Implementation of Green Infrastructure in Four West Coast US Cities Depends on Regulation and Historical Infrastructure

La mise en œuvre de les infrastructures vertes dans quatre villes de la côte ouest des États-Unis dépend de la réglementation et de l'infrastructure historique

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RÉSUMÉ

Une gestion efficace des eaux pluviales est essentielle pour améliorer l'écologie et les écosystèmes riverains dans les zones urbaines. Les infrastructures vertes à « avantages multiples » - qui offrent des avantages non seulement environnementaux mais aussi sociaux - deviennent de plus en plus attractives dans les villes en tant qu'alternatives aux infrastructures traditionnelles de gestion des eaux pluviales grises. Dans cette étude, nous caractérisons l'évolution des politiques, des priorités et des processus de planification des eaux pluviales dans quatre villes américaines : Los Angeles, San Francisco, Portland et Seattle pour voir comment cela a influencé leur stratégie d'Infrastructure Verte. Nous nous appuyons sur des entretiens semi-dirigés pour comprendre les objectifs et la motivation des politiques relatives aux eaux pluviales dans ces contextes géographiques. Nous constatons que l'évolution des infrastructures (réseaux d'égouts combinés ou séparés) et des politiques a finalement façonné les priorités et l'adoption d'infrastructures vertes pour chacune de ces quatre villes. Fait intéressant, dans les villes plus anciennes qui disposent de systèmes d'égouts unitaires (San Francisco, Portland et Seattle) et qui sont confrontées à des événements polluants importants, réduire les volumes d'eaux pluviales est un objectif essentiel qui peut être atteint avec le développement d'infrastructures vertes. En revanche, la ville dotée d'un système d'égouts séparé (Los Angeles) a eu du mal à respecter les normes de qualité de l'eau en utilisant les mêmes technologies, à la fois en raison du manque de financement et de compromis environnementaux.

ABSTRACT

Effective stormwater management is essential for improving ecology and riverine ecosystems in urban areas. Multi-benefit Green Infrastructure - which provides not only environmental but also social benefits - is becoming more popular in cities as an alternative to traditional single-purpose grey stormwater infrastructure. In this study, we characterize the evolution of stormwater policies, priorities, and planning processes across four US cities: Los Angeles, San Francisco, Portland, and Seattle to see how it has influenced their Green Infrastructure strategy. We used semi-structured interviews to understand goals and drivers for stormwater policies across these geographical contexts. We find that the evolution of infrastructure (either combined or separate sewer systems) and policy has ultimately shaped priorities and adoption of Green Infrastructure for each of these four cities. Interestingly, although the older cities built with combined sewer systems (San Francisco, Portland, and Seattle) face the risk of large polluting events, the overarching goal in these cities to reduce stormwater volumes is clear and achievable with Green Infrastructure. In contrast, the city with separate sewer system (Los Angeles) have struggled to meet water quality standards using the same Green Infrastructure technologies, both due to lack of funding and environmental tradeoffs.

KEYWORDS

Green Infrastructure, stormwater management, water quality, urban streams

1 INTRODUCTION

The effects of urban land development is a primary driver of global environmental change, imparting significant changes to local and global water resources and water cycle dynamics. Effective management of water resources, and rivers in particular, will require effective management of urban runoff, i.e., stormwater. Mounting water quality issues and the price tags for clean ups have prompted communities to shift from single-purpose grey stormwater infrastructure to Green Infrastructure (GI) that provide recreational, aesthetics, and stormwater management benefits. However, the adoption of GI has not been uniform across the US (McPhillips et al., 2018); a growing body of research points to political, social, and technological barriers as factors contributing to this variability (Hopkins et al., 2018; Roy et al., 2008). More broadly, however, we posit that this variability is driven by the wide range of priorities for water management. In the US, priorities for stormwater management may vary among cities, depending on whether the city has combined or separate sewers, impaired water quality, or impaired stream habitat (Figure 1).

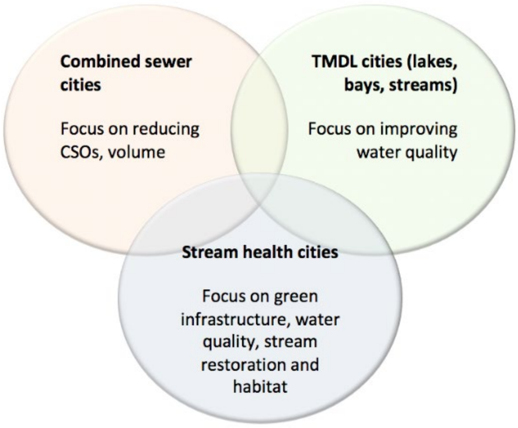

Figure 1. Urban stormwater management priorities grouped into three categories

In this study, we consider the historical evolution of water management and infrastructure within four US cities -- Los Angeles, San Francisco, Portland, and Seattle – to characterize the evolution of stormwater policies, priorities, and planning processes to see how it has influenced their GI strategy.

