H.R. 2424: The Community Parks Revitalization Act (2013)

An analysis of the scientific basis for action

Summer 2014
ENVP U9229: Workshop in Applied Earth Systems Management
Masters of Environmental Science and Policy
School of International Public Affairs, Columbia University
Submitted: August 13, 2014

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Executive Summary

"The nation behaves well if it treats its natural resources as assets which it must turn over to the next generation increased, and not impaired, in value." — Theodore Roosevelt

The Community Parks Revitalization Act (2013)

This Act authorizes the Secretary of Housing and Urban Development (HUD) to administer federal grants and a loan program for the rehabilitation, construction, innovation, and programming and recovery actions in urban parks to benefit metropolitan communities. The primary criteria steers resources toward projects that leverage local funding to address health, economic development, and conservation concerns that are the primary benefits of Parks and Recreational facilities.

To address the impact of urbanization on the environment, the criteria further specifies projects utilizing environmentally beneficial components, the provisioning of environmental benefits to urban areas and sustainability benchmarks, like the Leadership in Energy and Environmental (LEED) Certification. For the loan portion of the proposed legislation, the criteria include whether the project uses new or innovative approaches and the extent to which the project helps to maintain or protect the environment.

The Scope of this Report

The Community Parks Revitalization Act addresses many social, health, economic development, and environmental issues critical to its design and implementation. The scope of this report focuses specifically on the scientific and environmental components of the Act. The analysis centers on establishing the scientific basis of the essential argument that parks play a significant role in the local environment and the extent to which they mitigate the effects of urbanization in increasing densely populated metropolitan areas. Consequently, this report details the environmental problems being addressed, identifies scientific indicators to measure the success of likely outcomes, and discusses the policy implications. The scientific foundation should play a critical role in understanding of the intent of the Act and should serve as a basis to gain necessary community support. A subsequent report will focus on the main policy and administrative issues of the Act.

The Problem

Population growth in U.S. cities outpaces growth in the rest of the country, resulting in over 83% of the population living on 3.7% of the total available land in the United States. According the U.S. Census Bureau, the urban growth rate over the decade from 2000 to 2010 was 14.3%, or 1

new person for each 7 current residents (see ***Figure 1***).[1] With each new person, stress on the urban system increases, therefore leading to a deepening of the deterioration of natural ecosystem services and their direct and indirect benefits to people.

Modern urban environments have compromised the ability of nature to absorb excess pollutants, to buffer the effects of weather and to provide a comfortable environment for populations. Pavement, narrow corridors of streets lined with buildings, the concentration of industry and automobile traffic are all features of the modern urban environment. Parks act as valuable community assets inherited as part of a legacy in the growth and development of the modern landscape and a provide respite from intensity of the city. However, the complexity of the interactions between humans and the environment make it difficult to fully understand the exact value for their ability to mitigate the effects of urbanization.

The Science

In recognition of the complexity of systems, rather than approaching metropolitan environments as something separate from nature, this report focuses on these environments as a distinct form of ecosystems. As such, each urban environment requires unique inputs of resources and energy to produce goods and services specific to its needs. The environmental problems lie in the inefficiencies and the wastes produced by these systems. While many other issues exist when addressing urban ecosystems, this analysis focuses on three of them: storm water management, air pollution and the urban heat island effect. Parks play a significant and measurable role in each of these examples.

Storm Water Management

A rainstorm that deposits just half an inch of rain onto an urban surface produces 17 million gallons of water per square mile, or roughly enough water to fill three Olympic-sized swimming pools. The urban environment covers surfaces with buildings, asphalt roads and concrete. Because of these impermeable surfaces, an average 55% of rain, or 9.35 million gallons of water, becomes runoff draining into the sewage treatment system or directly feeding into adjacent waterways (see ***Figure 2***). Consequently, rain carries contaminants like spilled oil, detergents, heavy metals solvents, pesticides, fertilizer, and bacteria from pet waste, later putting a burden on sewage systems and thus releasing this mixture into the environment. Given current climate data and the predictions for the future, a continuing rise in the number of heavy precipitation events will exacerbate this problem.

Parks help decrease storm water runoff in urban environments through the following mechanisms: 1. Interception of water by vegetation so that it never reaches a surface to runoff, 2. higher infiltration rates into the soil, 3. higher evaporation rates, and 4. storage of water by

[1] U.S. Census Bureau, Public Information Office. (2012). ***Growth in Urban Population Outpaces Rest of Nation***. Retrieved from website: http://www.census.gov/newsroom/releases/archives/2010_census/cb12-50.html

vegetation. Parks and recreational facilities often include design features such as wetlands and catchment ponds to slow down and store water, thus leading to significant savings for communities. The City of Philadelphia, for example, estimates that the total annual value of parks in storm water management based on savings in sewage treatment was just under $6 million.

The success of the parks utilizes measurements of the change in surface water depth in rivers or streams that occur immediately after a storm begins. The peak flow rises sharply as a direct result of the influx of water into the system. By delaying the time period of the peak flow and the maximum height of the flow, the risk for flash flooding decreases and with it the potential damage to the infrastructure of the city (see ***Figure 5***). Being intentional about allowing for water to run through the natural bioinfiltration provided by the parks accomplishes the goal of slowing the water runoff rate and decreasing the overall amount.

Air Pollution

Approximately 127 million urban residents live in areas that routinely exceed air quality standards. According to a study published in the fall of 2013, total combustion and ozone emissions accounted for over 210,000 premature deaths each year in the U.S.[2] Road transportation, power generation and industrial emissions factor heavily in the production of carbon particulates from the incomplete combustion of fuels and the generation of oxides of sulfur and nitrogen which form the basis for acidified rain and smog respectively. Smoke and dust particles in the air that are smaller than 2.5 μm are a particular concern, because of their concentration in the urban environment and their effect on the health. Furthermore, rising asthma rates, particularly for urban, minority youth, cause lost days at work or school and admissions to emergency rooms, at a cost in 2007 of over $56 billion.[3]

Vegetation in parks significantly reduces amounts of air pollutants. Leaves remove particulate matter and absorb or break down gases like Ozone, Sulfur Dioxide and Nitrous Oxide enter the leaves and are absorbed by water between the cells of leaves to form acids or by chemical means are broken down. Estimates from 1994 in New York City indicate that tree cover removed 1,821 metric tons of air pollution; something estimated at a value of $9.5 million.[4] In a study using data from 2005, looking specifically at the Portland Park system, 2 million pounds of pollutants and 53 million pounds of Carbon dioxide were removed in one year.[5] A study released in July

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[2] Caiazzo, F., Ashok, A., Waltz, I. A., Yim, S. H. L., & Barrett, S. R. H. (2013). Air pollution and early deaths in the united states. part 1 quantifying the impact of major sectors in 2005. ***Atmospheric Environment***, ***79***, 198-208.

[3] National Center for Environmental Health, Division of Environmental Hazards and Health Effects. (2011). ***Asthma in the U.S.***. Retrieved from Centers for Disease Control website: http://www.cdc.gov/vitalsigns/pdf/2011-05-vitalsigns.pdf

[4] Nowak, D. J. USDA Forest Service, (2002). ***The effects of Urban Trees on Air Quality***. Retrieved from website: http://www.nrs.fs.fed.us/units/urban/local-resources/downloads/Tree_Air_Qual.pdf

[5] American Forests: Protecting and Restoring Forests. http://www.americanforests.org/our-programs/urbanforests/10-best-cities-for-urban-forests/10-best-cities-for-urban-forests-portland/portland-urban-forest-fact-sheet/

2014 indicates that the contributions of trees to overall air quality improvement helped avoid 850 premature deaths and 670 thousand incidences of respiratory distress throughout the U.S.[6]

Measuring the success of parks in air quality improvement use existing routine air quality monitoring. Modern sampling techniques allow for monitoring improvements over time and the ability to geospatially reference changes in the levels of Ozone, Carbon Monoxide, oxides of Sulfur and Nitrogen and particulate matter. The ability of the parks to function in this role depend on two important aspects. First, although vegetation in parks has the capability of removing pollutants from the air, the age of the trees, the number of leaves, and the density of the vegetation factor into the amount of pollutants captured. Secondly, the distribution of parks in the urban landscape often places them away from the main inputs of the air pollution creating pockets of elevated levels in distressed segments of the city.

The Urban Heat Island Effect

Urban areas contain materials like concrete that retain heat during the day and then slowly release that heat to the air at night. The urban heat island effect accounts for higher temperatures in the core areas of the central city when compared to the areas surrounding the city. On a hot summer evening, this can account for as much as a 22ºF difference in the air temperature leading to increases in energy consumption and creating a health risk for the elderly or impoverished residents. Moreover, heat tops the list of weather related deaths in urban areas.[7]

The U.S. Forest Service found that New York City's street trees provide an estimated $27 million a year in energy savings by simply providing shade which can cool peak temperatures of open areas up to 20-45°F. Furthermore, evapotranspiration, a process in which water is lost or evaporated from the leaves and roots of plants and in the surface soils to the atmosphere, dissipates the heat in and around the vegetation resulting in a cooler air encompassing it.[8] Evapotranspiration can help reduce peak summer temperatures by 2-9°F.

