Vice Presidency of Sectors and Knowledge
Institutions for Development Department
Research Department

Call for Research Proposals

Sustainable Cities in Latin America and the Caribbean
(RG-T2063)

I. Justification and Background

Most large Latin American urban areas are vulnerable to various negative development externalities, including congestion, pollution, and depletion of green areas and biodiversity. This vulnerability increases when economic and population growth coincide with poor regulation, inefficient use of resources and energy, and high levels of emissions.

Even though in recent decades some metropolitan areas have achieved remarkable reductions in the intensity of their emissions, many challenges persist for most cities. Cities generate most of the world's greenhouse gas (GHG) emissions, and accelerated urban growth can have significant effects on both agriculture and biodiversity. Therefore, changing the configuration of cities, improving their regulations, providing key infrastructure, and altering the lifestyles of urban dwellers can have a major impact on mitigating those emissions, reducing their contribution to global warming, and protecting agricultural lands and biodiversity. Today's urban residents make up half of the world's population but account for 71 percent of energy-related greenhouse gas emissions. That proportion is expected to rise to 76 percent by 2030 (Hoornweg et al., 2011).

Urban sustainability is an issue of the highest relevance for the future of society as a whole (McGranahan et al., 2001). This statement is even more relevant in Latin America due to its urbanization, which is higher than in other regions. Large Asian cities present the same challenges. In this context, the Inter-American Development Bank and the Asian Development Bank are sponsoring a series of city studies to assess the environmental sustainability of urban growth in both regions. Urban planners in fast-growing cities could foster emission reduction by building infrastructure and housing that result in densely populated yet livable city centers. On a broader scale, cities and regions could cooperate by insisting upon greener sources of electrical power. This call for proposals aims to identify the research teams and the cities in which an initial set of studies will be commissioned for the Latin American case.

II. Objectives

The objective of this research initiative is to sponsor key research to measure the sustainability of the urbanization process in a sample of cities in Latin America and the Caribbean. A set of parallel studies will be commissioned by the Asian Development Bank for a sample of cities in Asia. Studies should collect and use urban sustainability data in several areas of the region's cities, and link those data to sound policy recommendations.

Each city study should seek to fulfill three specific objectives:

1. Characterize different urbanization patterns of the cities analyzed and their performance in key sustainability metrics during the last three decades, and make a prediction for future decades.

2. Identify clear correlations between urban morphological elements—and associated socioeconomic consequences—and resources demand, including an estimate of the main metabolic flows (water, food, raw materials, and products) and outflows (sewage, waste, or CO_2 emissions).

3. Provide guidance to help determine the most appropriate and effective strategies for investing in urban infrastructure, in order to optimize resource use efficiency while satisfying key indicators of socioeconomic well-being.

III. Scope and Methodology

One of the major goals of each study (whether of one city or several) is characterizing the urban development patterns of the different cities to be analyzed. The main methodology to be adopted should be based on six critical attributes, as follows:

1. Urban footprint: this includes the urban layout, as determined by the boundaries of the urbanized environment, the main urban infrastructures, and elements of urban ecology, including the density and distribution of critical ecosystem services in urban areas.

2. Governance: the structure of local governments and administrative boundaries, with special emphasis on the linkages to regional and national governing bodies and the authority to raise and spend local tax revenues.

3. Social patterns: the distribution of social groups (as defined by average income and education levels), as illustrated in Figure 2.

4. Urban work: the distribution of employment among different economic activities (industry, commerce, services), including a survey of the extent and intensity of the informal urban economy.

5. Urban density: inhabitants per square kilometer.

6. Global indicators: urban sustainability, climate, human development, and low-income population (in absolute numbers and as a proportion of the total urban population).

A clustering of distinct urbanization patterns will emerge through an analysis of the spatial distribution of these indicators.

Selected research teams are expected to perform the following tasks:

1. **Define the range of data needed and estimation methods**, establish all main statistical methods to be employed—including spatial geographic information system (GIS) protocols—and provide a first-order description and spatial representation of the range of values for all seven attributes: footprint, resource consumption, governance, social patterns, work, density, and global indicators.

