

# Infraestructuras verdes e instituciones multilaterales de desarrollo: un nuevo enfoque para un planeta sostenible de ciudades

## Green infrastructures and multilateral development institutions: a new approach for a sustainable planet of cities

**BÁRBARA PONS GINER**

### Resumen

A partir de hoy y hasta 2050, se espera que las ciudades emergentes del mundo en desarrollo alberguen entre 2.000 y 2.500 millones de nuevos habitantes, consumiendo más espacio urbano nuevo de lo que existe hoy en día. La humanidad se enfrenta al enorme desafío de construir infraestructuras urbanas para crear entornos sostenibles que proporcionen calidad de vida y se adapten al cambio climático si queremos tener un planeta de ciudades sostenibles en 2050. La planificación metropolitana basada en las infraestructuras verdes está emergiendo como una prioridad estratégica para abordar los retos de los procesos de urbanización rápida que experimentarán las ciudades en el mundo en desarrollo en las próximas décadas. Las "infraestructuras grises" del transporte, del agua y de la energía están todavía en la cima de las agendas e inversiones urbanísticas, sin embargo las áreas verdes relacionadas con el sistema hidrológico natural no se consideran prioritarias, ignorando la creciente evidencia de su enorme contribución a la sostenibilidad urbana y resiliencia. Este área de conocimiento aún no está completamente integrada en las instituciones financieras y de desarrollo internacionales, creando así una oportunidad para generar recursos de investigación, educación y financieros que podrían plantear nuevos enfoques para un desarrollo urbano más sostenible. El debate en torno a la Nueva Agenda Urbana en Hábitat III ha abierto un escenario para compartir información sobre este tema y alentar a las instituciones financieras multilaterales e internacionales a trabajar en esa dirección.

### Palabras clave

Infraestructura verde, planificación del paisaje, desarrollo urbano sostenible, bancos multilaterales de desarrollo, urbanización global.

### Abstract

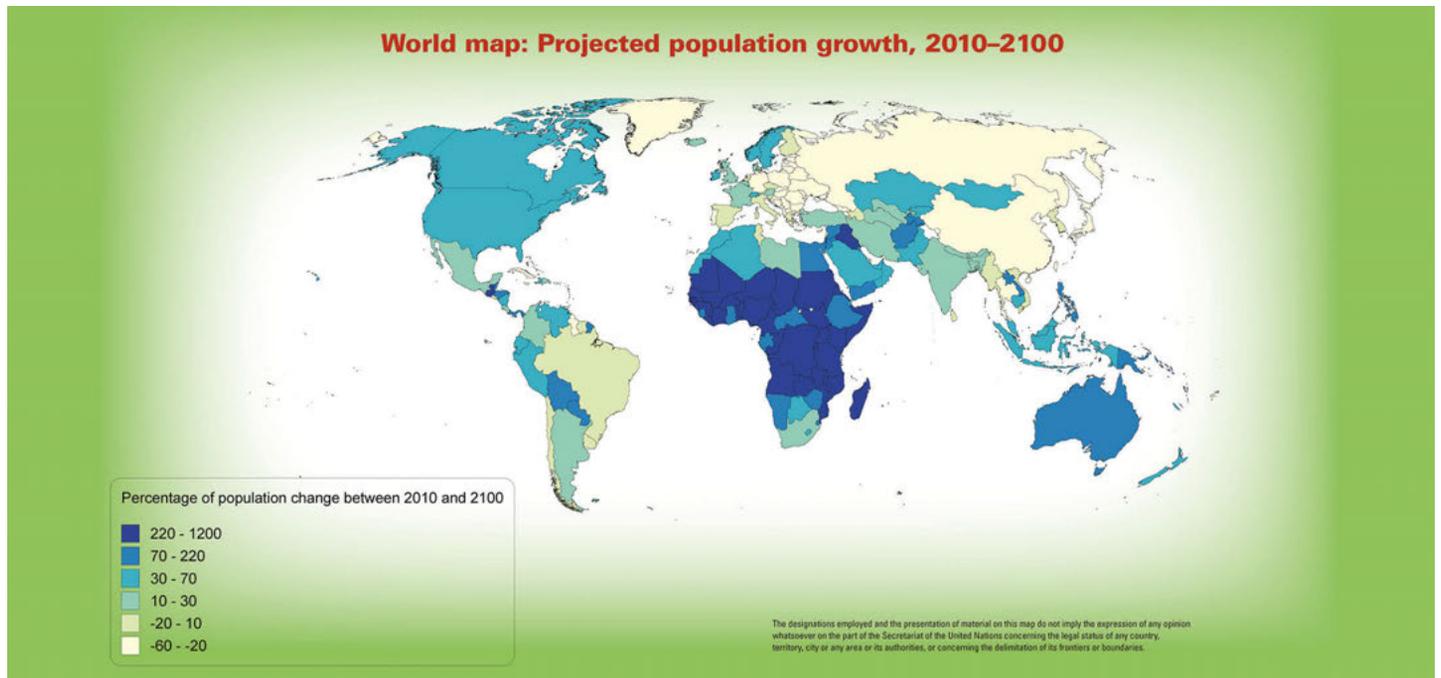
From today until 2050, the emerging cities of the developing world are expected to host between 2 and 2.5 billion new dwellers, consuming more new urban space than there exists today. Humanity faces the enormous challenge of building urban infrastructure to create sustainable environments which provide quality of life and are adapted to climate change, if we want to have a sustainable planet of cities by 2050. Metropolitan planning based on green infrastructure is emerging as a strategic priority in addressing the challenges of rapid urbanization processes experienced by cities in the developing world today and in the next decades. Transport, water and energy "grey infrastructures" are already at the top of the urban development agendas and investments, but green areas related to the natural hydrological system are not considered yet a priority, ignoring the growing evidence of their enormous contribution to urban sustainability and resilience. This area of knowledge is still not fully developed in the international financial and development institutions, thus creating an opportunity to develop research, education and financial resources that could open new approach to a more sustainable urban development. The debate held around the New Urban Agenda in Habitat III has opened a scenario to share information on this topic and encourage the multilateral and international financial institutions to work in this direction.