In order to measure the success of parks in mitigating the urban heat island effect, tools such as geospatial maps and imaging can aid in comparing and contrasting specific park data (see figure 4). Two key strategies for mitigation, would increase the cover of the urban forest and decrease the number of surfaces that trap heat. Evaporating water has the effect of cooling the environment. The same strategy that seeks to manage water applies to the heat island effect.

Policy Implications

Two main considerations affect the ability to leverage the ecosystem services of parks. First, local planners and policy makers need to address questions related to the intended use of parks, the

[6] United States Department of Agriculture, Forest Service (2013). . Forest Service Study Finds Urban Trees Removing Fine Particulate Air Pollution, Saving Lives.
[7] EPA (2014). http://www.epa.gov/heatisland/
[8] New York Department of Environmental Conservation (2014). http://www.dec.ny.gov/lands/30344.html

main plant cover, and the location of parks. Second, considerations regarding the extent to which park improvements must incorporate, or not, the emerging field of green infrastructure.

Green infrastructure includes approaches that can best leverage the environmental services provided by parks. These approaches, practices and technologies reduce the environmental impacts of urbanization by protecting natural systems or by mimicking natural processes. Permeable pavements for example, allows for water to infiltrate into the soil below a solid surface. The simplest approach involves intentionally planting more trees or restoring wetlands in the park.

Effective and efficient park design lies in a delicate balance between the needs of ecosystem services and the desires of a community. Revitalizing a wetland for the purposes of water management potentially conflicts with the desire to have new soccer pitches. Athletic fields purposely incorporate compacted soil, reducing the amount of rain that can absorb into the ground by as much as 75%. On the other hand, trees also require continual maintenance, indicating a long-term commitment of time and resources for any city. The effect of a park on any one community directly relates to its size, the land use within parks, and the overall distribution of parks within a city.

Introduction

Community Parks Revitalization Act (H.R. 2424 of 2013)

On June 18, 2013 New Jersey's 8th congressional district representative, Democrat Albio Sires, sponsored the Community Parks Revitalization Act (HR 2424).[9] This act authorizes the Secretary of Housing and Urban Development (HUD) to implement a community revitalization program for various park and recreation purposes, including federal grants and loans for the rehabilitation and construction, innovations, recreation programming, and recovery action programs. HR 2424 establishes a program enabling communities to better leverage resources to address health, economic development, and conservation concerns through needed investments in parks, recreational areas, facilities, programs, and other complementary activities. The bill proposes implementing two economic incentives: First by providing funds for grants for fiscal years 2013 to 2022 and secondly providing $50 million in loans each year for four years from 2014 to 2018.

Eligibility to receive grants and loans depends in part on location due to the expressed goal of regional representation. Local governments located within standard metropolitan statistical areas (MSA), as determined in accordance with the most recent decennial Census, may apply to a receive a grant. These areas contain a core urban area of 50,000 or more population, consist of one or more counties, and have a high degree of social and economic integration (as measured by commuting to work) with the urban core. The size of the MSA varies and crosses traditional state and municipal boundaries. For example, the MSA that includes New York City comprises an area that extends over the cities of Allentown, Pennsylvania and Stamford, Connecticut and includes 19.9 million people as of 2013.

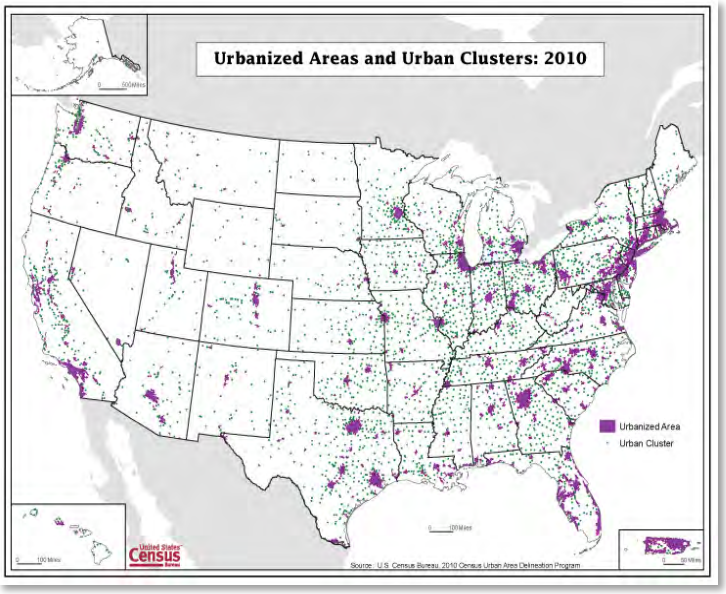

Figure 1: A map showing the locations of the Urbanized Areas (>50,000 people marked in purple) in the U.S.
Source: U.S. Census Bureau.

[9] Sires, A. in U.S. Congress. (2013). ***Community Parks Revitalization Act***. Retrieved from United States Government Printing Office website: http://www.gpo.gov/fdsys/pkg/BILLS-113hr2424ih/pdf/BILLS-113hr2424ih.pdf

Grants

HR 2424 proposes three competitive grant types as follows:

1. Rehabilitation and construction grants for remodeling or creating new parkland areas and facilities. This includes landscape improvements, building necessary infrastructure and support facilities and the installation of lights and emergency phones to improve urban park safety.
2. Innovation and recreation program grants provide funds for supplies, a workforce and facilities with an emphasis on designing methods to increase access to recreational areas.
3. Recovery action program grants for designing and implementing strategies for the purpose of overall recreation system recovery.

The grant recipient can modify approved projects if it can effectively demonstrate that unforeseeable issues impacted the implementation of the initial project proposal. Furthermore, each local government must match the amount received from a rehabilitation and construction grant. Grant recipients must match at least 57% of the total amount from the grant.

Loans

Section 2 of the bill calls on the HUD to establish the selection criteria for projects with anticipated total costs greater than $20 million. The criteria must include the following:

- The extent to which the project is regionally significant to the generation of recreational opportunities;
- The extent to which it fosters innovative public-private partnerships;
- The likelihood that assistance would enable the project to proceed;
- The extend to which the project uses new or innovative approaches; and
- The extent to which the project helps to maintain or protect the environment.

The bill defines the criteria for selection of a project for the loan portion of the bill to encourage a diversity of project types and geographical locations. The HUD sets the criteria for awarding grants based on the following criteria:

- The project serves a community with a high population density, deficiencies in the condition of existing recreational areas and facilities, improves access to neighborhood recreational facilities for underserved populations, located in an area with higher than average unemployed people and promotes physical activity.
- Encourages community participation in determining rehabilitation and development needs and compliments efforts at the local level in development and revitalization.
- The project uses environmentally beneficial components, provides environmental benefits to urban areas and sustainability benchmarks, like Leadership in Energy and Environmental Design (LEED) Certification.
- Improve access to transportation and contains safe routes, bikeways and sidewalks to connect to the local neighborhood.

The Scope of this Report

The Community Parks Revitalization Act addresses many social, health, economic development, and environmental issues critical to its design and implementation. The following report focuses on the scientific and environmental components of the act in order to identify the environmental problem being addressed, the proposed solution, and the development of scientific indicators to measure the success of the Act. These factors play a critical role in understanding the scientific foundation of the Act that will later directly influence in harnessing the support necessary for budget allocation. During the next semester, the team will focus on the main policy and administrative issues of the Act.

What causes the Environmental Problems?

What is the Environmental Problem being Addressed?

The Community Parks Revitalization Act addresses the negative environmental consequences of increased urbanization. Despite losses to these essential services, cities across the U.S. continue growing at a rapid rate. According to the U.S. Census Bureau, the U.S.'s urban population increased by 12.1% from 2000 to 2010, outpacing the nation's overall growth rate of 9.7% for the same period.[10] Growth comes at a cost. Increasing population growth impacts to environmental maintenance and environmental public health.

Increasing urbanization has resulted in deterioration of natural ecosystems, which in turn diminishes the ability of nature to benefit people. Ecosystem services are defined as, "the benefits human populations derive, directly or indirectly, from ecosystem functions"[11] and include improving water and air quality, reducing the impact of severe climate events, and maintaining public environmental health.[12,13] While many problems associated with urbanization have environmental, social and economic repercussions, this report focuses on three key components: storm water management, air quality and the microclimates of cities. To address this loss, urban policy makers increasingly turn to community parks as a means to reestablish and revitalize the ecosystem services in an urban environment. This bill seeks to reverse that trend by revitalizing urban parks as a critical element of a more sustainable and viable community.

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10 Growth in Urban Population Outpaces Rest of Nation, Census Bureau Reports (2012). http://www.census.gov/newsroom/releases/archives/2010_census/cb12-50.html

11 Costanza, R., d'Arge, R., de Groot, R., Farber, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O'Neill, R., Paruelo, J., Raskin, R., Sutton, P., van den Belt, M. (1997).The value of the world's ecosystem services and natural capital. Nature 387 (15), 253–260.

