Urban Agriculture as Green Infrastructure: The Case of New York City

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Efforts to reduce storm water through innovative green infrastructure projects may provide unique opportunities for cities to finance urban agriculture. Since 2011, New York City has been able to provide funding to four urban agriculture projects, including a one-acre commercial rooftop farm, through its Green Infrastructure Grant Program.

Different forms of green infrastructure
Source: New York City Department of Environmental Protection

New York's experience suggests that if productive landscapes are integrated into storm water management planning, cities may be able to both reduce storm water flow and resulting water pollution and at the same time support the creation of farms and edible gardens, at a lower cost than traditional storm water adaptation measures would require. The organisational challenge in New York and elsewhere is to affirmatively support urban agriculture projects in green infrastructure programs by prioritising the multidimensional benefits of edible landscapes, including their function as a climate change adaptation strategy as well as for their capacities for storm water absorption.

Combined sewer overflow

Most cities have combined sewage systems in which sewage and storm water are conveyed to water pollution control plants in a single pipe during wet weather. Because these treatment facilities are engineered to handle only dry-weather flows, during rain events the excess of the combined flow is often diverted, untreated, into nearby waterways to avoid inundating the facilities. In the case of more extreme weather events — which may occur more frequently due to climate change — heavy rains cannot be absorbed and may flood roads and properties. In cities with inadequate or poorly maintained sewerage infrastructure the flooding may be even more frequent and more severe. Both types of events lead to high social and environmental costs, including significant pollution of urban waterways with potential public health consequences (Walsh et al., 2009). Cities are under increasing pressure to adapt to climate change in general and to reduce combined sewer overflow (CSO) pollution in particular. In the USA the federal Clean Water Act mandates action to stem this source of water pollution (Adler et al., 1993).

A conventional strategy to address CSO is to invest in "grey infrastructure": expanded water pollution control facilities; increased-diameter sewage pipes that hold larger volumes of storm water; or tanks to store sewage until it can be pumped back through the water pollution control plants after it stops raining. These options are both costly and politically unpopular in communities faced with the prospect of hosting this infrastructure. A potentially more cost-effective option that avoids facility siting conflicts and can offer host communities benefits beyond reduced flooding and pollution is to increase the permeability of the cityscape through diverse forms of "green infrastructure": parks, landscaped median strips on roadways, permeable pavement, and agricultural sites. Green infrastructure not only absorbs and slows storm water to reduce the quantity that enters the sewer system; it can increase biodiversity, reduce the urban heat island effect and, in the case of urban farms and gardens, provide all of the benefits associated with urban agriculture.

New York City's Green Infrastructure Program

New York City is under a consent order to reduce CSO pollution. In developing a management strategy, the city evaluated the costs and benefits of grey and green infrastructure and found that investing in a green scenario that includes some grey infrastructure was significantly more cost-effective than a conventional approach (DEP, 2010). New York City's Department of Environmental Protection (DEP) committed to investing USD 192 million in green infrastructure by 2015 (DEP, 2012), including "blue roofs" that hold rainwater and release it to the sewage system slowly, extra-large street tree planters, landscaped storm water "green streets", parking lots paved with porous concrete, and vacant paved lots and asphalt rooftops turned into gardens. Over 20 years, the green scenario would cost USD 5.3 billion, including the USD 2.4 billion for this green infrastructure. In contrast, an estimated USD 6.8 billion would be required for a scenario based solely on the types of grey infrastructure mentioned above (DEP, 2010). The green infrastructure scenario thus saves the city and the property owners who pay water and sewer fees USD 1.5 billion in costs over a 20-year period.