### Keywords

Green infrastructure, landscape planning, sustainable urban development, multilateral development banks, global urbanization.

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[Fig. 1] World Map: Projected population growth, 2010-2100

Source: United Nations Department of Economic and Social Affairs, UN-DESA: [http://www.un.org/en/development/desa/population/publications/pdf/trends/WPP2012\\_Wallchart.pdf](http://www.un.org/en/development/desa/population/publications/pdf/trends/WPP2012_Wallchart.pdf)

## The challenges of global urbanization until 2050

“This century has been a losing battle with the issue of quantity.

In spite of its early promise, its frequent bravery, urbanism has been unable to invent and implement at the scale demanded by its apocalyptic demographics. (...)

How to explain the paradox that urbanism, as a profession, has disappeared at the moment when urbanization everywhere – after decades of constant acceleration – is on its way to establishing a definitive, global “triumph” of the urban condition?”

REM KOOLHAAS (1994, 1995:961)

Cities are the largest, more ambitious, and complex project of humanity. Urban centers have been the scenario of the greatest advances of the homo sapiens: the political, economic and financial power, the scientific research, the production of technology and the world artistic creation are all concentrated in cities. But cities are also the biggest concentrations of waste, sinks of consumption and focal points of pollution of the planet. Hosting about 54% of the world’s population, cities are responsible for an estimate of 75 percent of global CO<sub>2</sub> emissions, with transport and buildings being among the largest contributors (IPCC, 2014a). Cities also concentrate the highest risks of natural disasters related to water issues (storms, floods, water pollution, landslides, raise of sea level), due to the water cycle interruption in urban environments and the creation of impervious surfaces in the process of urbanization (WB, 2013).

On the social side, cities host the most extreme economic inequalities of today’s world, which organizations like the World Bank or the International Monetary Fund have identified to threaten global progress.<sup>1</sup> According to the United Nations (UN),<sup>2</sup> today’s cities are home to more than 3,900 million people (UN-DESA, 2014), 1,000 of whom are estimated to live in informal settlements of large cities in the developing world, in so-called “slums”, in horrific social and environmental degradation conditions.<sup>3</sup> The prospects of international agencies such as the UN or the World Bank agree in that, if the current trend of creating informal city in the developing world continues, this number will increase in between 2 and 2.5 billion people in the next 35 years, 95% of which will live in the expanding cities of Africa and Asia. Will it be sustainable a world with more than 3 billion people, half of the future urban population, living in slums?

1 International Monetary Fund (IMF, 2015): *Causes and Consequences of Income Inequality: A Global Perspective*. Available at (Last visit April 14, 2016): <https://www.imf.org/external/pubs/ft/sdn/2015/sdn1513.pdf>

2 UN estimates on percentages of urban population are the most cited in the scientific and academic community, although there are sectors that criticize the use of these statistics for such a complex concept as the urban condition at the present time, when the concepts of rural and urban are subject to constant debate. For a discussion of this topic see Brenner and Schmid, 2013 and Gleeson, 2012.

3 For a detailed description of the origin and the conditions of living in the slums, see Davis, 2006.

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**Why green infrastructure?**

“It’s a fundamental shift in thinking...to get governments to regard green infrastructure as they do other infrastructure investment”

JOHN GRIFFIN, former Maryland Secretary of Natural Resources

As a result of the expected population growth in the coming decades, it is estimated that the world’s urban area will triple between the year 2000 data and 2030 (400,000 km<sup>2</sup> to 1.2 million km<sup>2</sup>),<sup>4</sup> and will continue growing at least until 2050, when the world’s population is expected to stabilize between 9 and 10 billion inhabitants). Or, put another way, 70% of the urban infrastructure that will exist in 2050 has not yet been built (UN-Habitat, 2016). This phenomenon is already happening in the present, and is a consequence of the documented trends in gradual but steady decline of urban densities in all countries of the world.<sup>5</sup> This is a huge challenge but also an opportunity from the perspective of implementing new forms of sustainable urban planning and management, to provide equal access to a healthy urban environment, quality of life and increase resilience to natural hazards, incorporating mitigation and adaptation to climate change through ecosystem services provided by green infrastructure (GI).

