
GREEN INFRASTRUCTURE

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Highlights

- Green infrastructure, such as urban parks, community gardens, green buildings, and green roofs, represents a network of human-managed and natural ecosystems that together enhance ecosystem health and climate change resilience, contribute to biodiversity, and benefit human populations through the maintenance and enhancement of ecosystem services.
- Environmental education *in, about, and for* green infrastructure provides significant opportunities for improving human-nature connections in the city.
- Environmental education *in* green infrastructure entails formal and informal place-based learning in built and natural green infrastructure settings.
- Environmental education *about* green infrastructure offers a framework for teaching about the benefits of urban green infrastructure, such as ecosystem services.
- Environmental education *for* green infrastructure provides opportunities for promoting urban environmental stewardship by engaging residents in the planning, maintenance, and use of green infrastructure projects.

Introduction

The term “sustainable city” evokes images of green roofs, energy-efficient buildings, bioswales, bike lanes, urban forests, and other types of green infrastructure. These urban features clearly have value for ecosystem and human health, but

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they also have great educational potential. Green infrastructure can help urban residents improve their understanding of complex sustainability issues, provide opportunities for residents to interact with urban nature, and potentially encourage citizens to take actions to enhance the environment in cities.

Green infrastructure can be defined as a network of human-managed and natural ecosystems that together enhance ecosystem health and resilience, contribute to biodiversity, and benefit human populations through the maintenance and enhancement of ecosystem services (Gómez-Baggethun et al., 2013; McPhearson et al., 2016; Novotny, Ahern, and Brown, 2010). Green infrastructure projects provide a broad array of human and ecosystem services in areas such as food, energy, security, climate regulation, water management, education, and aesthetics. The field of urban ecology has advanced a conceptual framework that considers the ecology *in*, *of*, and *for* cities (McPhearson et al., 2016). This framing reflects ecological research taking place *in* cities; a systems approach to study the ecology *of* cities that considers the complexity and dynamic interactions of social, ecological, economic, and built components; and how the field can be positioned *for* advancing urban sustainability and resilience (Childers et al., 2015; Grimm et al., 2008; Pickett et al., 2001). These ideas resonate with the work of Lucas (1972), who proposed an education *in*, *about*, and *for* the environment. By synthesizing these ideas, we propose a framework of urban environmental education *in*, *about*, and *for* green infrastructure (Figure 27.1),

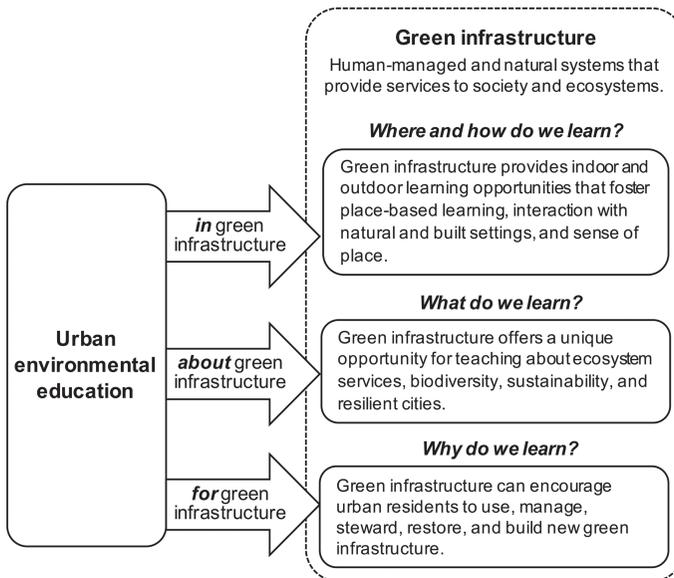


FIGURE 27.1. Urban environmental education *in*, *about*, and *for* green infrastructure.

and we bring these themes to life by sharing several case examples. Put another way, we address three questions related to green infrastructure education: Where and how do we learn? What do we learn? Why do we learn?

Education *in* green infrastructure refers to the rich opportunities for place-based education in cities. Here we discuss opportunities for using green infrastructure in classroom and after-school activities and deepening student contact with and attachment to their local environment. Education *about* green infrastructure refers to the vast learning opportunities provided by infrastructure projects in cities, where ecosystem services are entangled with human development and can teach fundamental lessons about systems thinking, sustainability, and resilience. Finally, education *for* green infrastructure focuses on the need for increased public education regarding the benefits of green infrastructure, which could increase public support, management, and stewardship of present and future green infrastructure projects.