12 M. Luisa Martínez, Octavio Pérez-Maqueo, Gabriela Vázquez, Gonzalo Castillo-Campos, José García-Franco, Klaus Mehltreter, Miguel Equihua, Rosario Landgrave (2009). Effects of land use change on biodiversity and ecosystem services in tropical montanek cloud forests of Mexico. Forest Ecology and Management, Volume 258 (9): Pages 1856-1863.

13 The Economics of Ecosystem Services & Biodiversity. http://www.teebweb.org/resources/ecosystem-services/

Why is it a Problem?

Environmental Maintenance

Storm water management creates direct and indirect costs and requires state and local spending towards efforts to mitigate the effects. Due to the magnitude of both problems and the inherent difficulties of removing contaminants like nitrous oxide, carbon dioxide and sulfur dioxide, urban areas require expensive built infrastructure to manage them. A half of inch of rain produces over 17 million gallons of water per square mile. In nature, permeable green areas provide an efficient and cost effective means for controlling the rate of the runoff and for cleaning the water as it infiltrates into the ground. However, impervious surfaces from roads and buildings, result in 55% of that total, or 9.35 million gallons of water, running off into either sewage treatment or directly in adjoining waterways. Hence, during storm surges, combined sewage systems cannot control overflows that contain untreated human and industrial waste.

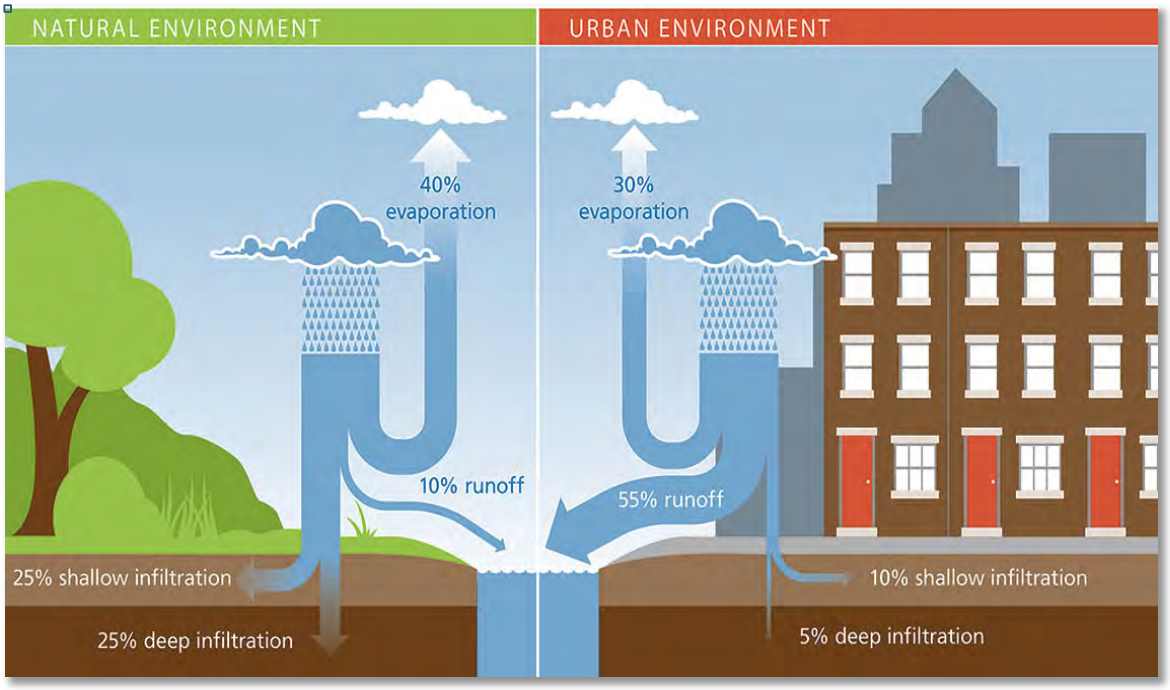

Figure 2: The Hydrologic Cycle for Urban vs. Natural Environments.
Source: City of Philadelphia

Environmental Public Health

Over 80% of the United States' population currently resides in urban areas and the resulting population densities feel the negative effects of low quantity and quality natural ecosystems. While adverse health effects result from a wide array of things, including high medical costs associated with physical inactivity and related health issues, this report focuses on air pollution and changing microclimates in urban areas.

Cities across the U.S. routinely exceed the national standards for air quality, which often occurs along with increased rates of asthma and other breathing problems.[14] In addition, cities are also responsible for 70% of carbon dioxide emissions nationally, causing local temperature increases that in turn increase the concentrations of local air pollutants.[15] Furthermore, air pollution and particulate matter accumulation contribute to infrastructure deterioration, which also requires additional investments in its maintenance. Unfortunately, the distribution of parks in the urban landscape places them away from the main inputs of the air pollution creating pockets of high levels in distressed areas of the city. Studies of urban air quality show that low-income neighborhoods, like East Houston, bear a disproportionate amount of the total air pollutants and contain few parks.[16]

Furthermore, as mentioned above, cities have increased temperatures due to increased concentrations of greenhouse gases combined with large amounts of surfaces that absorb heat, high amount of energy used in the urban centers and the narrow arrangement of buildings.[17] This effect, known as the urban heat island effect, can lead to respiratory difficulties and heat stroke. In fact, in the United States, heat is the primary weather-related cause of death.[18]

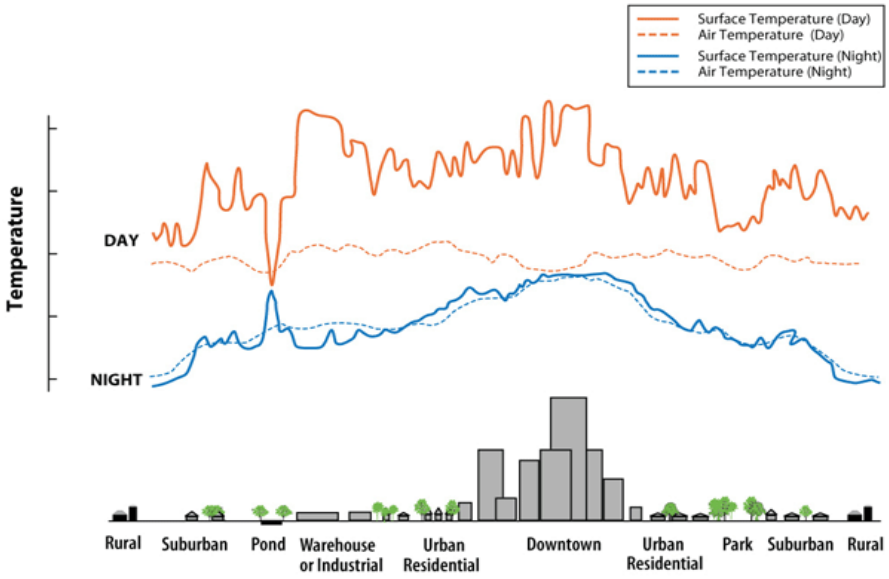

Figure 3: Surface and Air temperature profile for an urban area showing the overall effect of the urban heat Island. Source: Environmental Protection Agency (EPA)

[14] American Lung Association (2014). What's the state of your air?

[15] Bergeron, Louis (2010). "Urban CO2 domes increase deaths, poke hole in 'cap-and-trade' proposal, Stanford researcher says". Stanford Report.

[16] Sexton, K.; Linder, S.; Delclos, G.; Stock, T.; Abramson, S., Bondy, M.; Fraser, M.; Ward, J. (2006) ***A Closer Look at Air Pollution in Houston: Identifying Priority Health Risks;*** Mayor's Task Force on the Health Effects of Air Pollution; University of Texas School of Public Health, Institute for Health Policy: Houston, TX.

[17] Urban Heat Islands (UHIs). (2011, August 26). Retrieved from http://www.urbanheatislands.com

[18] EPA (2014). http://www.epa.gov/heatisland/

The Need for Government Action

As urbanization increases and requires more infrastructures for housing, businesses, and transportation, cities require strategies to decrease the negative impacts of disrupted ecosystem services in densely populated areas. Cost effective strategies in dealing with the consequences of urbanization for both city and federal governments include investing in preventative actions through existing park infrastructure. For example, a report from the Trust for Public Lands (2007) found that Philadelphia's city park system contributed nearly $7.5 million in savings for storm water treatment and mitigation.[19] The upfront costs of this bill, including providing support to for community parks and program, would be minimal in comparison to the costs of addressing more serious problems at a future date. Shrinking city budgets leave many parks as a low priority for local governments. The matching grants proposed provide a financial incentive to city governments to invest in the creation and maintenance of community parks and programs for their city residents.

Supporters, Opponents, and Compromises on the Definition of the Problem

The Secretary of Housing and Development, Representative Albio Sires (Representative for New Jersey's 8th district, and author of this bill), as well as 38 Representatives from urban areas across the country support this bill. Stakeholders with a vested interest in community parks range from outdoor enthusiasts to health care providers; something that often times places the social issues as a priority while detracting attention from the environmental problem. At its core, the environmental problem of this bill represents a compromise of social and environmental values and concerns whereby each cosponsor, stakeholder, or community defines the problem from varying perspectives. The bill itself accepts this variety of views and allows for the local municipality to decide how community parks will be utilized.