Land Use	% of Combined Sewer Watershed	Potential Strategies and Technologies
New development and redevelopment	5.0 %	Stormwater performance standard for new and expanded development
		Rooftop detention; green roofs; subsurface detention and infiltration
Streets and sidewalks	26.6%	Integrate stormwater management into capital program in partnership with DOT, DDC, and DPR
		Enlist Business Improvement District; and other community partners
		Create performance standard for sidewalk reconstruction
		Swales; street trees; Greenstreets; permeable pavement
Multi-family residential complexes	3.4%	Integrate stormwater management into capital program in partnership with NYCHA and HPD
		Rooftop detention; green roofs; subsurface detention and infiltration; rain barrels or cisterns; rain gardens; swales; street trees; Greenstreets: permeable pavement
Parking lots	0.5%	Sewer change for stormwater
		DCP zoning amendments
		Continue demonstration projects in partnership with MTA and DOT
		Swales; permeable pavement; engineered wetlands
Parks	11.6%	Partner with DPR to integrate green infrastructure into capital program
		Continue demonstration projects in partnership with DPR
		Swales; permeable pavement; engineered wetlands
Schools	1.9%	Integrate stormwater management into capital program in partnership with DOE
		Rooftop detention; green roof; subsurface detention and infiltration
Vacant lots	1.9%	Grant programs
		Potential sewer change for stormwater
		Rain gardens; green garden
Other public properties	1.1%	Integrate stormwater management into capital programs
		Rooftop detention; green roof; subsurface detention and infiltration: rain barrels; permeable pavement
Other existing development	48.0%	Green roof tax credit
		Sewer charges for stormwater
		Continue demonstration projects and data collection
		Rooftop detention; green roofs; subsurface detention and infiltration; rain barrels or cisterns; rain gardens; swales; street trees; Greenstreets; permeable pavement

New York green infrastructure plan: Opportunities, strategies and technologies Source: New York City Department of Environmental Protection

Green infrastructure absorbs and slows storm water run-off, increases biodiversity, reduces urban temperatures and can provide food and economic benefits

In addition to these benefits, green infrastructure simultaneously provides natural resource sinks that reduce air pollution and assist in urban climate control by cooling the city during hot summer months. It also provides important green networks in urbanised areas, enhancing the quality of life of urban dwellers and increasing their property values by an average of 2–5 % (NRDC, 2013). When the green infrastructure is a garden or farm, it supplies fresh fruit and vegetables and many other social and economic co-benefits to communities, including the health benefits of increased access to produce, the physical benefits of gardening, garden-based educational opportunities, job creation and the creation of safe spaces (Cohen et al., 2012). Community gardens increase the value of nearby properties (Voicu and Been, 2008).

Urban agriculture as green infrastructure

As part of New York City's Green Infrastructure Grant Program, DEP provides funds to private property owners and organisations to build green infrastructure projects. In order for projects to receive funding, they must demonstrate feasibility and be designed to capture and retain a minimum of 1 inch (2.54 cm) of storm water from the impervious tributary area. In the first round of green infrastructure grants, the city provided USD 592,730 to the Brooklyn Navy Yard, a collection of industrial buildings on the waterfront that served as a shipyard during the Second World War, and the Brooklyn Grange, a rooftop farming company, for the funding of what the Grange calls "the world's largest rooftop soil farm". Covering approximately one acre (0.4 ha), the farm is located on the rented roof space of Building No. 3 in the Brooklyn Navy Yard. The Grange grows a variety of produce according to organic principles, including tomatoes (40 varieties), salad greens, carrots, herbs, peppers, beans, radishes, and chard. In addition, they keep egg-laying hens, and bees in a commercial apiary. Brooklyn Grange sells its produce to local restaurants and retail stores, to their community supported agriculture (CSA) members

Brooklyn Grange farm Photo: Brooklyn Grange (http://brooklyngrangefarm.com)

and to the larger public via weekly farm stands in various neighbourhoods. The Grange has expanded its farm business to include an educational non-profit (providing educational tours and workshops) and urban farming and green roof consulting and installation services to others interested in urban (rooftop) farming. As a result of its permeable rooftop farm and agricultural activities, the Brooklyn Grange manages over 1 million gallons (3,785,411 litres) of storm water per year, helping to reduce the amount of CSO flowing into New York City's East River.

The DEP has also provided more than USD 770,000 to support the creation of three additional farms and gardens (and two others that have been approved but not yet funded) with some edible landscaping (see table 1). The amount of food production of these sites varies significantly (from a vegetable garden to a plot for herb cultivation that is part of a non-edible landscape design for a recreational space), but they share a focus on multidimensionality in terms of the benefits stemming from the project. Although the DEP views urban agriculture or edible landscaping as a positive feature of a project proposal because of the co-benefits of food production, the focus of the Green Infrastructure Grant Program on storm water management dictates that a project's ability to retain at least one inch of water during rainfall is the primary criterion for funding. (The DEP actively monitors the retention capacity of green infrastructure interventions citywide, though individual projects are not necessarily monitored.)

