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Upscaling Natural and Social Capitals for Decentralized Urban Stormwater Management

Optimisation des facteurs naturels et sociaux pour la gestion des eaux pluviales en milieu urbain décentralisé

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RÉSUMÉ

La gestion publique décentralisée des eaux pluviales, avec utilisation de techniques alternatives dispersées sur le bassin versant, est de plus en plus pratiquée par les collectivités. Mais elle doit répondre à des contraintes uniques liées à l'accès aux terrains et à l'engagement des citoyens. L'accès permanent aux terrains publics et privés est une contrainte qui pourrait être résolue de façon créative dans de nombreuses zones urbaines, grâce à la réaffectation de terrains vacants et de parcs publics. Ces espaces ont un potentiel important de services écosystémiques et notamment la rétention des eaux pluviales par la réalisation de jardins pluviaux à l'échelle des parcelles ou, en regroupant les parcelles, de zones humides artificielles et de bassins de rétention. Afin d'optimiser les bénéfices conjoints à ces infrastructures écologiques (comme la rénovation urbaine, l'amélioration de la santé publique) et d'obtenir un accès permanent, les services gestionnaires des eaux pluviales doivent tenir compte des facteurs sociaux et autres facteurs humains dans leurs plans de gestion. Une étude novatrice réalisée par l'USEPA dans le bassin versant de Shepherd Creek (à Cincinnati dans l'Etat de l'Ohio, Etats-Unis) met en évidence le rôle des facteurs humains, sociaux et culturels. Ses conclusions serviront à l'élaboration des plans à venir en vue d'améliorer les projets d'infrastructures écologiques, la rétention des eaux pluviales et la mobilisation des citoyens, en faisant appel à des organismes relais et des partenariats avec les autorités municipales.

ABSTRACT

Decentralized municipal stormwater management, whereby best management practices are dispersed throughout a watershed, are gaining popularity but face unique constraints related to land access and citizen engagement. Decentralized installations require perpetual access to public and private land, a constraint that may be solved creatively in many urban settings through the repurposing of vacant land and public parks. Vacant land has the potential to provide ecosystem services such as stormwater runoff detention. Using green infrastructure techniques, vacant lots may be transformed into lot-scale rain gardens or aggregated into larger-scale, landscape features that incorporate constructed wetlands and retention ponds. To maximize the provision of green infrastructure co-benefits (e.g., urban renewal, public health improvement) and gain perpetual access, stormwater managers should account for social and other human capitals in their management plans. In this presentation, we will highlight the role of human, social, and cultural capitals in the USEPA's groundbreaking study in the Shepherd Creek Catchment (Cincinnati OH USA) and how its outcomes will inform future plans to upscale green infrastructure projects in order to capture more stormwater and engage more private citizens through the use of bridging organizations and partnerships with municipal governments.

KEYWORDS

Bridging organizations, green infrastructure, Shepherd Creek, social capital, citizen stormwater management

1 INTRODUCTION

Urban areas are typically the nexus for highly intensive water cycles. This is due in large part to the replacement of pervious with impervious surface. In this conception of the urban water cycle, runoff is emphasized over infiltration that stresses urban streams and wastewater infrastructure. Urban streams are often afflicted with what has been deemed the *urban stream syndrome*- flashy hydrographs, altered stream channels, elevated contaminant and nutrient loads, and ecological degradation (Walsh et al. 2005). While many environmental factors contribute to the status of these streams, urban stormwater runoff has been identified as a major source of stream degradation. Green infrastructure (GI), whereby investments in natural capital create working landscapes that manage stormwater at the source, has been proposed as a partial remedy for urban stream syndrome by disconnecting impervious surfaces from stormwater infrastructure (i.e., municipal separate storm sewage systems). Likewise, GI is an increasingly popular component of combined sewer overflow (CSO) solutions in the United States where municipal governments are under consent decree to reduce the volume of combined stormwater and sewage that enters urban receiving bodies.