Environmental Education In Green Infrastructure

Environmental education *in* green infrastructure is concerned with rooting education in place. If green infrastructure in cities can be used for environmental education, then the lessons learned are necessarily about the local environment where learning occurs. In the words of Geertz, “[N]o one lives in the world in general” (1996, p. 259). Place-based education in green infrastructure can make abstract ecological principles concrete.

Demonstration projects can illuminate the potential for environmental education *in* green infrastructure. For example, the Center for Sustainable Building Research at the University of Minnesota in the United States initiated a demonstration project titled “Art, Story, and Infrastructure: A Model for Experiential Interconnection in Environmental Education.” This project takes kindergarten students on a tour of the urban water cycle using water infrastructure from the Minnesota landscape, from treatment facilities to the school building sink, all the while incorporating place-based environmental education and participatory art. Another example is the Urban Ecology Center at Riverside Park in Milwaukee, Wisconsin (Figure 27.2). This center showcases a green building, solar power station, public art, urban wasteland being transformed into a park, riparian habitats, classrooms, and a climbing wall, all of which are intended to improve visitors’ environmental experiences and knowledge. Educational efforts such as these are rich in their ability to string together disciplines like civil engineering, landscape architecture, and building design to trace both ecological and human processes, all grounded in the learners’ lived environment.

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FIGURE 27.2. The Riverside Park branch of the Urban Ecology Center, Milwaukee, Wisconsin, United States. Credit: Urban Ecology Center.

Despite the potential to use place-conscious education and systems thinking to advance sustainability education, current public educational models face challenges in using these approaches. Such strategies may require additional financial resources and time from school districts and teachers. Moreover, some green infrastructure projects lack access and educational interpretation, making them difficult destinations for classroom field trips. Further, the place-based nature of education in green infrastructure may not align with more abstract, place-neutral methods of educational assessment that emphasize measurement and accountability. Challenges notwithstanding, examples around the world illustrate the potential of environmental education *in* green infrastructure. Cities, schools, and community organizations may need to collaborate and invest additional resources to unleash this potential.

Environmental Education *About* Green Infrastructure

Urban environmental education provides opportunities to teach *about* the benefits of green infrastructure and therefore improve urban residents' understanding of the impact that green infrastructure has on their own health and

well-being. This approach includes lessons about planning and designing multi-functional and inclusive urban green infrastructure. Teaching *about* green infrastructure can borrow ideas from urban ecology to increase public understanding of high-performing social, ecological, and biophilic landscapes (Beatley, 2011; Novotny, Ahern, and Brown, 2010). In particular, the concept of ecosystem services, a widely used term in urban ecology (Elmqvist et al., 2013), can be used to frame the benefits of green infrastructure and ecosystems for human health and well-being. For example, in San Francisco, the California Academy of Sciences provides tours of its Leadership in Energy and Environmental Design (LEED)-certified green building to teach visitors about using green infrastructure to reduce waste, save energy, reuse materials, provide healthy indoor environments, create rooftop habitats for birds and insects, and other ecosystem services (Figure 27.3).

In general, ecosystem services refer to those ecosystem functions of green infrastructure that are used, enjoyed, or consumed by humans. Ecosystem services can be categorized into four types: provisioning services (e.g., drinking water, raw materials, and medicinal plants); regulating services (e.g., pollination, water purification, carbon sequestration, flood control, climate



FIGURE 27.3. At the California Academy of Sciences in San Francisco, California, United States, a docent educates visitors about ecosystem services provided by the green roof, including insulation, storm water control, and fresh air, which help the academy and surrounding parkland thrive. Credit: Alex Russ.

regulation); habitat and supporting services (e.g., nutrient cycling, soil formation, photosynthesis, habitat for species); and cultural services (e.g., recreational, educational, and spiritual experiences) (Gómez-Baggethun et al., 2013; Millennium Ecosystem Assessment, 2005; TEEB, 2011). Urban residents, whether they recognize it or not, rely on ecosystem services produced by green infrastructure both within and outside the city. Urban green infrastructure is especially important in providing services with direct impact on human health and security such as air purification, noise reduction, urban cooling, and storm water runoff mitigation, but it also provides places for social cohesion and connection, recreation, and development of sense of place. Further, green infrastructure is being increasingly used as a nature-based solution for climate change adaptation and mitigation in cities (McPhearson et al., 2016). For example, cities are investing in green infrastructure as a specific management tool for combining engineered and ecological systems (e.g., bioswales) in place of engineered systems lacking ecological or green features (e.g., concrete sewer drains) to provide ecosystem services such as cooling, storm water management, urban heat island reduction, carbon storage, flood protection, and recreation (Novotny, Ahern, and Brown, 2010).