   To ensure a robust methodology, rigorous quantification will be performed using (i) data provided by the countries, local governments, or reputable research institutes of the urban areas studied, and duly scrutinized; or (ii) data available in the technical and scientific literature subject to peer review; or (iii) results (in the form of quantitative indicators) from models developed for this project, using any of the above as input. Whenever data quality allows, estimates are performed through a GIS platform to establish a spatial distribution of the results, allowing for spatial representation.

2. Extensive **review of urban sustainability indicators**, in order to help clarify the indicators to be used in attribute 6 of the methodology defined above.

   This is relevant, as there has been a great deal of work intended to formulate useful metrics of urban sustainability. The result has been the formulation and compilation of indicators to provide specific quantitative and qualitative measures of every aspect of urban sustainability. Aside from the obvious need to track progress or the lack thereof, these efforts are also meant to establish a robust and scientifically sound basis upon which generic indexes can be used to make a comparative analysis of resource consumption in a range of cities. Enlightened metrics tend toward indexes based on a holistic urban assessment that considers the prospects for reducing the environmental consequences of urban consumption while supporting economic, social, and cultural priorities.

   This first task will review the types of indicators available for the last three decades and aim to provide a more robust scientific basis for assessing and tracking the various aspects of urban sustainability.

3. **Characterization of the urban footprint.** The footprint will be characterized by tracing the densities and distribution of the urbanized environment (buildings, urban infrastructures) and the ecological structures (green areas, wet systems). The

characterization will be performed by crossing information of local maps and through remote sensing.

4. **Characterization of urban governance**. Urban political and management structures will be characterized at all power levels: national, state, city, and borough. Local government organization will be assessed and the competences of each department (e.g., Housing, Planning, Education, Health, Security, Urban Natural Resources Management, and Transport) will be listed. The urban administrative structure should be spatially represented (districts, parishes, boroughs), making it possible to compare different levels of proximity between decision makers and citizens.

5. **Characterization of social patterns**. Patterns of the socially disadvantaged and the privileged will be characterized and established based on information about affluence, education (literacy), employment/unemployment, and consumption of individuals and/or families, and their impact on the urban ecosystem. Spatial representation of the results makes it possible to understand the distribution of social exclusion, and the degree of marginalization of the urban societies studied.

6. **Characterization of urban work.** The share of people employed in different activities represents the transition from an industrial economy to a knowledge-based one. The distribution of employment across different economic activities—industry, commerce, and services—will be characterized and represented spatially. This distribution will establish the density of economic activities along the urban space, as well as in the area right outside the urban fringe. Data availability will determine the possibility of characterizing the extent and intensity of the informal urban economy (undeclared activities).

7. **Characterization of global indicators.** A set of additional indicators will be collected, such as climate indicators (average, maximum, and minimum temperatures; and precipitation) and those useful for establishing appropriate benchmarks for the region.

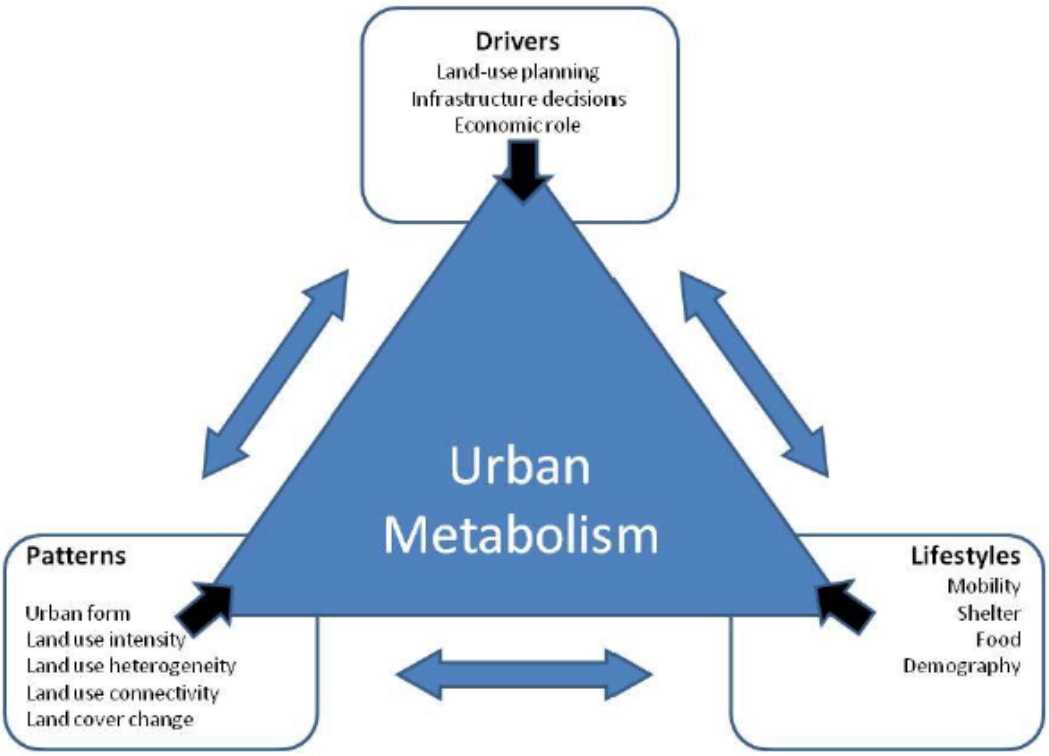
All indicators described above can also be understood in the context of an urban metabolism framework. Three elements influence urban use of environmental capital and resulting externalities: urban drivers, urban patterns (urban structure), and urban lifestyles—see Figure 1. Urban metabolism ultimately influences a series of urban quality-of-life indicators.