Stormwater runoff increases in proportion to the amount of impervious surface in a watershed, and in urban and suburban areas, much of this impervious surface is in residential parcels. Therefore, to treat the urban stream syndrome and reduce CSOs, management must extend to residential properties (i.e., décentralisation). However, stormwater managers have no means of gaining access to residential properties through regulatory processes in the United States, thus residential stormwater management must be voluntary. To engage or incent citizens as stormwater managers, we must go beyond the technical aspects of stream restoration and invest in social factors to motivate behavioral change (Green et al. 2012). When it comes to the human factor, three forms of capital influence the success of environmental management projects: human, social, and cultural capitals. One way to differentiate the forms of capital is through the number of people involved. Another way is temporal, or how long they endure. Below, each form is described with a definition and a common example.

1.1 Human, Social, and Cultural Capitals

Human capital is the stock of skills, education, experiences, and knowledge of an individual—what one knows and does. Investments in human capital are made by seeking education (Ostrom 2001). Likewise, learning of constraints is a form of human capital (e.g., realizing that you struggle with math or public speaking).

Social capital is similar to human capital except that it is shared among two or more people. One possible form of social capital is investing in the human capital of others by educating them or offering them opportunities. It is the stock of skills, knowledge, etc. that people bring to recurring, shared experiences (Coleman 1988). Social capital is developed through social networks or social connections. Connections can create formal roles between members, such as the roles between students and teachers (e.g., teachers teach and evaluate while students learn and behave appropriately). Or, connections/networks can be informal without any specific roles, like those of neighbors (e.g., some neighbors share baked goods and watch each others' pets while other neighbors intentionally annoy each other) (Coleman 1990). Social capital is expended or appropriated when used to influence the behavior of members of one's social network (e.g., you encourage your friends to join a team or volunteer for a good cause) (Sandefur and Laumann 1998). Another way to spend social capital is to gain information that you would not otherwise have access to (e.g., a colleague gives you a tip on a potential job opening or new client) (Parsons 1963).

Cultural capital is shared like social capital but spans a greater amount of time and is shared between generations. It reflects the culture of a people and place and is appropriated when that culture influences someone's behavior (Bourdieu and Passeron 1977). For example, the importance of education may be stressed throughout a family unit. Parents stress good grades to their children; those children grow up to stress academics to their children; and so on. After a few generations, the culture of the family is one of academic excellence (i.e., children's behavior is influenced to produce good grades) (Lareau and Weininger 2003). In the environmental management context, cultural capital may steer members of a cultural unit toward more environmentally friendly practices. For example, a child that grows up recycling may be more likely to continue that practice throughout adulthood and question the absence of a municipal recycling program should one not be offered in their place of residence.

In the Shepherd Creek Project (discussed below), we found the role of social capital to be a significant factor in influencing residents to enroll in a citizen stormwater management program on their private property (Green et al. 2012). From the lessons learned in that project, we plan to upscale our efforts to implement larger stormwater management features (i.e., green infrastructure) and to do so we must commensurately increase our investments in social capital and community engagement. As an external entity (i.e., a federal government agency), we face hurdles in accessing social networks and instead rely on partnerships with bridging organizations to accomplish our upscaled projects.

1.2 Bridging Organizations

Bridging organizations span the gaps among diverse constituencies to manage natural resources and solve development problems. These organizations can also play key roles in building local organizations, creating horizontal linkages, increasing grassroots influence on policy, and disseminating new visions and organizational innovations (see Brown 1991, Westley 1995, Folke et al. 2005, Hahn et al. 2006, Cash et al. 2006, Hahn et al. 2008, Malayang et al. 2007, Olsson et al. 2007, Berkes 2009). Crona and Parker (2012) define them as “organizations that link diverse actors or groups through some form of strategic bridging process.” They are not informal social networks but are intentional organizations with distinct personnel and resources. Through their links, they create and foster venues for trust-building, knowledge generation, collaborative learning, preference formation, and conflict resolution, among actors that are instrumental with regard to the resolution of specific environmental issues. Further, when bridging organizations hold a central position in the social network and have specific leadership skills, they can facilitate collaboration between parties, identify common interests, and reframe external threats into opportunities (Schultz 2009).