The definition of the problem, the impact of urbanization and the valuation of ecosystem services remain open-ended questions that must be answered in order to garner wide support for investing in the urban park infrastructure. Questions regarding how to monetize the services that an ecosystem provides, how the location or proximity relates to the valuation of benefits received, or even more basically in defining what 'valuing' an ecosystem means, all pose possible points of contention. Again, depending on the stakeholder, opposition or agreement depends on the evaluation of the negative impacts of the environmental problem and the role of ecosystem services plays an important role in addressing these issues.

19 The Trust for the Public Land. (2013). Pennsylvania's return on investment in the Keystone Recreation, Park, and Conservation Fund. Retrieved from http://cloud.tpl.org/pubs/benefits-pa-keystone-roi-report.pdf

What are the Proposed Solutions?

Urbanization and Community Parks

Urban areas disrupt natural systems by: altering the carbon and hydrological cycles; generating air and water pollution; creating localized heat-related issues, among other impacts. Community parks in urban municipalities provide these ecosystem services in an altered and impaired environment. This study focuses on the following three major services that community parks provide: reducing the impact of the heat island effect, reducing storm water runoff, and improving air quality. The relative value of these services differs depending on the city in question due to climatic conditions, geographical location and the nature of the parks.

What is a Park?

Community parks are publicly owned and operated areas located within the municipal boundaries of a given city. A study of the 100 largest cities in the U.S. revealed that these cities have a total of 22,354 parks distributed in more than 1 million acres.[20] While parks can range from less than an acre to over 2,000 acres, community parks in these cities on average span 40 acres, approximately the size of 21 NYC blocks or 36 football fields.[21] The Trust for the Public Land divides community parks into two categories: natural and designed parks. It defines natural parks as pristine or reclaimed lands managed primarily for ecological purposes or because of their unsuitability for other purposes; while designed parks and recreational areas contain amenities for activities, e.g. picnic grounds and ball fields. Most parks fall in between these two extremes, containing elements of both. Typically these parks utilize nature to provide ecosystem services, like a cool space under a tree, and engineered green infrastructure, like catchment ponds for water collection.

Effects Mitigated by Parks

Storm Water Management and Community Parks

A rainstorm that deposits just a half an inch of rain onto an urban surface produces 17 million gallons of water per square mile or roughly enough water to fill 3 Olympic-sized swimming pools. The urban environment covers surfaces with buildings, asphalt roads and concrete causing an average of 55% of the rain becoming runoff that winds up in the sewage treatment system or that directly runs in to culverts that feed into adjacent waterways. According to the National Climate Assessment report heavy precipitation events (rain falling at greater that 0.3 inches/hour) have been on the rise with corresponding increases in the severity and intensity of

[20] The Trust for the Public Land. (2013). Pennsylvania's return on investment in the Keystone Recreation, Park, and Conservation Fund. Retrieved from http://cloud.tpl.org/pubs/benefits-pa-keystone-roi-report.pdf

[21] Center for City Park Excellence, (2012). *2011 City Park Facts*. Retrieved from The Trust for Public Land website: http://www.tpl.org/sites/default/files/cloud.tpl.org/pubs/ccpe-city-park-facts-2011.pdf

the storms.[22] One illustrative event occurred in the Chicago Area in April of 2013 deposited 4.69 inches in a 24-hour period, on top of 2 inches the previous day.[23]

Storm water runoff is one of the biggest environmental problems across all the metropolitan cities in the United States. Increased storm water runoff occurs because of widespread impervious surfaces in urban areas that grow with the construction of buildings, parking lots and other urban infrastructures. An estimated ten trillion gallons of water flows over the impermeable surfaces of urban areas every year in the United States, picking up contaminants like spilled oil, detergents, heavy metals solvents, pesticides, fertilizer, and bacteria from pet waste. Around thirty billion gallons of sewage mixed with polluted runoff flow untreated into New York City waters every year.[24]

In parks, soils and trees decrease the amount of storm water runoff that goes into nearby waterways. Tree root systems and soil form a reservoir to capture and store storm water until it percolates into the lower soil layers, which have an incredibly high water retention rate. In addition, canopies of trees also reduce the amount of rainfall that reaches the ground, thereby allowing tree roots and soils additional time to absorb storm water.[25] Clay soils act as an efficient medium for filtration of pollutants and absorption of water. Clay and other soils absorb water for future use by trees and other vegetation, and also eventually for people as well. Urban parks can reduce storm water runoff by as much as 65%, even up to 100% retention in some places.[26]

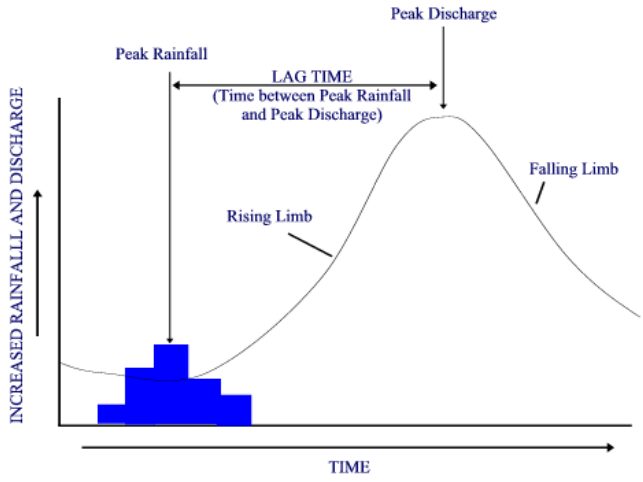

Figure 5: The change in the amount of water in a river after a rainfall.
Source: http://croesy-gcse-geography.doomby.com/pages/rivers.html

[22] Walsh, J., D. Wuebbles, K. Hayhoe, J. Kossin, K. Kunkel, G. Stephens, P. Thorne, R. Vose, M. Wehner, J. Willis, D. Anderson, V. Kharin, T. Knutson, F. Landerer, T. Lenton, J. Kennedy, and R. Somerville. (2014). Appendix 3: Climate Science Supplement. ***Climate Change Impacts in the United States: The Third National Climate Assessment***, J. M. Melillo, Terese (T.C.) Richmond, and G. W. Yohe, Eds., U.S. Global Change Research Program, 735-789. doi:10.7930/J0KS6PHH.

[23] Chicago area rainfall totals. (2013, April 18). ***CBS Affiliate WBBM, Chicago***. Retrieved from http://chicago.cbslocal.com/2013/04/18/chicago-area-rainfall-totals/

[24] Gotbaum, Betsy (2007). ***Twelve for 2030: Responses to PlaNYC, a Greener, Greater New York***. New York, NY: Office of the New York City Public Advocate.

[25] Day, S.D, and S.B. Dickinson (Eds.) (2008). Managing Storm water for Urban Sustainability using Trees and Structural Soils. Virginia Polytechnic Institute and State University, Blacksburg, VA.

[26] Tree City USA Bulletin (2010). How Trees Can Retain Water Storm water Runoff. Arbor Day Foundation, No.55

Increasing the number of trees and work to maintain their health provide positive effects on storm water management. In a recently released study by the U.S. Forest Service, the average tree will provide relief from $40 of costs per year. The magnitude of the impact is shown in tree coverage; for example, the Chicago area has over 157 million trees.[27]

Design improvements such as permeable pavement and retention tanks can have a similar effect. Permeable pavements mimic the process in which soils filter water by containing different layers of drain pipes, geotextiles, base rocks, bedding rocks and joint rocks below the surface. Green roofs of designed parks also function similarly to trees in community parks. Studies have shown that green roofs are capable of removing 50% of the annual rainfall volume from a roof through retention and evapotranspiration.[28] In places like Phoenix where water scarcity persists as a problem, green roofs and permeable pavement can incorporate retention tanks or catch basins for rainwater collection and storage for future use.

Air Pollution

As mentioned in an earlier section, air pollution poses a widespread problem in urban areas across the U.S., resulting in negative impacts on public health. Community parks help reduce air pollution, improve air quality by absorbing pollutants such as ozone and nitrogen oxides, and reduce carbon dioxide emissions in urban areas. Urban trees in the United States remove approximately 711,000 metric tons of pollutants, particulate matter and ozone, for examples from the air annually, saving $3.8 billion in medical and maintenance costs.[29] Moreover, a U.S. Forest Service study of cities using the iTree evaluation system found that an average of one life every year per city is saved by urban trees and forests.[30] In Portland, for example, trees in community parks remove approximately two million pounds of pollutants and 53 million pounds of carbon from the air annually.[31] Studies have also shown park design contributes as well: 109 hectares of green roofs can remove up to 7.87 metric tons of air pollutants annually.[32]

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[27] Nowak, D. J., Hoehn, R. E., Bodine, A. R., Crane, D. E., Dwyer, J. F., Bonnewell, V., & Watson, G. U.S Forest Service, Northern Division. (2013). ***Urban trees and forests of the Chicago Region***. Retrieved from U.S. Forest Service website: http://www.itreetools.org/resources/reports/Chicago_Region_rb_nrs84.pdf

[28] Robert D. Berghage , David Beattie , Albert R. Jarrett , Christine Thuring , Farzaneh Razaei , Thomas P. O'Connor (2009). Green Roofs for Storm water Runoff Control. EPA

[29] Portland Bureau of Transportation. https://www.portlandoregon.gov/transportation/article/363601#urbanlower

[30] United States Department of Agriculture, Forest Service (2013). . Forest Service Study Finds Urban Trees Removing Fine Particulate Air Pollution, Saving Lives.