The term “Green Infrastructure” refers to a concept that has assumed an increasingly important role on the agenda of planners and city makers in recent years. Its definition is still open to debate and depends on the scale at which it is defined.<sup>6</sup> At the metropolitan scale, it can be defined as a multifunctional network of open spaces; at the local scale, it can be defined as a management tool of rainwater that mimics natural hydrological processes.<sup>7</sup> The union of the two words, “green” and “infrastructure” is intentional and looks for the conjunction of two disciplines related to city making that have traditionally been antagonistic: civil engineering, whose purpose was to plan and build “gray” infrastructure, and landscape architecture, which dealt with “green stuff”, too often seen just as a superficial make up to make cities beautiful. The necessary convergence of these two disciplines in contemporary planning is very important in the management and planning of water in the city, but the interesting idea is that fuses the concept of something that “works” and supports processes to organize the city with the concept of the green, the living, and the ecologically sound. The term GI is therefore very powerful to indicate that landscape features are no longer purely makeup, decorative. Instead, we are talking about green elements that work and support important processes for the sustainable operation of the city.

The report of the UN International Panel on resources in cities (IRP, 2013) estimated investments in the period 2005-2030 of 41 trillion US\$, of which just over 55% (US \$ 22.6 billion) will be needed to water systems, 22% (9 billion) for energy and 19% (7.8 billion) for airports and ports.<sup>8</sup> But most important is that this report emphasizes that ignoring the environmental dimension to build or rebuild urban infrastructure could mean a collapse of infrastructure in 30 or 40 years, when climate change impacts will be more evident, which would imply much higher financial costs.

There is growing scientific evidence and economic quantification of the benefits of green infrastructure systems, such as moderating temperatures, reducing air and water pollution, and increasing the aesthetic value of public spaces, which ultimately influences the increase value of private real estate property. Just as a brief example of that evidence, in Barcelona, according to research by Chaparro and Terradas,<sup>9</sup> it was estimated that the plant cover of 141 trees/ha allowed to eliminate a total of 305.6 tons of pollutants (166 T PM10, 72.6T of O<sub>3</sub>, 54.6TNO<sub>2</sub>, 6.8T SO<sub>2</sub> and 5.6T CO), providing a service to the city estimated at US\$ 1.2 million. Trees also

4 ANGEL, Shlomo (2012): *Planet of Cities*. Lincoln Institute of Land Policy, Cambridge, MA.

5 ANGEL, Shlomo (2012).

6 For more definition of GI in the anglo-saxon context, see: Benedict and McMahon, 2006; Firehock, 2010; Rouse and Bunster-Ossa, 2013; GREEN INFRASTRUCTURE CONCEPT AND DEFINITION. Available at (last visit April 14 2016): <http://www.nature.org/about-us/the-case-for-green-infrastructure.pdf>; y la web de la American Society of Landscape Architects, <http://www.asla.org/greeninfrastructure.aspx>. For definitions in the European context, see: EC 2009; EC 2012; EU 2013a; EU 2013b; EU 2014.

7 ROUSE, David C. and BUNSTER-OSSA, Ignacio F. (2013). *Green Infrastructure: a Landscape Approach* (PAS 571). Published by APA Planning Advisory Service. Paperback, 144 pp. ISBN: 978-1-611900-62-0. Available at: [https://www.planning.org/pas/reports/subscriber/archive/pdf/PAS\\_571.pdf](https://www.planning.org/pas/reports/subscriber/archive/pdf/PAS_571.pdf)

8 United Nations Environment Program, International Resources Panel (IRP, 2013): *City-Level Decoupling: urban resource flows and the governance of infrastructure transitions*. Available at (Last check November 24<sup>th</sup>, 2015): <http://www.unep.org/resourcepanel/Publications/City-LevelDecoupling/tabid/106135/Default.aspx>

9 CHAPARRO, L., y TERRADAS, J. (2009): *Ecological services of urban forests in Barcelona*. Barcelona: Institut Municipal de Parcs i Jardins Ajuntament de Barcelona. Àrea de Medi Ambient. Available at: <https://www.itreetools.org/resources/reports/Barcelona%20Ecosystem%20Analysis.pdf>



[Fig. 2] Polluted urban river corridor in India, 2005.

SOURCE: IADB and Terraza et al, 2015.

mitigate the summer temperature and reduce the use of air conditioning, allowing a total savings of 25,500 MWhr, equivalent to US\$ 4 million per year (Chaparro and Terradas, 2009). But these quantifications of environmental services are relatively new and have not spread enough at academic level or at the institutional level in the municipal governments of cities in developing countries.