Bridging organizations provide a long-term platform for learning and collaboration, and this is particularly important when projects take an adaptive or iterative approach. Adaptive management requires monitoring, continuous learning, and system feedback, all which entail sustained on-the-ground effort. Thus, adaptive management projects proposed and implemented by external agents can benefit from the coordination and specializations offered by bridging organizations (Schultz 2009).

2 THE SHEPHERD CREEK PROJECT

Our upscaled project will take an adaptive, iterative approach and will be informed by the technical and social lessons learned from the Shepherd Creek Project described in this section. Through an interdisciplinary and integrated approach, this research tested a novel method that focused governmental resources (administered as incentives) on environmental management through stormwater management practices on suburban private land with particular emphasis on deriving multiple benefits from green infrastructure (i.e., “citizen stormwater management”). In the Shepherd Creek Watershed (Cincinnati, Ohio, USA), we invested in the human capital of the neighborhood by sending out brochures to eligible residents. These brochures aimed to educate the neighborhood on issues surrounding urban stormwater and to also describe each resident’s opportunity to participate in our stormwater management program, which would provide rain gardens and rain barrels to residents through a reverse auction (Thurston et al. 2008). In addition, we demonstrated the two forms of stormwater management practices available through our program—rain barrels and rain gardens—in a public park. We created an organization with the specific task of cultivating social capital—the Mt. Airy Rain Catchers. Under the umbrella of this bridging organization, a promotional website was developed with additional information, and staff was on hand to answer questions or address concerns.

Human capital was assessed by calculating the amount of stormwater runoff abated for each property and comparing the volume of water abated in those properties that did not require any financial incentive to install green infrastructure to those that did request financial payment to gain access to their property (Thurston et al. 2008). One surprising result was the number of \$0 bids, indicating that even a nominal induction of human capital via an education campaign was sufficient to enroll many participants (i.e., no economic incentive was necessary aside from free BMP installation and maintenance). Approximately 55% of bids were for \$0, which indicates that these homeowners would participate in the absence of an economic incentive.

The role of social capital was assessed statistically through bootstrapping (with replacement) techniques. We compared the average distance between properties associated with successful bids to the average distance between an equal number of properties that were randomly selected from all eligible properties (Green et al. 2012). Findings revealed the role of social capital as clusters of properties tended to participate in the second round of bidding, indicating that as first round participants shared their experiences, their neighbors became more willing to trust the program and

enroll. In the first year of the program, enrollment was randomly distributed. Residents from all over the neighborhood signed up to receive rain gardens and/or rain barrels on their property. For these residents, the education campaign and the promise of economic incentives were enough for them to enroll in a novel program. For many other residents of the neighborhood, their engagement apparently required some degree of tapping into their social networks. Many of these residents enrolled the second year of the program only after seeing rain gardens and rain barrels installed on their neighbors' properties. We speculate that the residents that enrolled in the second year needed more than education to get them to enroll; they also needed to establish trust that the program would be worthwhile for them. It appears that once they saw the program benefitting their neighbors, they were more likely to participate.

These agglomerations of participating properties may indicate a shift in the neighborhood culture regarding stormwater management and have positive implications for long-term watershed health. Because cultural capital operates along a multi-generational temporal scale, and agency funding support does not, we are unable to quantify the effects of cultural capital.

One key lesson from the social capital side of Shepherd Creek is the value of time in novel environmental management schemes. Had the program only run for one year, a large segment of residents that did eventually participate would have been written off as disinterested non-participants. When introducing new ideas or any sort of change to a community, it takes time to build trust and to get citizens to buy in and engage. Sometimes, tapping into a social network can provide a shortcut to trust building, and bridging organizations can provide that vital connection to a social network.