Urban metabolism can be defined by the actions of anthropogenic subsystems—social, economic, institutional—interacting with the environment through consumption of materials and energy, and accumulation of materials in the urbanized environment while diverse solid wastes and emissions into the air and water are rejected. A key element of these anthropogenic subsystems is the extensive infrastructure networks serving the urban populace. Infrastructures for mobility, water and sanitation, energy, and waste are thus at the very heart of urban development, and constitute major economic sectors by contributing significantly to raising citizens' living standards and quality of life.

Selected research proposals should aim to use the urban metabolism framework to clearly delineate and quantify direct correlations between urban development patterns and the flows and conversion of materials and energy through urban infrastructures. Resource-flow models serve to identify challenges, such as bottlenecks, as well as potential improvements that lead toward future service-oriented, eco-efficient infrastructure scenarios.

Figure 1

Urban Metabolism Framework



Source: Mink et al. (2010).

Tables 1 through 4 present a sample of indicators for the main elements of urban metabolism, including urban use of environmental inputs, urban drivers, urban structure, and urban quality.

Table 1
Urban Use of Environmental Inputs

Energy and climate	Water	Waste	Land use
- CO_2 emissions – production - CO_2 emissions – transportation	- Territorial water extraction - Groundwater levels	- Waste intensity – production - Waste intensity – residential use	- Soil sealing - Land footprint

- CO_2 emissions – residential use - Carbon footprint - Energy efficiency – production - Energy efficiency – transportation - Energy efficiency – residential use - Renewable energy production - Energy footprint	- Water scarcity - Water use efficiency - Wastewater treatment - Water quality extraction - Water quality release - Water footprint	- Waste recycling - Waste incineration - Waste landfill	

Table 2
Urban Drivers

Population and households	Income and lifestyle	Local climate	Prices	Transportation
- Population size - Population growth - Household formation - Household size	- City GDP - Household income - Poverty incidence	- Temperature (high and low) - Rainfall	- Land prices - House prices - Water prices	- Traffic volume - Modal split - Travel time - Commuters - Car ownership

Table 3
Urban Structure

Size	Land cover and use	Transport	Urban form	Buildings
- City size	- Sealed land - Built-up land - Open spaces	- Land transport - Transport network length (road, metro, smart bus networks)	- Compactness - Centrality - Density	- Building stock - Detached single houses - Homes in multiunit buildings

Table 4
Urban Quality

Air pollution	Noise	Infrastructure, green space, and accessibility	
- O_3 short and long - NO_2 short and long - PM_{10} short and long	- Daytime noise - Nighttime noise	- Access to safe water and sanitation - Access to adequate housing - Access to green spaces - Access to recreational land - Multimodal accessibility	

8. **Identification of different urban patterns and associated sustainability indicators.** This phase will provide a critical assessment of the results obtained in the previous steps, resulting in a clear picture of how distinct urban development patterns led to different socioeconomic and environmental consequences.