Another example is the New York City's Green Infrastructure Plan. It is a plan in a permanent review process, in which year after year they update data from different pilot projects which provide economic evaluations of the implementation of solutions based on GI. According to estimates of the Plan itself, in its 2014 edition, the development of infrastructure to address the water management in the city costs \$ 1,500 million US less than if it had been made with a focus based exclusively in gray infrastructure. Only the management of rainwater with green solutions save US\$ 1,000 million, at a cost of about 15 cents or less per gallon (3.78 liters) of water. The plan estimates that "Every fully vegetated acre of green infrastructure would provide total annual benefits of \$8.522 in reduced energy demand, \$166 in reduced CO<sub>2</sub> emissions, \$1,044 in improved air quality, and \$4,725 in increased property value."<sup>10, 11</sup>

## Research background

"Nature has been seen as a superficial embellishment, as a luxury, rather than an essential force that permeates the city."

ANNE WHISTON SPIRN (1984:5)

The origin of this research was the convergence of interests of the author on landscape planning and green infrastructure, and the interest of Emerging and Sustainable Cities Initiative (ESCI)<sup>12</sup> of the Inter American Development Bank (IADB) to study cases of good practice in urban regeneration of river corridors in Latin America. Both interests crystallized in a collaboration to study a number of cities in the region, in order to draw conclusions that are applicable to more complex case that the IADB had on the table: the urban corridor of the Choluteca River in Tegucigalpa (Honduras). The research was then extended to four case studies of urban corridor restoration in four Latin American cities (Rosario in Argentina; Cuenca in Ecuador; Monteria in Colombia; and Tegucigalpa in Honduras), extracting good practice experiences from the Latin American Region that could be implemented in other cities in the developing world.<sup>13</sup>

<sup>10</sup> New York City's Green Infrastructure Plan, Available at (last visit April 14 2016): [http://www.nyc.gov/html/dep/html/stormwater/nyc\\_green\\_infrastructure\\_plan.shtml](http://www.nyc.gov/html/dep/html/stormwater/nyc_green_infrastructure_plan.shtml)

<sup>11</sup> Note of the author: 1 acre equals 0.40 hectares or 4,047 m<sup>2</sup>.

<sup>12</sup> For more information, see <http://www.iadb.org/en/topics/emerging-and-sustainable-cities/emerging-and-sustainable-cities-initiative,6656.html>

<sup>13</sup> The research took place during the years 2014 and 2015, and constitutes the material on which the author has elaborated her PhD Dissertation.

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The theoretical part of the research assumes that there is already abundant literature and empirical evidence on the environmental and social desirability of introducing ecosystem services in the urban environment, with interventions such as the creation of linear parks along urban water courses. But, are these sorts of green infrastructure a priority in the Latin American context or a caprice of cities with highest economic level? Or, in other words, are these parks (or green infrastructure) a priority infrastructure or an expensive “aesthetic makeup” in the city?

To answer these questions, the research emphasizes the economic viability of the parks along river corridors with a threefold approach (see Table 1): first, the use and knowledge of the concept “green infrastructure” in the context; second, the existence or not of strategic planning at the metropolitan or regional scale, and the coordination of it with the watershed planning and management; and third, the return on investment in GI. Because this last topic was identified as one of the key issues to be taken into account by multilateral financial institutions when making decisions about the viability of these type of investments, the scope of the analysis was also subdivided in three topics: first, the aspect of urban management through public-private partnerships; second, the study of the distribution of value capture gains from the intervention; and, finally, the evaluation of the cost-benefit of the maintenance costs of these green spaces and the socio-economic benefits derived from their use and enjoyment by citizens.

***The “Emerging and Sustainable Cities Initiative” (ESCI) of the Inter-American Development Bank (IADB)***

Since 2011, the IADB is implementing the ESCI, an experimental cross-department initiative of the Bank to provide financing to local governments in order to plan their urban infrastructure in the medium and long terms. The initiative is grounded in a rigorous methodology by which a city is evaluated generating, in 12 months, an Action Plan based in 140 sustainability indicators. This Plan sets up short and long term actions that are economically quantified and organized by priorities. The plan is a roadmap for potential investments in the city, focusing on the environment, urban quality and institutional and fiscal sustainability.

It is usually done at the request of the mayors, when the legislature starts, and always includes at least one “anchor project” that can be completed before the legislature ends, but the bulk of the Plan are urban infrastructure investments for the medium and long term, with the idea that the strategy can last several legislatures regardless of political vicissitudes of the municipal government. This has been possible because the plans are supported by the IADB and by the local community, represented both by local experts and by public participation in general.