3 UPSCALING: THE SLAVIC VILLAGE PROJECT

Recent work emphasizes the potential to create links between implementing green CSO solutions and other problems facing post-industrial cities, such as the foreclosure crisis and vacant land, environmental justice, and food deserts (Georgia Institute of Technology 2010). Our future efforts to identify and leverage other sources of social, human, and cultural capitals to address larger-scale water resources management are set in Cleveland, OH (USA), a post-industrial U.S. city facing compounding issues of a proliferation of vacant land, and concomitant regulatory pressures from CSOs.

Urban exodus in many rust belt cities resulted in dramatic population decline which has worsened as a result of the foreclosure crisis. For example, Cleveland experienced a 56.6% reduction in population from its peak in 1950 (914,808 residents) to 2010 (396,815 residents) according to the U.S. Census Bureau. Cleveland also faces regulatory pressure from the U.S. Environmental Protection Agency (USEPA) to upgrade its stormwater and wastewater infrastructure to reduce the occurrence of CSOs by 4 billion gallons per year at a cost of 3 billion dollars (U.S.). These problems seem to foment a sound fit for an expeditious approach: utilize vacant land as a site for decentralized stormwater management. Using GI techniques, vacant lots in Cleveland's Slavic Village Neighborhood may be transformed into lot-scale rain gardens or aggregated into multi-acre features such as constructed wetlands and retention ponds.

Instead of exclusively investing in physical capital for stormwater upgrades, sewage and stormwater managers should couple investments with commensurate investment in human capitals for long term success (Green et al. 2012). Replacing aging infrastructure with new technologies, even GI, without necessary investments in human, social, and cultural capitals are susceptible to community rejection (e.g., Le 2012). While simple in theory, this approach poses many difficulties on the ground; stormwater utilities are not traditionally in the business of operating and maintaining green space and often work as monolithic service organizations where ratepayers are contacted only through billing, which limits the relationship. In this context, our next research efforts aim at scaling up from individuals to institutions. We aim to utilize bridging organizations, such as community development corporations, and partner with municipal utilities to address the critical issues of combined sewer overflows and vacant land.

3.1 Bridging Organizations of the Slavic Village Project

As an interdisciplinary team at the USEPA, Office of Research and Development in Cincinnati, Ohio, we take an integrated approach to stormwater management that includes hydrology, economics, soil science, ecology, social science, and law and policy. In the Slavic Village Project, we will test the hypothesis that adaptively and iteratively managed decentralized GI can have an impact on CSO events while also providing co-benefits to the Slavic Village Neighborhood. These co-benefits include

ecosystem services such as habitat provision for beneficial arthropods (e.g., pollinators), runoff quantity abatement, and water treatment through natural infiltration. These co-benefits are within the purview of our expertise, and we work with the Northeast Ohio Regional Sewer District (NEORS), described below) on implementing the project in a manner that maximizes these benefits.

However, to maximize other co-benefits, especially those of a social nature, we must partner with organizations experienced in reaching the residents of the Slavic Village. For example, community revitalization is a co-benefit of GI that we hope to achieve by taking vacant lands out of the real estate market and improving them with rain gardens. For this approach to be successful, neighbors will need to accept rain gardens as a value-added asset to their community. To maximize the efficacy of this aspect, we will utilize bridging organizations (described below).

The other primary institution of the Slavic Village Project is NEORS, the sewer district charged with making upgrades to the regional combined sewer and stormwater system to reduce CSO events. We partner directly with NEORS to achieve the overall goal of project implementation and to achieve some of the GI co-benefits besides water quantity abatement. Our partnership with NEORS gives us a setting to test our hypothesis. Further, the broader objectives of the USEPA, such as to restore the integrity of the nation's water per the Clean Water Act, are structured to be met via cooperative arrangements with local governments. For their part, the NEORS seeks USEPA approval of their long-term control plan in order to comply with court orders regarding their CSOs.

As is the case in most sewer districts, they are staffed with engineers expert in the field of infrastructure development. NEORS also has the capacity to access funding from sewer rates and a recently enacted stormwater fee based on the percentage of impervious surface on a residential property. However, their capacity to engage residents is limited, and partnerships with community development groups will very likely increase their social capital.