2 METHODS

These four cities differ in terms of their historical trajectory of stormwater infrastructure. Los Angeles has a separate storm sewer system, while San Francisco, Portland, and Seattle have both combined storm sewer systems and separated systems. San Francisco, 90 percent of the stormwater system is combined; 10 percent is separated. In Portland, approximately one-third of the city is managed by combined sewers, one-third is separated, and one-third is informal drainage and underground injection control wells. In Seattle, one-third is separated and the remaining two-thirds are combined and partially combined. These distinctions are important, since the regulations for combined sewer systems differ from those of separated stormwater systems. In general, regulations for combined sewers require reduction of stormwater volumes in order to reduce the occurrence of combined sewer overflows (CSOs). In contrast, regulations for separate storm systems may be focused on improving water quality in lakes, bays, and streams (e.g., through Total Maximum Daily Load studies, TMDLs), and/or improving habitat and fluvial conditions in urban streams.

In addition to historical analysis of city-wide stormwater infrastructure and policy, we used semi-structured interviews to (1) understand goals and drivers for GI policies; (2) identify barriers, challenges, and limitations of GI; (3) compare planning processes for implementation of GI across these geographical contexts. We conducted a total of 33 semi-structured interviews with stormwater experts in Los Angeles, San Francisco, Portland, and Seattle areas over the summer of 2017. We identified and contacted experts using convenience and non-probability snowball sampling. Interviewees generally fell into one of five categories: Federal agencies, local agencies (cities and counties), consultants and nonprofits, and academic researchers. The majority of experts who participated in this study represented the local scale, i.e., cities and counties within and surrounding the four study areas.

3 RESULTS

The evolution of infrastructure and policy has ultimately shaped priorities and adoption of GI for each of these four cities (Figure 2). Both San Francisco and Portland have achieved compliance with combined sewer regulations, but in different ways. San Francisco used large, grey infrastructure placed around the perimeter of the city, while Portland used a combination of green and grey infrastructure to meet combined sewer requirements. Having achieved compliance in 90% of the city, San Francisco is now focused on other (less regulated) concerns, such as environmental justice, inland flooding, and sea level rise. In contrast, Portland has shifted focus managing their separated stormwater system and urban streams, but their goals for these systems are less clear: for example, should the city target flooding, water quality, urban heat island, or sensitive aquatic species? Lacking the « regulatory hammer » that was associated with their combined sewer requirements, the city has moved into what one participant referred to as a « regulatory vacuum ». Seattle still struggles to meet the combined sewer requirements, and the high cost of their combined sewer program means that the city is left with very limited funding for other mounting environmental issues, such as stormwater runoff and heavy metal contamination in urban streams. Los Angeles relies increasingly on infiltration systems to both recharge aquifers and provide water quality treatment. However, this may have negative impacts to in-stream habitat and ecosystems that depend on this water.

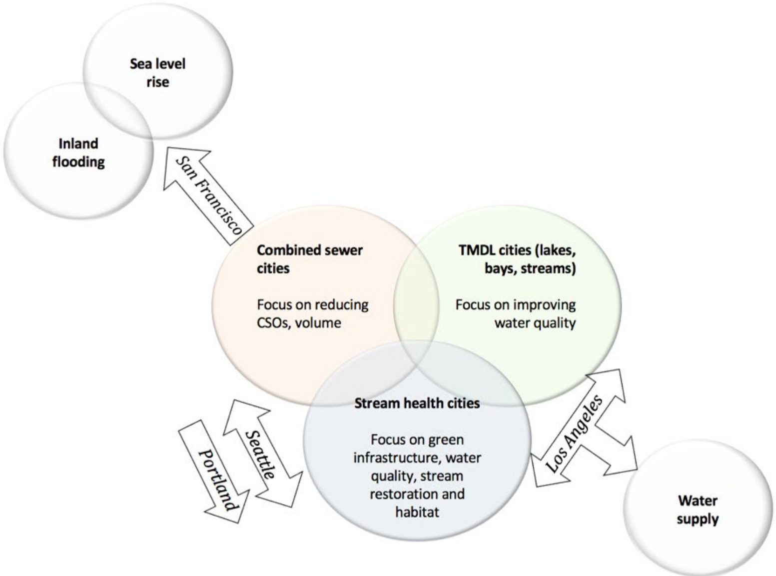

Figure 2. Stormwater management priorities for the four west-coast urban cities

Overall, the results of this study indicate that GI has been more widely adopted to meet combined sewer regulations (e.g., in Portland and Seattle) than separated sewer regulations (e.g., Los Angeles), although more detailed quantitative analysis is needed. Interestingly, while cities with combined sewer systems face risks of highly polluting combined sewer overflows (CSOs), the overarching goal in these cities to reduce stormwater volumes is clear and achievable with GI. In contrast, cities designed with separate sewer systems struggle to meet water quality standards using the same GI technologies, both due to lack of funding and environmental tradeoffs.

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