The initiative has been very successful in Latin America, and the methodology has been replicated with two regional financial institutions: Banobras in Mexico and Findeter in Colombia. 140 medium-sized (cities between 100,000 and 2 million people), “emerging” (cities which grow above average in population and GDP) cities have been identified, out of which 40 have been already analyzed. For the cities it is a great help, as they often have not enough technical skills to do this kind of analysis. For the IADB and other banks this is a tool to prioritize investments on a sustainable basis. The ESCI has also developed a web platform where all information generated is shared, from homogeneous statistics and data bases of the cities to good practices experiences or research activities developed with local universities.

At the beginning of the implementation of the ESCI, the goals of the Action Plan were urban sustainability in general. But, as the initiative is advancing, there is a growing evidence (both confirmed by the accumulative experience with the cities

CASE STUDIES		El Barranco del Tomebamba (Cuenca)	Ronda del Sinú (Montería)	Frente Costero del Paraná (Rosario)	Corredor del Choluteca (Tegucigalpa)
Knowledge of the concept “Green Infrastructure”		X	X	X	X
Strategic Planning at the regional/metropolitan scale		X	X	X	X
Return on investment	Urban management model	X		X	X
	Value capture			X	
	Socioeconomic assessment		X	X	X

Table 1: Summary of the topics analyzed on each case study.

SOURCE: Prepared by the author.

involved in the ESCI and by further academic research) that supports the idea that prioritizing transportation, water and green open space systems is the way forward towards urban sustainability and resilience for most of the cities.

The outcome of the research of the four case studies of urban river corridors regeneration is being used to improve the performance of the ICES other cities of the Latin American region with polluted urban rivers. For this paper we have selected to show in more detail a summary of the case of the regeneration of the Parana River waterfront in Rosario (Argentina), for being the case with most complete data related to the return on the investment in green infrastructure, which is one of the issues identified as being crucial in the decision making processes at the multilateral financial institutions.

### Green infrastructure return on investment: the case of the regeneration of the Paraná river waterfront in Rosario (Argentina)

“Land immediately about the Park, the frontage of it being seven miles in length, instead of taking the course anticipated by those opposed to the policy of the Commission, has advanced in value at the rate of two hundred per cent per annum.... It is universally admitted, however, that the cost, including that of the original off-hand common-sense blunders, has been long since much more than compensated by the additional capital drawn to the city through the influence of the Park.”

FREDERICK LAW OLMSTED (1870, 1997:199)

14 The documentation of this case study was possible thanks to the collaboration of the Municipality of Rosario and the interviews with the former Secretary of Planning, Mirta Levin, and with the current Planning Secretary Paul Barese. These interviews took place in Rosario, Argentina, in December 2014. This case study has been published as a Technical Note of the IADB in Terraza et al., 2015. Available at (last visit, April 14 2016): <http://publications.iadb.org/handle/11319/6930?locale-attribute=es>

15 The other three case studies analyzed in the dissertation are: *El Barranco* of the Tomebamba river in Cuenca (Ecuador), *La Ronda* of the Sinú river in Montería (Colombia) and the Urban Environmental Corridor of the Choluteca river in Tegucigalpa (or Central District) of Honduras.

The following text is a brief summary of the socio-economic assessment of the Parana River waterfront in Rosario (Argentina),<sup>14</sup> which is one of the four case studies<sup>15</sup> analyzed in a broader research promoted by the Inter American Development Bank.

The city of Rosario was created on the shore of the Parana River and this condition of riverside city has been a determining factor in its urban setting and its productive activity throughout its history. The commercial port was the basis of economic and social prosperity of the city, which was consolidated with the formation of the industrial belt of Gran Rosario and the growing commercial and financial activity that characterized the city during most of the twentieth century. However, since the 1970s, economic and social changes made the port come into decline, and with it the entire city.

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[Fig. 3] Aerial view of the city of Rosario, Argentina, and the Paraná River.

SOURCE: LEVIN, 2014.



After decades of joint reflection by the municipal authorities and the general public, in the early years of the 21<sup>st</sup> century, the city enjoys the great transformation of the old commercial harbor into a green riverfront promenade open to the public. The waterfront of Rosario has evolved from being a private, abandoned and degraded space to become a linear park open to all citizens, with an exceptional landscape quality. Around this waterfront park residential buildings, cultural and entertainment centers, restaurants and plazas have been built for the enjoyment of citizens and visitors. And all this has been possible with the direction and coordination of municipal authorities and mainly private investment.<sup>16</sup> This case study was selected for being an indisputable reference in the region of good strategic planning in the medium and long term, good management of public resources available to improve water quality and to build quality public space, and an effective and coordinated implementation.

The goal of this evaluation is to assess whether the regeneration of the waterfront of Rosario has been a profitable investment that can be maintained over time. That is, if the creation of green spaces in the Parana River waterfront generates benefits to society that exceed the costs, including maintenance costs. To demonstrate with real numbers that this investment is economically sustainable over time can be useful as a reference for other operations to promote parks and urban regeneration along river corridors in other cities in the Latin American region.