The social network of primary institutions and primary and secondary facilitators (i.e., bridging organizations) is mapped in Figure 1 and explained in Table 1. Further description of each facilitating bridging organization is below.

3.1.1 Slavic Village Development Corporation

Our primary facilitator is the Slavic Village Development Corporation (SVDC), a nonprofit community development organization with a record of successful physical improvement and community building. They enjoy strong political support in local government and are aggressive in their pursuit to improve the quality of life in the Slavic Village neighborhood. Their record has built a large stock of social capital that will bridge our pursuits through trust building and engagement with their many volunteers. At a more basic level, SVDC is located in Cleveland and, as a result, is able to maintain lines of communication with NEORS, often on behalf of the USEPA, not possible for our team in Cincinnati some 4.5 hours away.

3.1.2 Cuyahoga County Land Bank

The Cuyahoga County Land Bank (CCLB) is charged with acquiring abandoned property, demolition of abandoned homes, and transfer of vacant land to various entities (e.g., willing buyers, city land bank). Because our project focuses on vacant land, partnering with the CCLB is very valuable in terms of human and social capital. CCLB has expertise in vacant and abandoned land management far beyond that of our team. They also have relationships with neighborhoods and demolition contractors that have facilitated our efforts to experiment with pilot GI projects, such as a green demolition specification effort currently underway in conjunction with our CSO project. The green demolition specification is a group of guidance documents, using straightforward language, to describe how demolitions can be executed to yield a higher-performing vacant lot that is the product of an overall environmentally sound process.

3.1.3 Cleveland Botanical Garden (among others)

Secondary facilitators include the Cleveland Botanical Garden and the Cleveland Urban Design Collaborative, both of which have introduced our team to other organizations and kept us abreast of the unfolding events in Cleveland. These groups have strong networks of other organizations, volunteers, and local government. The Garden and Design Collaborative both have expertise in vacant land repurposing, especially for community agriculture, which may prove beneficial in our effort.

The partnership with the Garden in particular has provided access to funding agencies and institutions which has proven indispensable when progress with our primary partners stalled and our own agency experienced funding restrictions due to the sequestration of federal funding.