[31] American Forests: Protecting and Restoring Forests. http://www.americanforests.org/our-programs/urbanforests/10-best-cities-for-urban-forests/10-best-cities-for-urban-forests-portland/portland-urban-forest-fact-sheet/

[32] Yang, Yu, & Gong (2008). Quantifying air pollution removal by green roofs in Chicago. Atmospheric Environment, 42: 7266-7273

Urban Heat Island Effect

Urban heat island effect is one of the major environmental concerns because it has been found that in a city with 1 million or more residents, the annual mean air temperature can be 1.8–5.4°F warmer than the surrounding areas. And in the evening, this difference can be as high as 22°F. Parks help mitigate the urban heat island effect through increases in vegetation that facilitate natural evapotranspiration that leads to cooling. Temperature increases as predicted from the rise of anthropogenic carbon increases in the atmosphere suggest that the effect will be greater in the urban environments due to the fact that CO_2 is a heavy gas that settles in the lower atmosphere in locations where it is generated. One five year study found that the average carbon dioxide concentration in the urban environment to be 66 ppm higher than their surrounding rural areas, leading to and average temperature change of 7ºF.[33]

Evapotranspiration, a process in which water is lost or evaporated from the leaves and roots of plants and in the surface soils to the atmosphere, dissipates the heat in and around the vegetation resulting in a cooler air encompassing it.[34] Evapotranspiration can help reduce peak summer temperatures by 2-9°F. Recent research shows that deciduous trees or vines are most effective in cooling.[35] Vegetation also supplies shading, which can cool peak temperatures of open areas up to 20-45°F, thus alleviating the urban heat island effect in surrounding areas.

Although not typically thought of in regards to community parks, many urban parks house large expanses of buildings. For example, buildings cover more than a fourth of the surface of Riverbank Park, a 28-acre community park in New York City.. Higher solar reflectance, otherwise known as albedo, plays a key role in reducing the temperatures of the surrounding areas through green infrastructure known as cool roofs. Considering that dark roofing contributes 38% of the urban heat island effect, and that cool roofs absorb less solar heat and stay up to 50-60°F cooler than conventional roof materials during peak summer weather, building infrastructure in community parks can incorporate cool.[36,37] Green roofs have a similar effect and also have the added benefit of reducing the temperature of surrounding infrastructure around a park as well.

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[33] George, K., Ziska, L. H., Bunce, J. A., & Quebedeaux, B. (2007). Elevated atmospheric CO_2 concentration and temperature across and urban-rural tansect. ***Atmospheric Environment***, ***41***, 7654-7665.

[34] New York Department of Environmental Conservation (2014). http://www.dec.ny.gov/lands/30344.html

[35] EPA (2014). http://www.epa.gov/heatisland/mitigation/trees.htm

[36] Jim Brown and Sons Roofing (2014). http://www.jimbrownandsonsroofing.com/cool-roofing/

[37] EPA (2014). http://www.epa.gov/heatisland/mitigation/coolroofs.htm

Figure 4: Geospatial Maps showing the vegetation and temperature distribution of New York City. Source: NASA, The New York City Regional Heat Island Initiative

Feasibility of Community Parks as an "Intervention"

Overall, the bill encourages innovative thinking and solutions for these pressing environmental problems in urban environments. A great deal of existing research demonstrates the ecosystem services that natural parks provide, however much of this research is based at the local level and is not aggregated to the wider mandate in the bill. Community parks are unique depending on their location in the U.S. presenting different challenges in urban areas with varying climate and different environmental issues. Parks need to be tailored to the needs and values of the local community.

Analysis of the Solution

Green Infrastructure

As more Americans migrate to cities the need for more sustainable infrastructure to fight the negative effects of urbanization has become evident. Such things as impervious surfaces, excess energy use and carbon dioxide emissions have greatly hindered the ability of our natural ecosystem to regulate our environment. One answer for parks comes from the emerging field of green infrastructure.

What is Green Infrastructure?

Green Infrastructure refers to "an array of technologies, approaches, and practices that protect and use natural systems or systems engineered to mimic natural processes" to reduce the environmental impacts caused by urbanization.[38] Green infrastructure methods can be implemented essentially anywhere vegetation and soil can be worked into the environment, which makes parks their most logical home in urban areas. Examples of green infrastructure include restoring natural landscape features such as forests, grasslands and wetlands; reducing the amount of land covered by impervious material by building such things as playgrounds and walkways with permeable pavement and reducing storm water runoff with green roofs, rain catchment and vegetation.

Picture 1: Green Infrastructure in Brooklyn. Source: gowanusyourfaceoff.org

Benefits of Green Infrastructure

Storm Water Management:

Ten trillion gallons of water flow over the impermeable surfaces of American cities every year picking up contaminants like spilled oil, detergents, heavy metals solvents, pesticides, fertilizer, and bacteria from pet waste. Large rainstorms cause increased amounts of runoff that can cause sewer systems to overflow, allowing both the storm water and sewage runoff to flow out into surrounding waterways that can serve as primary water sources for the flora and fauna of the natural environment. The sewage acts as a fertilizer, increasing the populations of algae and bacteria and decreasing the availability of oxygen for aquatic organisms leading to eutrophication of the water. Green infrastructure like permeable pavement keeps storm water out of the sewer systems by intercepting it where it falls and either containing it for later use or allowing it to infiltrate into the earth.

[38] EPA's definition of Green Infrastructure

Reduced Urban Heat Island Effect:

The urban heat island (UHI) effect occurs when built-up urban areas become warmer than the areas that surround it. An increase in vegetation via green infrastructure practices in parks would mitigate the UHI effect by providing substantial shading in urban areas otherwise covered by heat absorbent paved surfaces like buildings, streets and sidewalks. Computer models used in a 2009 study conducted by the municipality of New York found that widespread implementation of green roofs and planting of trees in green spaces showed a significant reduction of air temperature of up to 2˚F at 3 PM (the average peak time of energy use in the city).[39] A 2010 Columbia University Study entitled "A Temperature and Seasonal Energy Analysis of Green, White, and Black Roofs of a green roof in Queens, New York" discovered that green roofs are on average 60˚F cooler than black roofs in the summer and lose 34% less heat on average in the winter.[40]

Vegetation coverage, park size, and water bodies are three main factors affecting the cooling effect. Coverage of vegetation is the most widely discussed one in mitigating urban heat island effect. Tree size and canopy characteristics can affect the penetration of solar radiation. Several studies show that 70%-80% of the cooling affects is due to tree shading. Conversely, areas covered in grass have a net negative impact on the cooling effect, being warmer than the surrounding areas covered in trees. In regard to park size, it has been widely accepted that larger parks are on average stronger cool islands than the smaller ones. With larger area in the park, the cooling effect can be more evident. Water ponds in the park can also contribute to the cooling effect due to evaporation and the larger amount of energy (specific heat) needed to raise the temperature of water.

Improved Air Quality:

Air pollution is a major environmental concern in most cities in the U.S.. It poses significant threats to human health, and can cause lung, throat and eye irritation, respiratory and heart disease and cancer.[41] Despite decades of clean air progress, approximately 124 million Americans still live in areas that exceed ambient air quality standards.[42] Apart from source reduction of pollutant emission, an important focus is the role of parks, and more specifically the vegetation in parks, in the absorption and degradation of air pollutants in urban areas.

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[39] U.S.A. NASA. *Mitigating New York City's Heat Island Integrating Stakeholder Perspectives and Scientific Evaluation.* By Cynthia Rosenzweig, William Solecki, and Lily Parshall.

[40] S.R. Gaffin, C. Rosenzweig, J. Eichenbaum-Pikser, R. Khanbilvardi, T. Susca. "A Temperature and Seasonal Energy Analysis of Green, White, and Black Roofs" Columbia University, Center for Climate Systems Research. New York.

[41] Nowak, D. J., 1994. Air pollution removal by Chicago, urban forest. In: McPherson, E.G., Nowak, D.J., Rowntree, R.A., Chicago's Urban Forest Ecosystem: Result of the Chicago Urban Forest Climate Project. USDA Forest Service General Technical Report NE-186, Radnor, PA, pp. 63-81.

[42] U.S. Environmental Protection Agency. 2012. Our nation's air: status and trends through 2010. EPA-454/R-12-001. Office of Air Quality Planning and Standards. Research Triangle Park, North Carolina.