Out of the total 17 km of waterfront of the municipality of Rosario, approximately the northern 12 km have already been transformed into public open spaces until December 2015, while the southern 5 km remain in the transformation process. Therefore, for the analysis of the impacts of the recovery of green areas along the river, we have selected the 12 km that are already of public use. These areas include public spaces with different uses, but basically they are green areas and facilities for the development of recreational and cultural activities. Because of the number, size and prime location along the river, all these public spaces form a system of green areas connected around the Paseo de la Costa, structuring a network of great environmental, cultural, recreational and landscape quality of the city. It is this linear park, 12 km long and 136 hectares of surface area, selected to measure the socioeconomic impacts.

<sup>16</sup> For more information on the model of urban management with public-private participation developed in Rosario, consult Terraza et al., 2015.

The development of techniques of economic evaluation of environmental assets, many of them in the field of econometrics, is still in an early stage of development,

[Fig. 4] The river waterfront urban sectors as defined in the Rosario Urban Plan 2007-2017 (PUR 2007-2017).

SOURCE: <http://www.ceats.org/archivos/III%20Evento%20Regional/EXPOSICION-MIRTA-LEVIN.pdf>.



and are used in this study considering all the precautions that it implies. According to Sepúlveda (2008),<sup>17</sup> within the framework of welfare economics there are basically two ways to estimate the value of an environmental good or service: indirect and direct. Indirect methods try to approximate the value of a good or an asset through related markets from which the prices of similar goods can be obtained. Instead, direct methodologies simulate a hypothetical scenario and request a response to a change. Indirect methodology used in this case is the *hedonic prices*<sup>18</sup> and direct methodology is *contingent valuation*.<sup>19</sup>

Here we present the results of the assessment of the impacts of the interventions carried out by the Municipality of Rosario to recover the waterfront of the city on the Paraná. The impacts analyzed are:

- The benefits that the community gets from the parks and public areas built in the coastal area, using the hedonic prices and the contingent valuation methods;
- The increment in tax revenue by raising property values due to construction;
- The cost of construction and maintenance of all interventions;
- Job creation due to economic activities located in the new areas.

The socioeconomic benefits calculated in the case of Rosario is, due to the limitations of reach, an approximation and certainly does not exhaust the list of positive impacts of a mega project such as the transformation of the waterfront of Rosario. Given the above caveat, it can be argued that, considering only its use value as urban parks and after the analysis in this research, the waterfront linear park reports to families in the area of influence an economic benefit of around US\$ 3 million per year. If we more holistic methodology, more appropriate to multifunctional interventions, such as the hedonic pricing method, it can be argued that the benefit that the city derives from the sectors analyzed, reflected in the price of the real estate property, beyond possible errors of estimation, is US\$ 260 million.

Against this level of profit, the estimated investments required for re-functionalization the coastal area, which have been financed with public and private funds, are in the order of 150 million. The comparison of the two amounts indicates that, at this level of approximation, the renewal program of the waterfront was widely beneficial in social, environmental and economic terms.

17 SEPÚLVEDA VARGAS, Rubén Darío (2008): "Valoración económica del uso recreativo del parque Ronda del Sinú, en Montería, Colombia". *Semestre Económico*, volumen 11, No. 22, pp. 67-90. Universidad de Medellín, Colombia.

18 Para más información, consultar ROSEN, Sherwin; (1974). "Hedonic Prices and Implicit Markets: Product Differentiation in Perfect Competition"; *Journal of Political Economy*: 34-55.

19 Para más información, consultar MITCHEL, R.C. y R.T. CARSON (1989). *Using surveys to value Public Goods. The contingent valuation method*, Resources for the Future, Washington D.C.

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[Fig. 5] View of the old Puerto Norte in Rosario.

SOURCE: Terraza et al., 2015.

[Fig. 6] Photomontage of the project for the Rosario waterfront in Puerto Norte (in construction).

SOURCE: Terraza et al., 2015.



Moreover, the fiscal impact, resulting from the valuation of the plots, is estimated in US\$ 2 million annually. This additional tax revenue nearly doubles the cost of maintenance estimated at US\$ 750,000 per year. It is also noted that the difference between the estimated increase in property value and the estimated increase in tax revenue seems to confirm that the property tax is not a proper tool to capture urban capital gains.<sup>20</sup>

Finally, it is estimated that the program has involved the creation of more than 320 permanent jobs related to maintenance and the development of economic and cultural activities in the area.

To synthesize the data collected and to provide a rough idea of the magnitude of the impact that such a program can represent for other cities in the region, Table 2 shows mean values per hectare of green area. These numbers are to be interpreted with all the caveats mentioned in the study.

20 For a deeper discussion on this topic, see CUENYA, Beatriz and PUPARELI, Sonia (2006): "Grandes proyectos como herramientas de creación y captación de plusvalías urbanas. Proyecto Puerto Norte, Rosario". *Medio Ambiente y Urbanización*. Buenos Aires, n. 65, pp. 81-108, and SMOLKA, Martim O. (2013). *Implementación de la Recuperación de Plusvalías en América Latina: Políticas e Instrumentos para el Desarrollo Urbano*. Lincoln Institute of Land Policy, Cambridge, MA.