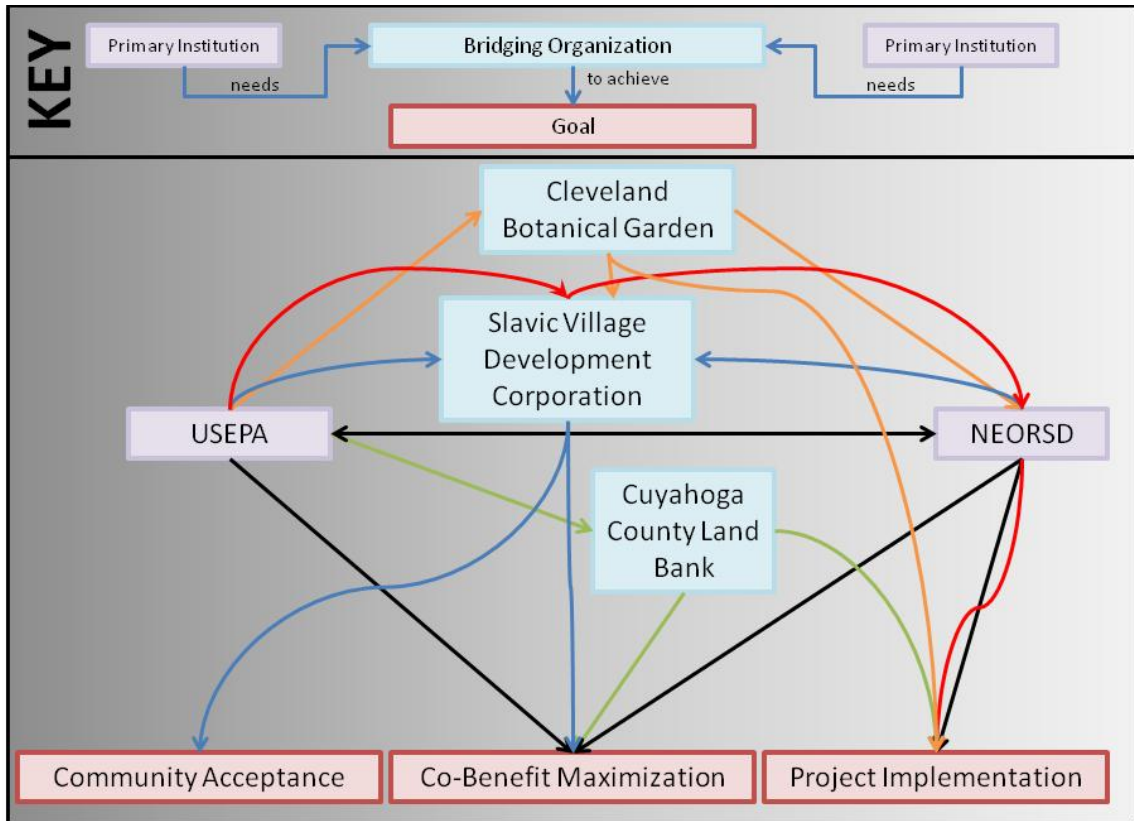


Figure 1: Social network of the Slavic Village Project, Cleveland OH (USA). This map illustrates the many relationships at play in the Slavic Village Project and how each relationship contributes to a particular goal. Bridging organizations are in blue. Relationships mapped by arrows of various colors indicate the specific relationship (see Table 1 for explanation). Direction of arrows points toward the organization that can provide a bridge to meet a goal or to another organization or network. Three goals in red at bottom: community acceptance, project implementation, and co-benefit maximization.

Table 1: Read in conjunction with Figure 1, this table explains the relationships that form the social network of the Slavic Village Project. For example, the first line reads "The US Environmental Protection Agency needs the Slavic Village Development Corporation to fulfil the goals of community acceptance and co-benefit maximization because SVDC can engage the neighbourhood, provide access to the local social network, build trust in the project, and potentially assist with operation and maintenance by providing volunteers." Because NEORS D needs SVDC for the same objectives, the entries are merged. The color in the "Key" column corresponds to the line color mapping the bridging relationship on Figure 1.

Bridging Organizations				
Organization Seeking	Organization Sought	Goal	Key	Explanation
USEPA	Slavic Village Development Corporation	community acceptance; co-benefit maximization	Blue	to engage neighborhood, access to social network, appropriate social capital, build trust, potentially assist with volunteer operation and maintenance
NEORS D				
USEPA	Slavic Village Development Corporation	project implementation	Red	to facilitate green infrastructure agenda in conjunction with NEORS D
USEPA	Cuyahoga County Land Bank	project implementation; co-benefit maximization	Green	to provide vacant land and demolition expertise to get project implemented and to maximize the co-benefits related to vacant land repurposing
USEPA	Cleveland Botanical Garden	community acceptance; project implementation; co-benefit maximization	Orange	to provide research support; to facilitate connections between all organizations; to provide access to social network of institutions and organizations; to provide experience with community agriculture
USEPA	NEORS D	project implementation; co-benefit maximization	Black	to provide setting for proof of concept; to implement water quality standards; to protect Lake Erie from CSOs
NEORS D	USEPA			to approve long term control plan for consent decree compliance

4 CONCLUSION

From our experience with human and social capital in the Shepherd Creek Project, we learned the importance of community engagement for the long-term success of GI projects. As we upscale our efforts in terms of the size of our GI installations, we must make commensurate increases in our

investments in human and social capitals. Because we are an external agency with limited contacts with the communities involved in any of our upscaled community and watershed-level projects, we must rely on bridging organizations in order to tap into the social network of community development organizations and volunteers.

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Conflict of Interest

The authors declare no conflict of interest.

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