Environmental education *about* green infrastructure reflects the ways cities provide opportunities for complex and interdisciplinary sustainability lessons. Green infrastructure offers lessons in science, mathematics, art, design, history, social studies, and beyond. From storm water pathways to pocket parks with bird habitat to plazas with permeable surfaces, green infrastructure in cities provides endless venues for lessons about how human settlements interact with ecosystems. In urban environmental education, green infrastructure gives visibility to processes such as water flowing through cities, sunlight converted to heat and electricity, food being grown, species migration using greenway trails, and urban forests that support biodiversity and recreation.

Cities are complex and best studied as an entanglement of systems that are social, cultural, technical, and ecological in nature (e.g., Grimm et al., 2008; McPhearson et al., 2016; Pickett et al., 2001). By focusing on the multiple functions of green infrastructure, urban environmental education teaches about systems thinking. For example, urban community gardens provide food, absorb excess storm water, mitigate microclimate fluctuations, support urban biodiversity, and provide aesthetic benefits. These gardens become places for recreation, reflection, social bonding, and cohesion. Similarly, green roofs and vegetated areas can increase rainwater infiltration and reduce peak flood discharge and associated water pollution while also delivering mental and physical health benefits such as providing spaces for recreation, relaxation, and reducing stress.

These kinds of green infrastructure projects are critical for building community resilience, and they simultaneously offer rich contexts for urban environmental education.

Environmental Education For Green Infrastructure

Environmental education can amplify public support *for* green infrastructure. Urban environmental educators can play a critical role in fostering support for current and future green infrastructure projects, helping cities push toward a community-based form of urban land management that has been described as urban ecological or civic ecology stewardship (Krasny and Tidball, 2015; Svendsen and Campbell, 2008). Environmental education can help to promote, create, and maintain green infrastructure in multiple ways.

First, educators can involve adults and children in the planning and maintenance of green infrastructure. Such projects may require deep and sustained partnerships between local governments, grassroots groups, nonprofit organizations, businesses, and schools. For example, in the Bronx, New York City, community-based organizations such as the Bronx River Alliance, Youth Ministries for Peace and Justice, and The POINT Community Development Corporation involved high school students and other urban residents in designing a concept plan for greenways along an urban river and streets. As another example, the 1.2-hectare Grands-Moulins–Abbé-Pierre garden in Paris offers an inspiring case of how residents actively manage green spaces and rediscover nature in the city. These examples show that diverse members of urban communities can play a role in decision making about green infrastructure development.

Second, urban environmental education can involve people in using green infrastructure. With bike lanes, gardens ready for growing vegetables, and green buildings open for tours, cities are providing green infrastructure projects that become dynamic examples of sustainability woven into the daily life of citizens. In this way, green infrastructure acts as a stage for informal environmental education as people spontaneously engage “hands-on” with green infrastructure projects. For example, many community-based education/restoration organizations in the United States offer free canoeing in restored urban waterways for residents to rediscover local recreational opportunities, potentially raising public support for urban open space.

Third, education related to green infrastructure may inspire interest and future action to expand green infrastructure in cities. Berlin offers an example of how



FIGURE 27.4. Natur-Park Südgelände in Berlin resulted from the efforts of civically engaged residents. Credit: Cecilia Herzog.

citizens knowledgeable about the benefits of open and multifunctional spaces supported the revitalization of an urban green space. In the 1980s, local residents formed a nonprofit organization to protect an eighteen-hectare railyard. The railyard had been abandoned for five decades during Berlin's separation of East and West, a circumstance that allowed the landscape to regenerate while untouched by development. Despite the area's proximity to a densely populated neighborhood, civic activists and professional planners influenced policy makers to protect it. Their efforts, along with ecological research, helped transform the area into the Natur-Park Südgelände, opened in 2000 (Kowarik and Langer, 2005) (Figure 27.4). The park offers a model for green infrastructure that fosters a strong sense of place for residents by nurturing cultural values related to art, education, and sport. In this way, it also provides opportunities for education *in* and *of* green infrastructure.

Conclusion

Urban environmental education *in*, *about*, and *for* green infrastructure offers a unique voice as cities design, build, and promote ecologically and socially conscious infrastructure. In particular, we suggest that environmental education *in* green infrastructure can offer nature-based opportunities for place-based environmental education, help to build sense of place, and use spaces that otherwise may not be perceived as educational (e.g., waste-management

facilities, mechanical rooms of green buildings, and bioswales). Advancing environmental education *about* green infrastructure can showcase the social and ecological benefits of urban green infrastructure to residents' everyday lives, thus increasing awareness of the value of urban nature. Finally, we suggest that environmental education can be employed *for* encouraging hands-on stewardship or restoration of green infrastructure and for programs that encourage cities to build new green infrastructure and better manage existing infrastructure.

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