations working together keeping a community based structure.

The role played both by the community and the public bodies involved is fundamental; on one hand, the main credit for the change of trend belongs to the Bronx community, on the

other, the support (economic especially) at City, State and Federal level allowed the initiatives to be implemented.

Following community priorities may bring about important results, providing projects with State and City resources that would not be possible otherwise: in the case of the Bronx River, the community still plays a fundamental role since NYC cannot maintain all the green areas and requires the cooperation of volunteers. Local community organizations work to involve residents; their work is very effective because of its bottom-up approach, and because it is responsive to the interests of citizens. Therefore, in the case of the Bronx River, relevant mutual benefits we obtained through an effective collaboration.

The Bronx River and its surrounding area have undergone an important makeover in recent years, going from, in some segments, an industrial no-man's land to an increasingly people-friendly waterfront; from a polluted river to a beautiful stream; from asphalted to park. There remain, however, many accessibility, ecological, and environmental issues related to transportation and industries and any future improvements will also thanks to the collaboration of citizens and volunteers.

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