Urban Patterns and Resource Demands

Selected research teams should aim to provide robust correlations between urban patterns and resource demands, an estimate of metabolic flows associated with urban areas and the existing infrastructure, and measured degrees of correlationbetween indicators of urbanization patterns, infrastructure characteristics, and metabolic flows.

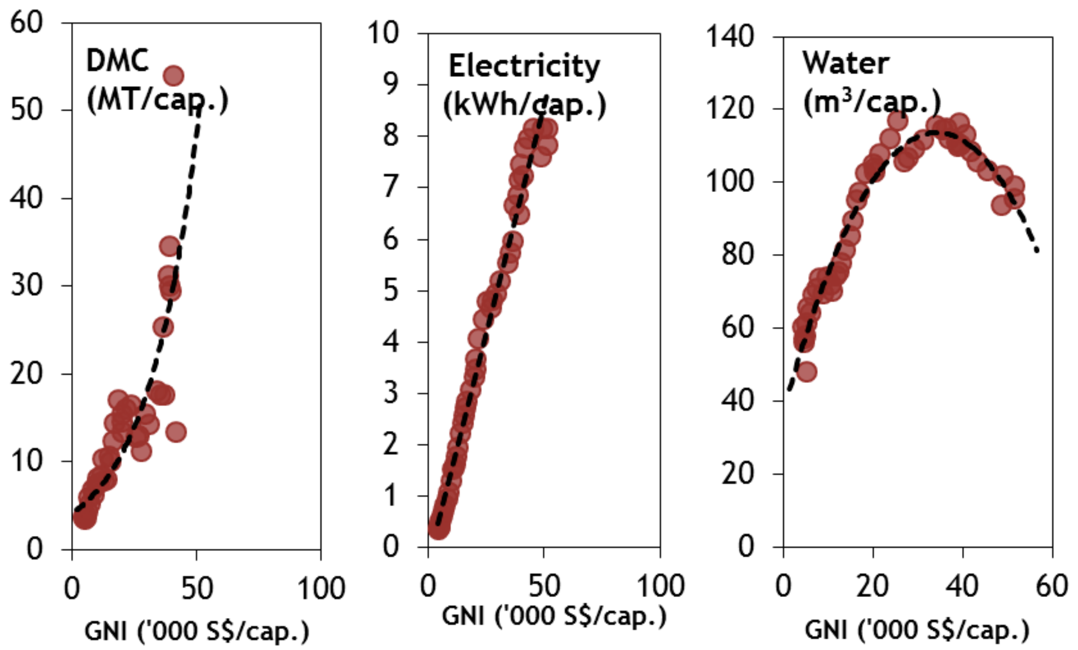
Recent work on the urban metabolism of Singapore reveals dynamic relationships between the growth of the urban economy, the urban land-use pattern, and the consequences for specific urban resources. Results clearly indicate that distinct dynamics are related to specific characteristics of the infrastructure serving the delivery and consumption of the specific resource (Figure 2).

For example, it is clear that overall material consumption rises exponentially as the urban economy grows, while electricity rises linearly and water peaks at a maximum. The distinction between these dynamics implies a need for targeted policies that are better tuned to the sensitivity of urban resource consumption to the urban economy.

The use of natural resources and the subsequent outputs to nature should be analyzed using Urban Metabolism concepts and tools (see Ferrão and Fernández, 2012; Mink et al., 2010).

Urban Metabolism has emerged as an effective framework to investigate the inherent intertwining of social, economic, and environmental aspects of the urban construct and respiration.

Figure 2
Dynamic Relationships between Growth in the Urban Economy and A) Urban Domestic Material, B) Electricity, and C) Water Consumption



The current literature indicates a significant knowledge gap in assessing the linkages between essential components of urban patterns, infrastructure, and urban metabolic flows. This project aims to close that gap. The work outlined here is intended to bring forward a new method to support strategic investments in sustainable urban infrastructures for different urban systems clusters.