Trees and shrubs in parks offer the ability to remove significant amount of air pollutants. Trees remove gaseous air pollution primarily by uptake via leaf stomata. For common air pollutants like sulfur dioxide, nitrous oxide and ozone, they can diffuse into intercellular space, and be absorbed by an aqueous film.[43] For particulate matter, the interception and retention of particles greatly varies depending on the size of both particles because smaller particles are less likely to settle out of the air and the size of the leaves, a maple represents a great surface area than a poplar tree leaf in regards to leaf size and overall number of leaves per tree, can influence the effect. Forest canopies in urban parks act as a shield to prevent pollution concentrated in the upper atmosphere from reaching ground levels which contributes to a significant below-canopy air quality improvement.[44] Leaves and bark of vegetation also absorb trace metals like lead and zinc. However, heavy metals can damage the tissue of leaves and harmfully impact the photosynthetic process.[45]

Energy Conservation and Climate Change Offsets:

Green infrastructure can help reduce the energy that residents use for heating and cooling as well as help reduce carbon dioxide emissions through direct removal from the atmosphere via vegetation. Trees in NYC Parks provide approximately $27.8 million in energy savings per year and reduce atmospheric carbon dioxide by 113,016 tons.[46]

Restored Ecosystems:

Green infrastructure can provide a habitat for countless species of flora and fauna. For example, park trees and green roofs provide nesting, migratory, and feeding habitat for a variety of birds, butterflies, bees, and other insects.

Examples of Green infrastructure

Water and Permeable pavement

Permeable paving (also known as pervious or porous pavement) is an infiltration system that allows water to pass through voids in the paving material, which is mainly composed of porous concrete, asphalt or plastic.[47] Permeable pavement acts in a similar fashion as its impervious counterpart except it does not contain the finer grade particles that typically fill the pour space of a typical asphalt or concrete paving. Instead, soil, gravel or sand that have pores large enough to allow storm water to percolate through replaces the finer grade particles. A stone bed, typically built under the surface material, acts as a temporary storage area for water.[48] The water is either

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[43] Nowak, D. J., Crane, D. E., Stevens, J. C., Air pollution removal by urban trees and shrubs in the United States. Urban Forestry & Urban Greening 4(2006): 115-123.

[44] Ibid.

[45] Beckett, K. P., Freer-Smith, P. H., Taylor, G., Urban woodlands: their role in reducing the effect of particulate pollution. Environmental Pollution 99(1998): 347-360.

[46] Bloomberg, Michael. *PlaNYC: A Greener¸ Greater New York*. New York: City of New York, 2010. Print.

[47] Storm water Management Best Practices." ***EPA***. Environmental Protection Agency, n.d. Web. 03 July 2014.

[48] Department of Environmental Protection Bureau of Watershed Management.

left there until it eventually drains out into the underlying soil or is collected and used for water conservation purposes. Permeable pavement can be used in roads, walking paths, parking lots, basketball courts and playgrounds in parks.

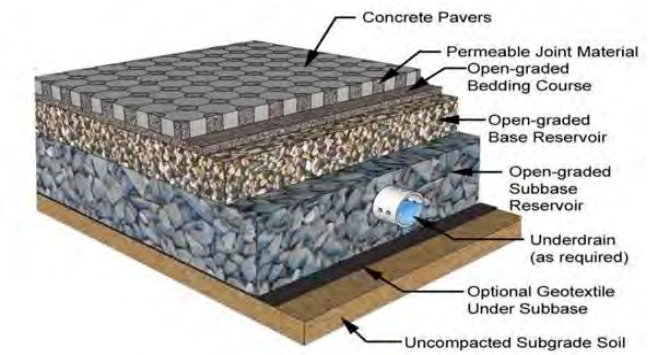

Figure 5: Schematic diagram of permeable pavement. Source: CSTpavers.com

As mentioned earlier, storm water that flows across parking lots, sidewalks and playgrounds pick up contaminants from the impermeable surfaces. Natural filtration of water through soil is the simplest way to control these pollutants. Permeable surfaces mimic this natural process preventing contaminates from entering such waterways as ponds, lakes, rivers and streams. However, in areas with high concentrations of sediments in runoff, porous pavements decrease in effectiveness because the pores get clogged. Hence, porous pavement requires routine maintenance that includes jet washing and vacuuming to clear away sediments.

Green Roofs

A green or living roof is an engineered roofing system where vegetation is planted in a growing medium over a waterproof membrane. Typically, green roofs are categorized into two classes, extensive and intensive. Extensive systems usually consist of one to six inches of planting medium and are best suited for smaller buildings that can't support an extensive amount of weight. Plants that are well suited for this type of green roof are mosses and low-growing, shallow rooted plants.[49] Intensive roofs typically have a much deeper soil base from eight to twenty four inches, which allows for much greater plant diversity. Intensive green roofs are most commonly found on top of larger buildings that can support the weight.[50] Green roofs are useful in water management as the vegetation takes up precipitation reducing the amount of water runoff from the roof by as much as 60% to 79% annually.[51] Unlike conventional storm-water management solutions that can be difficult to implement in dense urban environments such as storage ponds and wetlands, green roofs, which utilize existing roof space, are ideal for managing urban storm-water.

Bioinfiltration systems

Bioinfiltration systems or rain gardens are shallow, vegetated depressions, often located at a low

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Pennsylvania Storm water Best Management Practices Manual. 2006

[49] Voelz, Jan. ***The Characteristics & Benefits Of Green Roofs In Urban Environments***. UC Davis Extension, 2006. Print.

[50] Ibid.

[51] Oberndorfer, Erica, Jeremy Lundholm, Bass Brad, Reid Coffman, and Doshi Hitesh. ***Green Roofs as Urban Ecosystems: Ecological Structures, Functions, and Services***. Ryerson U, 2007. Print.

point of a landscape, that collects rain water runoff from impervious surfaces like walkways, playgrounds and parking lots. Rain gardens, which are typically composed of sandy, porous soils, allow the storm water to pool in the depression and eventually drain into the underlying earth.[52] Rain gardens are not meant to provide relief from large quantities of storm water runoff as their ability as a storm water management mechanism is solely reliant on the size of the depression and the rate at which water is absorbed by the underlying soil. However, rain gardens can be retrofitted with underlying drains to improve the rate of water infiltration into the soil. Plants should also be incorporated to assist with drainage.

Barriers

Green infrastructure is still very much a developing field. For example, in the U.S., our knowledge of the environmental advantages of green roofs in urban environments has advanced dramatically in the past decade, while other items like artificial trees are still in initial stages of development. Finally, most green infrastructure development has high initial costs, which often drive away interest. As the market for some these alternatives begins to grow, prices can be expected to go down, however, early implementers typically pay a premium. It is also important to note that green alternatives do require maintenance that may increase costs. Additional research is needed on the return on investment of these green infrastructure strategies.

Uncertain Aspects of the Solutions

Since HR.2424 is a national bill, it impacts different cities in different ways. The applicability of any revitalization project should include the following four basic considerations: 1. scale of parks; 2.surface cover in parks; 3. potential ecosystem disservices that could arise from parks; and 4. of implementing and maintaining the ecosystem services and technologies in parks. All of these factors contribute to the effectiveness of a park in terms of ecosystem services and how well they meet the diverse range of local needs and in different contexts.[53]

Uncertainties in the Science of the Proposed Solution

Scale

On average in the U.S., 10% of a city area is parkland.[54] However, location, population density of the city, and purpose of the park varies nationally. Larger parks afford more opportunities or have higher capacity to implement ecosystem services, such as storm water runoff management,

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[52] Storm water Management Best Practices." ***EPA***. Environmental Protection Agency, n.d. Web. 03 July 2014.

[53] The Nature of Cities (2014), http://www.thenatureofcities.com/2014/03/03/many-believe-that-better-information-on-the-monetary-value-of-ecosystem-services-is-critical-for-getting-cities-to-adopt-more-green-infrastructure-solutions-to-issues-such-as-storm-water-management-h/.

[54] Center for City Park Excellence, (2012). ***2011 City Park Facts***. Retrieved from The Trust for Public Land website: http://www.tpl.org/sites/default/files/cloud.tpl.org/pubs/ccpe-city-park-facts-2011.pdf

air pollution control, and urban heat island effect mitigation. On the other spectrum, smaller urban parks have less area in which to implement these services and may also have less opportunity for diversity in methods or tools to approaching such implementation.

Urban community parks in the U.S. contain an estimated 370 million trees with a structural value of approximately $300 billion.[55] Park size and vegetation coverage contribute significantly to cooling atmospheric temperatures, which aid in mitigating urban heat island effect. It has been widely accepted that larger parks have more evident cooling effects than smaller parks. For example, two similarly sized cities - Atlanta, Georgia and Philadelphia, Pennsylvania - have many parks of different sizes. Atlanta's Piedmont Park is 189 continuous acres of land, while Philadelphia's Fairmount Park is actually a system of parks in different areas that add up to 4,100 acres. Philadelphia has 15% of the area of the city as parks and Atlanta has 5% parkland, however because of population Atlanta provides 22.4 acres/1000 people, while Philadelphia has 6.4. The benefits to the urban population, for example the cooling effects depend on the number of, distribution and the population density that they serve in a local community. These types of characteristics contribute to the decision-making process of the structure and design of the parks.