Discussion

While the number of urban agriculture projects co-funded by the DEP Green Infrastructure Grant Program is small, the potential for supporting the construction of many more farms and gardens as part of this programme is substantial.

> Municipalities should coordinate green infrastructure investments with municipal urban agriculture goals to most effectively support both

In the communities in New York City with significant CSO problems, there are an estimated 2,000 acres (809 ha) of vacant land with mostly impervious surfaces and approximately 3,000 acres (1,214 ha) of flat rooftop space on buildings that have the potential to accommodate farms and gardens. As in many other cities, funds for water and sewer infrastructure in New York come from bonds issued by a public authority and paid for by water and sewer rate payers rather than from the general municipal capital budget,

which makes it somewhat more politically feasible to finance these projects and makes them less subject to municipal budget cuts that result from fiscal downturns.

Nevertheless, there are obstacles to expanding urban agriculture's role as green infrastructure. Administrative agencies in charge of water pollution control, like New York City's DEP, focus primarily on the absorptive capacity of green infrastructure. This is in part because the consent orders driving green infrastructure are about managing storm water, and agency mandates do not include supporting urban agriculture. Benefits such as the nutritional value of fresh vegetables, the educational opportunities of urban gardening, or the creation of communally managed open space are valued, but are subsidiary to water retention capacity. While the DEP has been an innovator in supporting urban agriculture through its Green Infrastructure Program, its prioritisation of storm water management has meant that the onus is on the city's urban agriculture community to propose new farming projects for funding under this programme.
A second challenge to expanding the use of urban agriculture as a green infrastructure is that farms require active management to produce storm water retention benefits year-round, including a cover crop outside of the growing season, as bare soil retains less storm water than plant-covered soil and is also subject to erosion. Though this management is often provided by for-profit farming businesses like Brooklyn Grange or non-profit community organisations, thus lowering public management costs, public agencies need assurances that these entities are financially viable or, in the case of a non-profit, well-established within the community, and therefore likely to maintain site management over the long run. In contrast, other green infrastructure projects, such as landscaped median strips or porous paving stones, often require less intensive maintenance to reliably stem storm water run-off.

Finally, while New York City's Green Infrastructure Grant Program is a valuable source of funds for individual farm and garden projects, it is not yet part of an overall municipal urban agriculture strategy. Planning that addresses the urban agriculture system as a whole would identify opportunities to make available sites for farms and gardens, capital for their construction (including but not limited to green infrastructure funds), and opportunities for non-profit and for-profit farming ventures to secure operating revenue.

Table 1: **Edible landscaping projects funded by NYC's Green Infrastructure Grant Program. (All sites are privately owned, yet most are accessible upon request.)**

Year	Site	Funding GI grant program
2011	Brooklyn Navy Yard rooftop farm	USD 592,730
2011	Lenox Hill rooftop gardens	USD 40,000
2011	Carroll Street Community Garden	USD 244,920
2012	Natural Resources Defense Council	USD 485,132
2013	South Bronx Overall Development Corporation – The Venture Center	Under review
2013	South Bronx Overall Development Corporation – The Jasmine Court	Under review

Key lessons

- Green infrastructure interventions to prevent storm water run-off (or storm-water flooding due to extreme weather events) can be less costly than grey infrastructure interventions.
- Green infrastructure has the additional benefit of assisting in urban climate control and increasing the quality of life of urban dwellers.
- Urban agriculture as a green infrastructure has additional benefits of providing fresh fruits and vegetables and other social and economic co-benefits to communities.
- Urban agriculture can be a multi-dimensional productive strategy of climate change adaptation.
- Green infrastructure grants are valuable sources of funds for urban agriculture projects and an opportunity for cities to support projects that simultaneously address multiple public needs.
- Municipalities should coordinate green infrastructure investments with municipal urban agriculture goals to most effectively support both.

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