Selected research teams should aim to characterize the urban resource consumption profiles of the city or cities being analyzed (see Saldivar-Sali, 2010). This typology aims to characterize the intensity of urban metabolism by assessing the consumption of eight types of resources: total energy, total materials, electricity, water, fossil fuels, industrial minerals and ores, construction minerals, and biomass (the last four are specified by Eurostat in its material flow analysis standards). The employed methodology holds that these eight resources are impacted by the independent, predictor variables of affluence, population, population density, and climate. In addition, aggregate carbon dioxide emissions were used as a dependent variable. Carbon dioxide emissions act essentially as an overall consumption proxy most closely linked to energy consumption. Figure 3 (see below) shows the results of several city types that can be found in Latin America.

The results of the typology allow for improved predictions regarding urban resource profiles for a wide range of cities, as illustrated in Figure 3. Type 3 cities are largely agricultural with a growing industrial base. Construction minerals consumption reflects expanding infrastructure. Cities of this type include Cali, Panama City (Panama), Manila (Philippines), and San Salvador (Republic of El Salvador). Type 4 cities display low consumption of total energy, fossil fuels, and electricity, and low carbon dioxide emissions. Construction minerals are consumed at low-to-medium levels, biomass and water at medium levels, and industrial minerals and ores at medium-to-high levels. Cities of this type include Lima (Peru), Tunis (Tunisia), and Rabat (Morocco). Type 5 cities are characterized by low carbon emissions. Consumption of total energy, fossil fuels, electricity, industrial minerals and ores, and construction minerals is at low-to-medium levels, while that of biomass and total materials is at high levels. Type 5 cities include Montevideo (Uruguay), Durban (South Africa), and Curitiba (Brazil). Type 8 cities consume low levels of electricity, and moderate levels of all other types of resources. Several countries hosting Type 8 cities are home to large cement manufacturers. They include Beijing and Shenzhen (China), Brasília (Brazil), Mexico City (Mexico), and Istanbul (Turkey). Finally, Type 9 cities are known for low consumption of industrial minerals and ores. While they consume moderate amounts of total energy, fossil fuels, electricity, and construction minerals (and emit carbon dioxide at a moderate level), they consume biomass at medium-to-high levels. Type 9 cities are found within *transition economies*. They include Belgrade (Serbia), Tripoli (Libya), Buenos Aires (Argentina), Tehran (Iran), and Lisbon (Portugal).

Figure 3
Selected City Typology Resource Consumption Levels

Note: Shown above are Types 3, 4, 5, 8, and 9, from left to right. Each graph illustrates consumption levels for the following resources: Bio – biomass; FF – fossil fuels; TE – total energy; EL – electricity; CO_2 – carbon emissions; Ind – industrial minerals and ores; TM – total materials; Con – construction minerals and metals.

Research teams should strive to measure urban resource intensity metrics on a variety of scales (e.g., per capita, per household, per urban district, and per city) and link these metrics to urban governance. There has been some preliminary work linking the temporal and spatial extents of urban systems with urban resource consequences. Some aspects of this relationship are the various factors that contribute to urban infrastructure “lock-in”. This term refers to the “inertia” that accompanies the construction and operation of large-scale systems. As a result of long service lives and large spatial scale, urban infrastructure is not easily modified or replaced with alternative urban technologies.

Pathways toward urban resource efficiency require a rigorous understanding of the inherent difficulties in transitioning from traditional, resource-inefficient urban systems to more efficient alternatives. Research teams should aim to identify the spatial and temporal extents of major urban infrastructure for the purpose of targeting elements of urban infrastructure that can be modified to produce efficiency gains in the short, medium, and long terms. This project aims to provide a quantitative understanding of the nature of urban infrastructure lock-in for a sample of Latin American cities.

Research teams should make an effort to delineate distinct pathways between current conditions, expectations of urban growth and change, and sustainable urban futures for the cities being studied. Successful studies will provide guidelines for strategic investment in promoting sustainable investments in urban infrastructures for different urban systems clusters. Of particular interest are the direct correlations between investment levels and alternative, nontraditional urban systems (such as district water systems and various renewable energy smart grid configurations), and defining a suite of alternative urban technologies that can be implemented in a range of urban clusters.

IV. Selection Criteria and Proposal Submission

Only research institutions may present proposals to study the urban sustainability of a city or cities, and only those that closely follow the methodology described above will be considered. The final number of proposals accepted will depend on the quality and proposed budget of the proposals received. Research centers may propose projects that include activities in more than one city.