Surface Cover

Different types of vegetation provide varying levels of ecosystem services. For example, stem water storage capacity can vary from 20% of the dry mass to 400%. Thus, not all plants are created equal. Furthermore, a pine tree can remove more air pollution than an oak tree and a younger growing tree captures more carbon dioxide than an older aging tree. Simply, a pine tree and a maple tree bring different values into the choices of park cover. A stand of maples looks splendid in the fall and accomplishes the goal of providing summertime shade. Pine trees with their year round needles intercept more water. The current distribution of parks provides a third set of considerations. Do the parks serve all people and will they continue to do so in the future.

On the other hand, baseball fields as surface cover in designed parks reduce water infiltration by 75% because of the compacted soil in the field. When compared with a natural surface cover, compacted surfaces provide less efficient mitigation methods, such as storm water runoff management. Another factor to consider is the potential conflict in the use of space in a park. Especially when a park is small, there are potential conflicts of interest on how to utilize that space. For example, the inhabitants or urban designers and planners of a city may prefer to install asphalt or artificial turf in a certain area as opposed to natural grass due to the cheaper costs initially and in upkeep and the suitability for the intended activities. Hence contention on valuing a park's function stems from the differences in the services provided by varied vegetation types and surface cover.

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[55] Nowak, D., Heisler, G. (2010). Air Quality Effects of Urban Trees and Parks. ***Research Series.*** http://www.nrpa.org/uploadedFiles/nrpa.org/Publications_and_Research/Research/Papers/Nowak-Heisler-Research-Paper.pdf

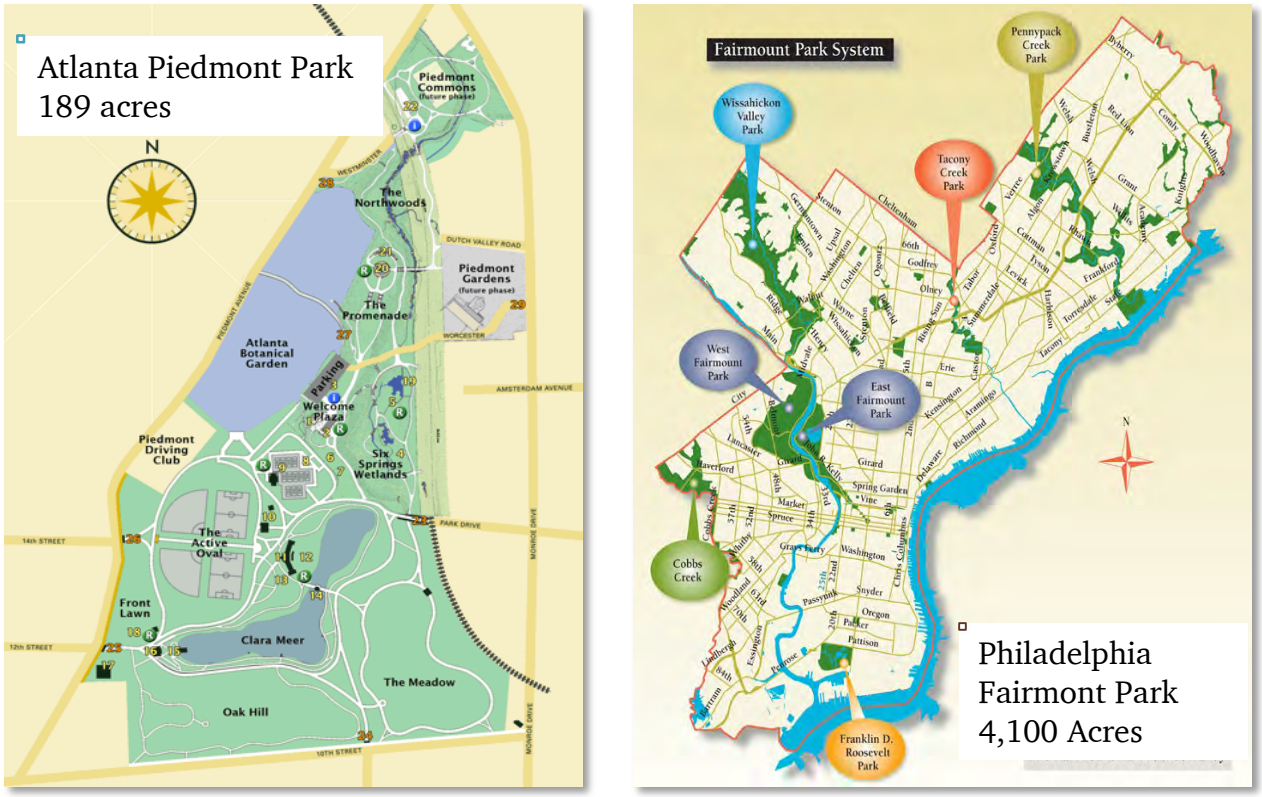

Figure 6: A Comparison of parks near the center of the cities of Atlanta and Philadelphia. Sources: Peidmontpark.org and the Fairmont Park Conservancy

Potential Ecosystem Disservices

While most scientists and researchers study the beneficial ecosystem services that natural and designed parks can provide, there is a scientific community who believe this positive framework is unbalanced and should include the counterproductive effects that parks could generate. Ecosystem disservices are the services as functions of ecosystems that are perceived as negative for human well-being.[56]

Ecosystem disservices include:

- Introduction of pests;
- Invasive species;
- Pollen/allergens; and
- Overshading or danger of trees.

As parks tend to have more vegetation than other parts of a city, some researchers argue that this can actually increase direct costs, such as costs for removing invasive species. Plants and trees can also contribute to higher levels of pollen, which potentially could be an allergen for humans.

[56] Escobedo, F. J., Kroeger, T., & Wagner, J. E. (2011). Urban forests and pollution mitigation: Analyzing ecosystem services and disservices. ***Environmental Pollution, 159***(8–9), 2078-2087. doi:http://dx.doi.org.ezproxy.cul.columbia.edu/10.1016/j.envpol.2011.01.010

The depth of ecosystem disservices depends on the location and with the needs of the stakeholders. For example, one party's aesthetically pleasing shade tree is another party's source of allergens, leaf litter, or obstructed views. These contrasting perceptions will depend not only on the structure of the park but also on the preferences of individuals and the specific pollution problem.[57] The range of impacts varies from the design and management of green infrastructure to uses that degrade natural areas. For example, adjacent developments can adversely impact native plants and organisms found in parks. Storm water runoff can contain an excessive amount of nutrients (e.g., phosphates and nitrates), causing algal blooms in water bodies, the growth of invasive exotic plants, and fish kills.[58]

Costs of Investing in and Maintaining Parks

Ultimately, monetary costs motivate urban decision-making. The major challenge depends on building the concensus with a range of stakeholders, that include policy makers, natural resource managers, the philanthropic community, and residents, that urban parks, whether natural or designed, have immense ecological value. Well-intentioned, urban planners often argue that parks eat up too much buildable land, or land that could be used for other types of development.[59] Thus, in order for stakeholders to better understand the role of green spaces in providing cost-effective solutions, monetary valuation must be defined, and this varies with the specific city.

Secondly, green infrastructure in parks can accrue high initial costs. For example, permeable pavement requires regular maintenance for surface infiltration capacity, such as reducing clogging in the pavement. Green roofs, another type of green infrastructure, require high maintenance and may be ineffective during dry seasons depending on the level of irrigation and type of plant coverage.[60] Therefore, for an arid, water scarce city like Phoenix, implementation of green roofs can require more costs for upkeep and require higher investments. For this reason, debates arise regarding cost-benefit analysis between investing in green infrastructure within parks or investing in storm water catchment basins outside of parks.

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[57] Ibid

[58] Hostetler, M., Allen, W., & Meurk, C. (2011). Conserving urban biodiversity? creating green infrastructure is only the first step. ***Landscape and Urban Planning,100***(4), 369-371. doi: http://dx.doi.org/10.1016/j.landurbplan.2011.01.011.

[59] The Nature of Cities (2014), http://www.thenatureofcities.com/2014/03/03/many-believe-that-better-information-on-the-monetary-value-of-ecosystem-services-is-critical-for-getting-cities-to-adopt-more-green-infrastructure-solutions-to-issues-such-as-storm-water-management-h/.

[60] Boyle, C. et al. (2012). Greening Cities: A Review of Green Infrastructure. ***The University of Auckland. .*** doi: https://cdn.auckland.ac.nz/assets/creative/about/research/Transforming-Cities/Publications/Greening%20Cities%20Aug%202012(1).pdf

Reaching Consensus

No matter the method used to value these services, it is inevitable that it costs a lot of money to replicate what nature does on its own. In order to reach consensus on the issue of community parks, three major components must be addressed:

- Awareness of the negative effects of urbanization;
- Understanding the value of an urban park; and
- Improved communication of return on investments on parks.

First, urban communities need to have a fundamental awareness of the negative effects of urbanization. Community residents, urban planners, and interest groups alike must be aware of the storm water runoff, air pollution and the urban heat island effect and their mechanisms in order to understand the framework of an urban park. Secondly, these stakeholders must build understanding of the value of an urban park. Because parks vary by scale and location, each planning application must have some definition for ecosystem values. Park planning requires assessment of community values as well as focusing on what types and how much vegetation or green infrastructure should be implemented in the parks.

