Cities and Rivers in Latin America: Challenges and Opportunities of Implementing Green Infrastructure in Ecuador

Villes et rivières en Amérique latine: défis et opportunités pour la mise en œuvre de l'infrastructure verte en Equateur

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RÉSUMÉ

Grâce à son économie dynamique et à ses villes en expansion, l'Équateur est prêt à construire des infrastructures urbaines étendues dans les décennies à venir et mettre en œuvre des technologies «vertes» durables en remplacement de l'infrastructure «grise» classique comme cela est le cas aux États-Unis et en Europe afin de répondre naturellement aux enjeux en matière de traitement des eaux pluviales et de gestion des corridors fluviaux. Pour Cuenca, en Equateur, nous avons modélisé les avantages hydrologiques potentiels de l'augmentation de l'infiltration dans les zones urbaines et péri-urbaines; analysé la distribution des espaces verts existants et les lacunes dans les couloirs riverains. Une équipe d'universitaires, de consultants, et de représentants des ONG et de l'Etat ont alors évalué les possibilités et les contraintes à la lumière des résultats de la modélisation, de l'analyse des écarts et de leur expérience professionnelle. Des corridors riverains importants subsistent le long des quatre grands fleuves de Cuenca. Il est encore possible de les élargir pour améliorer la connectivité écologique, augmenter la capacité d'inondation, filtrer les eaux de ruissellement avant d'atteindre les lits fluviaux, et disposer ainsi d'un parc urbain. Dans les zones montagneuses des techniques dites à «Low Impact Design » (LID) pourraient offrir des avantages hydrologiques en augmentant l'infiltration des eaux de pluie et des espaces verts publiques dans le centre urbain dense, mais notre analyse indique une plus grande efficacité hydrologique et des avantages écologiques plus importants si les LID sont mises en œuvre dans les zones péri-urbaines enregistrant une urbanisation rapide en préservant des corridors fluviaux et des espaces verts pour l'infiltration.

ABSTRACT

With its dynamic economy and growing cities, Ecuador is poised to build extensive urban infrastructure in the coming decades, presenting opportunities to implement sustainable 'green' technologies in lieu of the conventional, 'grey' infrastructure (now being retrofit in the US and EU to meet evolving expectations for natural stormwater treatment and stream corridors). For Cuenca, Ecuador, we modeled potential hydrologic benefits from increased infiltration in urban and peri-urban areas; analyzed the distribution of existing green areas and gaps in riparian corridors; and assembled an expert team from academia, consultancies, NGOs, and various levels of government to assess potential opportunities and constraints in light of modeling results, gap analysis, and their professional experience. Significant riparian corridors remain along Cuenca's four major rivers, with opportunities to expand riparian corridors to improve ecological connectivity, increase flood capacity, filter runoff before reaching river channels, and providing parkland. In upland areas, Low Impact Design (LID) techniques to increase infiltration of rainwater can provide hydrologic benefits and green areas for human use in the dense urban center, but our analysis indicates much greater potential hydrologic and ecological benefits from LID applications in rapidly urbanizing peri-urban areas by preserving wide stream corridors and green spaces for infiltration.

KEY WORDS

Green infrastructure, stormwater management, Latin America, rivers, cities

1 INTRODUCTION

In light of Ecuador's dynamic economy and growing cities, we can foresee that most of the country's urban infrastructure has yet to be built. Thus, there is now an extraordinary opportunity to influence how Ecuador's and Latin American cities in general will work in the future, and to integrate best practices learned from other areas into its urban fabric. One of the most promising opportunities is the incorporation of green infrastructure as an alternative to gray infrastructure for sustainable management of rainwater (Parkinson and Mark, 2005) (Kambites and Owen, 2007). Ecuador's new legal framework opens opportunities to integrate more holistic environmental management to preserve intact ecosystems and to restore already degraded environments. However, it remains to establish how this philosophy is translated into policies and actions.

