Habitat International 48 (2015) 177–187

Contents lists available at ScienceDirect

Habitat International

journal homepage: www.elsevier.com/locate/habitatint

Water urbanism in Bogotá. Exploring the potentials of an interplay between settlement patterns and water management

Claudia Rojas [a, *], Bruno De Meulder [a], Kelly Shannon [b]

[a] Department of Architecture, University of Leuven, Belgium
[b] School of Architecture, University of Southern California, USA

ARTICLE INFO

Article history:
Received 24 November 2014
Received in revised form
10 March 2015
Accepted 29 March 2015
Available online 11 April 2015

Keywords:
Water management
Low-cost housing
Bogotá
Landscape urbanism

ABSTRACT

A paradigm shift in water management is recognized as a necessary and fundamental step for adaptation to climate change and crucial for furthering sustainability. In contexts of rapid urbanization, this paradigm shift is particularly challenged since social and environmental needs often come into conflict. In Bogotá, as other Latin-American cities, demands for new housing are increasing daily, while the overall housing deficit remains an unresolved problem. Currently, the city faces the challenges to deal with the pressure to continue to urbanize flood prone areas with low-cost housing projects and simultaneously protect these areas in view of flooding, which promise to increase with the predictions of climate change. In order to contribute to context-responsive solutions to the water and housing issues, this paper investigates the shifting relations between settlement patterns, water infrastructure and landscape in Bogotá's El Tintal watershed. This sub-watershed of the Bogotá River has a rich history of formal and informal low-cost housing. The critical reading of the landscape transformation of the El Tintal has shown how the water system interventions were and can be instrumental in different stages of development. This reading was the base to elaborate design investigations that could translate to spatial adaptation measures. This paper argues that "soft" water management tools can be part of a twofold strategy to create spatial quality and provide resilience for more qualitative future urban development.

1. Introduction

Bogotá faces severe challenges in dealing with the pressure to develop flood prone areas with low-cost housing projects and simultaneously protect these areas in view of flooding, which promise to increase with the predictions of climate change. While sustainable urban water management is considered the most strategic and long-term requirement for climate change adaptation, the city's overall qualitative and quantitative low-cost housing deficit remains a major unresolved social issue. This paper investigates the shifting relations between water management and settlement patterns in Bogotá's western urban edge and proposes design strategies that have the potential to increase resilience, upgrade the spatial quality of low-income neighborhoods and provide space for new low-cost housing.

One of the largest obstacles to resolve the conflict between climate change-related issues and low-cost housing provision is the limited availability of land and its high cost. On the one hand, uncontrolled urbanization has rapidly consumed rural land and systematically encroached on water bodies, floodplains and wetlands, resulting in a fragmented ecosystem. Much of the development to the east of the Bogotá River has been built by filling wetlands, increasing impermeable surfaces and, in turn, has well been fitted with an inefficient sewer system. All this has led to a drastic reduction of landscape resilience. On the other hand, the high cost of land has both led to residential uses being continually pushed further and further out into the periphery and an impoverished quality of housing stock at the scale of urban design and architectural detailing. Large areas of self-constructed housing suffer the consequences of substandard urbanization, with a deficit of public space, social infrastructure, and low-level accessibility. Demands for new housing increase daily, while Bogotá's overall deficit remains unresolved. In 2011, the quantitative housing deficit for the city reached 258,046 dwelling units (Secretaria Distrital del Habitat, 2011). A first step towards increasing the resilience in the complexity of Bogotá's periphery should be the conversion of the

* Corresponding author. Kasteelpark Arenberg 51, 3001 Heverlee, Belgium.
E-mail addresses: claudia.rojasbernal@student.kuleuven.be (C. Rojas), bruno.demeulder@isro.kuleuven.be (B. De Meulder), skshanno@usc.edu (K. Shannon).

http://dx.doi.org/10.1016/j.habitatint.2015.03.017
0197-3975/

contested relations between low-cost housing and environmental stress into a constructive interplay, through the sensitive design of new housing typologies that work with the logics of the site and in relation to fragile water realities.

The Bogotá River watershed covers 589,143 ha, which represents a mere 0.5% of Colombia's territory yet hosts 19% of the country's population. The Bogotá Region, which is not defined by juridical or administrative terms, contains the city and the 17 municipalities around it – with a population of more than 8.6 million – forms a sub-region in spatial, functional and geographical terms. The region geographically coincides with a plateau located in the Bogotá River basin [Fig. 1]. The high rate of unplanned development of Bogotá has exhausted its carrying capacity of the watershed in terms of water supply, land use and the water's self-purification capacity. Water demands require the inter-basin transfer of water from the Orinoco watershed. Currently, 83% of the water consumed in Bogotá comes from the Paramo Chingazá, in the Orinoco watershed. The *paramos* is a high Andean ecosystem with a large water-storage capacity, coming from the plants and soils that are very sensitive to changes in temperature, wind and humidity. This ecosystem, the source of the Bogotá River, is threatened by livestock, agriculture and deforestation (Díaz-Granados, Navarrete, & Suárez, 2005). In addition, water supply implies extensive exploitation of the aquifers that underlie the plateau, causing a decline in the groundwater level and land subsidence (Van der Hammen, 2006).

Land use patterns on the plateau have changed rapidly since the 1960s. Agricultural activities have been displaced by industrial uses and flower farming (CAR, 2006), jeopardizing long-term food security. The capacity of the only El Salitre wastewater treatment plant (WWTP) is 4 m^3/s, which is roughly 25% of Bogotá's total wastewater production. The city's sewer system also has serious shortcomings. Although a separate drainage system was installed in urban areas developed after 1965, in reality it actually functions as a combined system. Therefore, direct discharges of untreated wastewater and combined sewage overflows are common (Rodriguez et al., 2008).

Climate change, and particularly the strong precipitation variations associated with El Niño and La Niña (respectively high drought and increased rainfall), is bringing increased challenges to urbanization in the plain of the Bogotá River The existing studies on climate change estimate an increase of 2–4 °C for the end of the century. The *paramos* is the most threatened ecosystem as its special vegetation would be unable to adapt higher temperatures. These ecosystems would be also affected by the changes in rainfall patterns. The models show a possible rainfall reduction of around 10%–20% between 2041 and 2070 especially in the mountains were *paramos* are located and rivers are born. These changes will trigger a reduction of water availability. At the same time, a possible rainfall increase of around 20%–30% and more frequent occurrence of extreme rain in central areas of Cundinamarca will increase flood vulnerability (IDEAM et al., 2014).

The aforementioned developments raise numerous technical questions since a large part of the city's periphery has been built below the level of the Bogotá River. It implies that urban wastewater has to be pumped into the river. The wetlands that once regulated the river's dynamics have disappeared almost completely, and the effects of El Niña and La Niña will be magnified by climate change. What technical solutions would be the most appropriate to deal with these phenomena? Is it possible to restore landscape resiliency while exploiting the potential of local interventions? Can we restore the wet nature of the floodplain at Bogotá's western urban edge? Perhaps, most importantly, how can these interventions help to improve the quality of the urban environment for local communities?

Fig. 1. Urbanization in the Bogotá River watershed is located mostly in the plain, a plateau located at an average altitude of 2600 m above sea level. Although the population growth rate in Bogotá has slowed down in recent decades, the city is still growing. However, the trend suggests that surrounding municipalities will grow at higher rates than the central city.