Lastly, the accomplishment of consensus requires improved communication of the return on investments of investing in parks. Sometimes urban planners focus on immediate returns on investment, where the social and economic needs are given higher priorities than the environment. By placing dollar signs to the amount of savings that cities can save on storm water runoff management, air pollution, and urban heat island effect, ambiguity over parks and their benefits will decrease, thus increasing progress in implementing or rehabilitating them.

A study released in July 2014 indicates that the contributions of trees to overall air quality improvement helped avoid 850 premature deaths and 670 thousand incidences of respiratory distress.[61] This saves millions of dollars in health costs. Furthermore, a study in Philadelphia shows that the city's park system contributed nearly $7.5 million in savings for storm water treatment and air pollution mitigation. By measuring and reporting these figures, the public can better understand the science and the relation to their lives in more ways than they know. They can also see the connection to the ways in which parks provide incomparable services that end up benefiting communities.

[61] D.J. Nowak et al. (2014). Tree and forest effects on air quality and human health in the United States. ***Environmental Pollution 193 (0)*** 119-129.

Measuring the Success of the Solutions

Defining Success

For each measurable outcome, several solutions contribute to the overall success. By establishing indicators, decision-makers can examine whether each solution proposed contributes to the established outcome, and therefore merits investment. Hence, metrics for measuring and evaluating the success involve reaching a target or goal. This section includes specific recommendations for the impacts on storm water, air quality and urban heat.

Measuring the effect

Storm water management.

Catchment ponds, permeable pavement and vegetation contribute to quality and quantity improvements of storm water runoff. These mechanisms function as small reservoirs to hold water, reduce the street water runoff, and decrease peakflow. As mentioned before, storm water that flows across parking lots, sidewalks and playgrounds pick up contaminants from the impermeable surfaces. By increasing the resident time of water, it allows for a more efficient sedimentation process whereby heavy and insoluble contaminants sink down, thus improving the water quality.

Permeable surfaces mimic this natural process, preventing contaminates from entering such waterways as ponds, lakes, rivers and streams. Vegetation and soils, which have an incredibly high water retention rate can capture and store storm water until it percolates into the lower soil layers. Canopies of trees also reduce the amount of rainfall that reaches the ground, thereby allowing tree roots and soils additional time to absorb storm water.[62] A comparative study recorded of a heavy rainfall in 1996 demonstrates the value.[63] The street runoff on asphalt surface averaged 14 mm high while permeable pavement was only 0.03 mm. Permeable pavement can delay the time to reach peak flow with the range from 5 to 10 minutes. In the metal concentration test of the water runoff, barium, calcium, iron, magnesium, manganese, sodium at least drop to 40% of original level. These examples demonstrate existing techniques that can prove the effectiveness of parks in improving storm water management: 1. Measuring the peak flow of surface water and 2. Monitoring metal concentrations in storm water runoff. In both cases, the optimal results should reflect a decrease in peak flow and metal concentrations.

Air quality improvement

Two features of vegetation coverage contribute to air quality improvement: the interception of particulate matter by forest canopy and absorption of air pollutants on leaf stomata. Trees and

[62] Day, S.D, and S.B. Dickinson (Eds.) (2008). Managing Storm water for Urban Sustainability using Trees and Structural Soils. Virginia Polytechnic Institute and State University, Blacksburg, VA

[63] Booth, D. B., & Leavitt, J. (1999). Field Evaluation of Permeable Pavement Systems for Improved Storm water Management. Journal of the American Planning Association, 65(3), 314-325

shrubs in parks offer the ability to remove significant amount of air pollutants. Trees remove gaseous air pollution primarily by uptake via leaf stomata. For common air pollutants like sulfur dioxide, nitrous oxide, carbon dioxide and ozone, they can diffuse into intercellular space, and be absorbed by a film of extracellular water.[64] For particulate matter, the forest canopy in the park can contribute to the interception and retention of particulate matters. Urban trees in the United States remove approximately 711,000 metric tons of pollutants from the air annually, saving $3.8 billion in medical and maintenance costs.[65]

As mentioned before, gaseous pollutants and particulate matter cause damage to the respiratory system, and cause asthma, lung dysfunction, cardiovascular disease and even lung cancer. The finer the particulate matter, the deeper it can go through the respiratory system, increasing the harmful effects. A decrease in respiratory disease cases can indirectly indicate the success of parks in improving air quality. Based on the statistical results from the National Recreation and Park Association, trees in parks can decrease 16% of ozone and sulfur dioxide, 13% of particulate matter, 8% of nitrogen dioxide, and 0 .05% for carbon monoxide.[66] In addition to decreases in respiratory diseases, decreases in levels of these pollutants in the air can aid in measuring the success of parks in improving air quality. In both cases, air quality monitoring and respiratory disease statistics, relevant information and methodologies exist and would allow for feasible mechanisms in measuring the success of parks.

Urban heat Island Effect Mitigation

The following three types of green infrastructures can contribute to mitigating the urban heat island effect, which include evapotranspiration and the shading effect of vegetation, changing surface color and albedo, and water bodies. The evapotranspiration and shading effect of vegetation are a measurable effect, with an estimated decrease in urban heat island effect temperature difference to about 50-70%. Compared with the dark color on asphalt pavement and cement buildings, the green grassland and green roofs on buildings can effectively increase the reflection of sunlight radiation and decrease the absorption.

38% of the urban heat island effect is attributed to dark roofing, and that cool roofs absorb less solar heat and stay up to 50-60°F cooler than conventional roof materials during peak summer weather. Compared with the dark color on asphalt pavement and cement buildings, the green grassland and green roofs on buildings can effectively increase the reflection of sunlight radiation and decrease radiation absorption. The evaporation of water requires heat that does not go into raising the ambient temperature. The heat capacity of water can become a heat moderator from daytime to night.

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Measuring the success of parks in mitigating the urban heat island effect proves to be quite simple and can be displayed graphically: using temperature decreases in a temporal or time sequence as an indicator. In a case study of the campus park in Portland State University, the infrared photography indicated that the temperature of the park between the buildings is significantly lower. The maximum temperature gap is 5.8 ºF between the most heavily vegetated area and asphalt pavement. Another indicator of temperature gap in different places, a decrease in the urban heat island intensity equals the temperature gap between average temperature inside the park and the average temperature within a 500m buffer zone outside the park. Estimates of the magnitude of the effects suggest that vegetation contributed on average to 1.6 ºF of the temperature decrease, evaporation contributed another 1ºF of temperature decrease and changes in reflective surfaces contribute another 1.3 ºF.

Challenges in Measuring the Success

While existing tools and mechanisms facilitate measuring the success of parks in restoring ecosystem services in urban settings, park size and local climate features contribute in different ways to the quantity and quality of ecosystem services provided. Several studies show that when determining the temperature difference and the depression of the urban heat island effect intensity, park size plays an important role..[67,68,69] Moreover, the baseline temperature and precipitation features can have an important influence upon the urban heat island effect mitigation.

Because park features comprise an interconnected system, another challenge faced in measuring the success of parks lies is attributing contributions of each component in restoring different ecosystem services. Similarly, measuring techniques and reporting differ from MSA to MSA. For example, temperature gaps will vary if measurements taken coincide with shade under trees or in an open field of a ballpark. Likewise, difficulties can arise when measuring surface water runoff peak flow. Furthermore, as budget and resource allocation always poses as a limitation, challenges may arise in having the necessary equipment to measure these components and counting on the resources to report findings. Nonetheless, measuring the success of parks plays an important role in evaluating the effectiveness and efficiency of public funding investments.

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Conclusion

Does the Act Successfully Address the Science?

With increasing urbanization across the United States, urban areas continue to suffer the effects of compromised ecosystem services once provided by nature in absorbing excess pollutants, buffering the effects of weather and providing a comfortable environment for populations. As discussed in this report, sound scientific evidence proves that parks play a significant role in decreasing the amount of storm water runoff, capturing air pollution and mitigating the heat trapped by urban environments., Parks provide a proactive and cost-effective solution to mitigating these impacts and save money when compared to the reactive approaches that require building infrastructure to store and clean storm water runoff, improve air quality and increase energy consumption to moderate inside temperatures affected by the urban heat island effect. Within the context of each individual city, the positive services must be weighed in with the factors of the local climate and community support. Placing a value on the positive benefits should figure into the ultimate design and rehabilitation planning for parks.

The central argument in HR2424 rests on the idea of parks as vital assets to the communities they serve, providing an enduring legacy that adds value through aesthetic and practical means. As a proactive measure to mitigating the negative consequences of increased urbanization, parks represent one of the few options for having such a wide scale effect because they represent on average 10% of the total area of urban areas. However, the design, location and infrastructure of parks directly impacts the extent to which parks can provide these environmental services as well as the quantity and quantity of those services. Furthermore, existing tools and methodologies allow for measuring the success of parks in storm water management, improving air quality and mitigating the urban heat island effect.