Each approved research proposal will receive financial support of **up to US$40,000** from the IDB, depending on the scope of work proposed and the number of cities covered. Proposed budgets will be evaluated taking into account the scope of work proposed. Projects that seek extra funding to complement financing by other institutions are strongly encouraged.

Each proposal should include a detailed discussion of the issues to be addressed, identification of the sources of data to be collected and used, and the empirical strategy to address them. We will give strong preference to the proposals that closely follow the methodology described in Section III above.

In addition, the proposals must include:

- The name of the research leader and a list of other researchers involved. The center should present a research team justified in its capacity to meet the objectives of the project, including relevance of prior experience. Curricula vitæ of all researchers involved in the entire project may appear in a separate annex. Subsequent substitutions for researchers originally specified in the proposal may be made with prior approval from the project coordinators, but the research leader (of each subject) should lead the entire project to full completion;
- A budget (**in a separate file**) indicating the time and resources to be used within the context of the research work plan must be included. The budget proposed by the

research center should disaggregate items financed by the IDB and those financed by the research center. The budget should distinguish between amounts assigned to professional honoraria, "overhead", and other major categories of research expenditures;

- Institutions must provide the name and contact information of their legal representative, with authority to sign contracts with the IDB, if selected to conduct the study.

Final papers will be disseminated as IDB working papers and may be included in a book that will disseminate the LAC and Asia studies. Other forms of dissemination or publishing should be explicitly approved by the Research Network coordinators. Proposals may include suggestions for further diffusion of the final version of the paper and its policy implications.

Proposing research institutions should register as Research Network members (contact Elton Mancilla at red@iadb.org).

Note: ALL proposals and research papers must be submitted in English.

V. Coordination, Thematic Advisors, and Tentative Schedule

The project will be coordinated by César P. Bouillon (Inter-American Development Bank, Research Department, Team Leader), Cynthia Boruchowicz (Inter-American Development Bank, Research Department), Nora Libertun de Duren (Inter-American Development Bank, Institutions for Development Department), Sebastián Miller (Inter-American Development Bank, Research Department), and Fernanda Magalhães (Inter-American Development Bank, Institutions for Development Department). Paulo Ferrão, Professor at Lisbon's Technical Institute (Instituto Superior Técnico, Technical University of Lisbon), and Doug Brooks (Asian Development Bank, Research Department) would act as external advisors for the Research Network.

The tentative schedule of activities is as follows:

- **August 8th, 2012:** Call for research proposals issued.
- **September 7th, 2012:** Due date for receiving proposals. Institutions should make sure that the complete documentation is submitted to the evaluation committee. Complete documentation includes: "Registration form" with all information requested; the research proposal and CVs (CVs up to three pages long).
- **September 14, 2012:** Announcement of selected **research proposals**.
- **October 5th, 2012:** Due date for receiving a **preliminary report** with an annotated outline of the research paper, data sources, and the methodology to be used in the study.
- **January 18th, 2013:** Due date for receiving a **first draft** of research papers.

- **February 7-8th, 2013**: **Technical Workshop** (in Washington, D.C.) with project leaders and advisors for the purposes of discussing the first draft of research papers.

- **March 8th, 2013:** Due date for receiving a **second draft** of the research paper.

- **March 28th, 2013: Videoconferences** with project leaders and advisors where the second draft of research papers will be discussed (if needed).

- **April 26th, 2013:** Deadline for **final version** of the research papers, including "do files", tables, databases and a summary that discusses policy lessons.

VI. Financial Contribution

The IDB will contribute up to **US$40,000** for each study, depending on the scope of work proposed.

The payment schedule is as follows:

- **15 percent** within 30 days of signing the formal agreement between the IDB and the respective research center;
- **10 percent** within 30 days of submission and approval of the preliminary report;
- **35 percent** within 30 days of delivery and approval of the first draft of the research paper;
- **20 percent** within 30 days of delivery and approval of the second draft of the research paper and the datasets utilized by the study, to the IDB;
- **20 percent** within 30 days of delivery and approval of the final research paper, the "do files", and tables and databases utilized by the study, to the IDB.

Failure to comply with any of the terms of the contract will imply a partial return of the funds paid up to the stage in which the lack of compliance occurs.

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