The partial conclusions of the Rosario case study are:

*Conclusion 1:* The environmental and urban recovery of an urban river corridor and the creation of public green spaces along its banks generate, as well as social and environmental quality improvements, quantifiable economic benefits exceeding the costs.

*Conclusion 2:* The implementation of a major urban project, as is the regeneration of a river corridor in a dense urban environment, must be accompanied by a

Table 2: Summary of the economic impacts of the transformation program of the waterfront of Rosario.

SOURCE: Terraza *et al.*, 2015.

PUBLIC-PRIVATE INVESTMENT ESTIMATE: (with a relevant street work and public open space component)	1.12 millions of US\$/Ha
BENEFIT FOR THE INHABITANTS OF THE CITY: (by the hedonic prices method)	1.91 millions of US\$/Ha
ANNUAL MAINTENANCE COST FOR GREEN AREAS: (Main component of the transformation program of the waterfront of Rosario)	5,514 US\$/Ha
FISCAL IMPACT OF THE INCREMENT IN VALUE OF THE PLOTS: (In property taxes)	14,804 US\$/Ha
PERMANENT JOBS CREATED: (for the operations and maintenance of the parks, the recreational areas and the service buildings)	2.35 jobs per Ha

regulatory development that allows for an equitable distribution of the gains among stakeholders, allowing the local government to get the return on the investment and always giving priority to the general interest.

To sum up, the evidence shown in this research can validate the hypothesis that investing in the regeneration of urban river corridors, creating linear parks along the river banks, is a very beneficial strategy from social and environmental point of view but, above all, it is a viable and economically sustainable strategy in the Latin American context. In particular, from the perspective of urban resilience and disaster prevention flood (which are a priority investment in Latin America for the multilateral development banks), urban green along the river network that flows through dense urban areas should be considered a priority infrastructure, at the same level as transport or housing infrastructure.

## Conclusions and proposals

“In the present lies not only the nightmare of what the city will become if current trends continue, but also the dream of what the city could be.”

ANNE WHISTON SPIRN (1984)<sup>21</sup>

Based on the data of the four case studies analyzed in the context of the ESCI of the IADB, the research has identified a fundamental challenge to advance in the path of the implementation of urban planning and projects based on the (re-)introduction of natural ecosystems in the city: to prove that urban green is not a luxury of rich cities, but a priority and a viable infrastructure for developing cities, at the same level than transportation or housing infrastructure. In the context of the multilateral development banks, the ultimate motivation of the shift towards a new “green” urban planning paradigm in developing countries is not (only) environmental, but economical above all.

The fundamental conclusion of this research is that progress in the implementation of urban planning and regeneration projects that contribute to the sustainability of emerging cities of developing countries should encourage planning based on regional water systems and green infrastructure, following three strategies:

- To overcome the lack of municipal funds and technical capabilities for planning, the contribution of multilateral financial institutions to urban development and resilience should include a strategy for financing local or metropolitan governments directly in order to plan their transportation, water and green infrastructure systems in the medium and long term (as in the ESCI strategy). The promotion of

21 SPIRN, Anne Whiston (1984): *The Granite Garden. Urban Nature and Human Design*. Basic Books, NY.

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planning at the metropolitan or regional level will provide the framework in which to insert any major urban infrastructure project, as is the regeneration of an urban river corridor, because that is the scale of the coherent understanding of the watershed and ecosystems on which the urban sustainability depends upon.

- The inclusion of the correct assessment of the return on investment of green infrastructure in the decision making of local governments and multilateral institutions, and the creation of an urban policy framework that allows the capture of the capital gains generated by green infrastructure in the most equitable possible way.
- The generation of shared knowledge and the training of local experts and politicians about the social, environmental and economic benefits of green infrastructure networks.

One of the outcomes of this research is a proposal to continue the debate around the New Urban Agenda of the Habitat III conference<sup>22</sup>, about the need of promoting a new paradigm of sustainable urban planning based in water and green infrastructure metropolitan systems in all international financial and development institutions investment initiatives in urban development. The main message of this new paradigm is that, far from being a superficial make up, water and urban green systems are a priority infrastructure (at the same level as transportation infrastructure or housing) for all cities, especially those in developing countries that will grow exponentially in the next decades.