1.1 Study Area

The city of Cuenca, located in the northern part of the Andes, is the capital of the Azuay Province in Ecuador. As its name indicates it is crossed by four rivers: the Tomebamaba, the Yanuncay, the Tarqui, and the Machángara Rivers. The city of Cuenca, founded by the Spanish in 1557 on the remains of the former Cañari and Inca civilizations, has grown from its historical core on a river terrace of the Tomebamba River both up onto a higher terrace and down onto a lower terrace or floodplain, guided by one of the oldest urban plans in Ecuador, written by the Uruguayan architect Gilberto Gato Sobral in 1947. Between then and 2010, the population increased 8.25 times and the urban area expanded 25 times. By 2050 it is anticipated that the population will double, reaching 900,000 inhabitants (BID, 2013). The main challenge facing Cuenca nowadays is urban sprawl. To curb the negative impacts of urban sprawl will require projects to increase control and a sustainable development especially in the peri-urban areas.

2 METHODS

With the objective to analyze potential opportunities and constrains of implementing green infrastructure in Cuenca, we have compiled and analyzed prior reports and relevant legislation/regulations, and precedents for green infrastructure. With the data collected in the field and in the Municipality we have identified special features of Cuenca through graphic support (maps and photographs) and relevant components of the various models of urban occupation and current water infrastructure, in order to analyze the distribution of existing green areas and gaps in riparian corridors and model potential hydrologic benefits from increased infiltration in urban and peri-urban areas. Finally, we have assembled an expert team from academia, consultancies, NGOs, and various levels of government to assess potential opportunities and constraints in light of modeling results, gap analysis, and their professional experience.

3 RESULTS AND DISCUSSION

The city and region of Cuenca present a unique opportunity to implement green infrastructure: it has relatively well-preserved green areas, protected water sources, and parallel "grey" infrastructure, including the first and only wastewater treatment plant in the country. As a result we can get many benefits through stormwater management and use of streams as a network of trails and parks.

3.1 Legal framework

In response to the need to manage the cities and their surroundings within a framework of integrated conservation, sustainable development and environmental protection, the government of Ecuador has adopted an exemplary constitution and unprecedented, which enhances the concepts of "Rights of Nature" and the "Quality of Life". Although this legal document does not speak of "green infrastructure", Ecuador's new constitution and laws should make possible significant improvements in management of the natural and human environment. Still, there are clear contradictions in the current legislation that hinder the proper implementation of these laws and regulations, especially in the peri-urban areas. For this reason, codes of urban, architectural, and engineering designs should be updated to facilitate implementation and consistently respond to the reality of the country.

3.2 Existing riparian corridors

Although the city of Cuenca lacks green areas, significant riparian corridors remain along its four major

rivers, with opportunities to expand riparian corridors to improve ecological connectivity, increase flood capacity, filter runoff before reaching river channels, and providing parkland. Implementing green infrastructure can create new green areas to benefit city residents. Connectivity between linear parks can be enhanced to improve biological connectivity and "human" accessibility. Furthermore, green areas in the city center can be connected to peri-urban green space, especially along streams in the peripheral zone, to create an integrated system of green corridors at a local and regional level.

3.3 Analysis of Runoff Under Business-As-Usual and Green Infrastructure Conditions

In upland areas, Low Impact Design (LID) techniques to increase infiltration of rainwater can provide hydrologic benefits and green areas for human use in the dense urban center, but our analysis indicates much greater potential hydrologic and ecological benefits from LID applications in rapidly urbanizing peri-urban areas by preserving wide stream corridors and green spaces for infiltration. Many of the peri-urban areas in Ecuador are not yet built out, offering potential to incorporate elements of green infrastructure.

4 CONCLUSIONS

As many Latin American cities, Ecuadorean cites face the challenge of peri-urban expansion, because a legal gap exists in planning, creating an “urban anarchy” with intrinsic consequences, such as water pollution or increased exposure to flood risk. With its dynamic economy and growing cities, Ecuador is poised to build extensive urban infrastructure in the coming decades. This presents opportunities to implement sustainable “green” technologies in lieu of the conventional, “grey” infrastructure. The US and the EU are retrofitting grey infrastructure to green to meet evolving expectations for natural stormwater treatment and stream corridors. Ecuador, as well as many other cities in Latin America, can skip the “grey” infrastructure step if spatial planning at city and regional scales incorporates green infrastructure, giving a logical continuity to the existing urban fabric.

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