The main objective of the proposal is to encourage the multilateral financial institutions of the world to fund green infrastructure planning and to create educational initiatives on sustainable urban design and planning for the developing world, re-organizing their financing priorities in order to contribute to the achievement of a sustainable planet of cities. The proposal is based in overcoming the three main challenges that prevent green infrastructure to be a reality in the fast growing cities of the developing world:

1. The lack of funds for planning, especially in small and intermediate cities, which have other budget priorities, where “the urgent” usually takes over “the important”. This lack of planning prevents those cities from having a clear order of priorities for important infrastructure investments and makes it more difficult to provide its citizens with a sustainable and safe urban environment.
2. The unawareness of the economic benefits of green areas and clean waters in the dense urban environment.
3. The lack of technical capabilities in landscape and green infrastructure planning of most local experts and politicians, and the lack of understanding of the importance of planning infrastructure systems (transport, water, green areas) at the right scale (the hydrological footprint of the city) for urban sustainability and resilience, in order to avoid the “tyranny of small decisions”.<sup>23</sup>

The proposal to be debated among the multilateral financial institutions includes three different actions:

1. *Proposal 1: To invest in green strategic planning.* This first action would be to open a debate on the initiatives on sustainable urban development implemented by multilateral institutions and the lack of investment in green infrastructure. The objective would be to evaluate how they are currently facing these global challenges and how they could improve their effectiveness in contributions to the sustainability of this planet of cities with a new urban planning paradigm based on water and green infrastructure metropolitan systems, coordinated with the more “traditional” grey infrastructure transportation systems. To invest

22 Habitat III is the third edition of the bi-decennial UN meeting on urban settlements, held in Quito (Ecuador) in October 2016. For more information, see: <https://www.habitat3.org/>

23 The economist Alfred E. Kahn identified in “the tyranny of small decisions” as one of the potential market failures of capitalist economy. The explanation was that a series of decisions, taken individually or relatively small in size and time, could seem rational, but accumulatively they produced a result that is not optimum nor desired by the majority of the population (Kahn, 1966 cited by Odum, 1982). In one of those interesting examples of cross-disciplinary enrichment, the environmentalist William E. Odum established that this very same phenomenon was applicable to environmental questions and to science in general, and presented a few examples of it on a paper published in 1982. Odum pointed out that this relevance of the “tyranny of small decisions” was especially clear when dealing with pollution or bad management of water or air, because they are fluids that work as systems, where every impact affects the whole system. For more information see:

ODUM, William E. (1982): “Environmental degradation and the tyranny of small decisions”. *BioScience* Vol 32 No.9; Oct 1982; pp:728-729.

in green infrastructure strategic planning, helping growing cities in developing countries to plan ahead the ecosystem network that will support their urban sustainability and resilience, at the same time as the transportation or energy networks, is emerging as a good practice in Latin America<sup>24</sup> and should be exported to the growing regions of Asia and Africa.

2. *Proposal 2: Encourage research on the economic value of metropolitan green infrastructure systems.* The only way to increment green solutions in urban infrastructure in emerging cities will be providing evidence of their better economic performance comparing them to traditional gray infrastructures. Investing in this research line will produce analysis and evidence that could better inform the decision making of these multilateral institutions (which is done basically by economists, who need economic evidence to support a shift in the urban infrastructure priorities), or local governments of emerging cities of developing countries.
3. *Proposal 3: Investment in Education.* The international financial institutions should invest in developing formative courses (masters, bachelor degrees) in local Universities of developing countries on green infrastructure planning, merging the disciplines of civil engineering, environmental sciences, urban planning and landscape design. This courses will incorporate first hand real case studies developed by collaborating multilateral institutions. The aim of the programs would be to elaborate simple and direct applicable findings, which ultimately will contribute to the desirable paradigm shift from the “traditional urban planning” to “green urbanism” (or “sustainable urban planning”) based in water and a green infrastructure metropolitan network system. This strategy may include the development of *Massive Open On-line Courses* (MOOCs), to share this knowledge with the city leaders, professionals and professors of developing countries.

In conclusion, the main idea of this work is that, at the global level, urban sustainability of the emerging cities that will expand until 2050 (mainly in Latin America, Asia and Africa) will depend largely on a paradigm shift in urban planning. To this end, there should be an international consensus to help local governments to plan their cities from a metropolitan (or regional, including the hydrological footprint of the city) system of transport, water and green infrastructure, prioritizing investments necessary both to regenerate urban ecosystems in deteriorated urban plots and to expand the city into the rural periphery protecting the existing ecosystems.

We have 35 years ahead to manage these challenges, which open before us a momentous period that will determine the quality of life of millions of people, and perhaps even the survival of our species on the planet. There is sufficient information, technical capacity and experience to help cities that will experience the greatest transformations in creating new urban spaces that are sustainable and bring quality of life for its inhabitants. The question is whether we will be able to transmit that information and those capabilities in the right places and at the right times.

### Acronyms

ESCI	Emerging and Sustainable Cities Initiative (in Spanish, ICES Iniciativa de Ciudades Emergentes y Sostenibles)
EU	European Union
GI	Green Infrastructure
IADB	Inter American Development Bank (in Spanish, BID Banco Interamericano de Desarrollo)
MOOC	Massive Open On-line Courses
UN	United Nations
UNEP	United Nations Environment Programme

<sup>24</sup> An example of this is the *Emerging and Sustainable Cities Initiative* (ESCI) of the IADB.

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