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Framework for Assessing Integrated Water Resources Management in Latin America: Case Studies of Buenos Aires and São Paulo

Christina Kathryn Faris

Christina Faris
Candidate

Geography and Environmental Studies
Department

This thesis is approved, and it is acceptable in quality and form for publication:

Approved by the Thesis Committee:

Dr. K. Maria D. Lane, Chairperson

Dr. Melinda Harm Benson, Committee Member

Dr. John Carr, Committee Member

FRAMEWORK FOR ASSESSING INTEGRATED WATER RESOURCES MANAGEMENT IN LATIN AMERICA: CASE STUDIES OF BUENOS AIRES AND SÃO PAULO

BY

CHRISTINA FARIS

B.A., ENGLISH, UNIVERSITY OF NEW MEXICO, 2013
B.A., INTERNATIONAL STUDIES, UNIVERSITY OF NEW MEXICO, 2013

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CHRISTINA FARIS

B.A., English, University of New Mexico, 2013

B.A., International Studies, University of New Mexico, 2013

ABSTRACT

This thesis examines the World Bank's Latin America and the Caribbean Blue Water Green Cities (BWGC) urban water development initiative that began in 2009. This program attempts to create a comprehensive Integrated Water Resources Management (IWRM) approach for policymakers at both local and national levels, improving water management approaches and disseminating data on lessons learned. This thesis evaluates the success of the BWGC initiative by analyzing Buenos Aires and São Paulo as case studies. Each city is analyzed through examination of the specific World Bank program and through application of a general assessment tool, the City Blueprint Framework (CBF), which was designed to evaluate IWRM projects holistically. This research attempts to answer how well the CBF works to assess the sustainability of IWRM in both cities, and how well the cities are doing as part of the CBF indicator. World Bank results show that all initiatives are projected to either finish on time with some funds undistributed, or be extended to a later date. City Blueprint Framework results combined a mixture of quantitative and qualitative data, revealing both cities were ranked low on the index and therefore seen as having unsustainable IWRM practices. By examining both the World Bank documents and the extensive data collected through the CBF, results show that the World Bank needs more comprehensive data from its projects, and that the CBF serves as an effective tool for analyzing the sustainability of IWRM.

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Chapter 1

Introduction

Water resources management is increasingly vital in a world altered by climate change. It is necessary to not only understand and study water resources, but to create a management framework that will be successful in each city and for each community. Understanding dominant water management frameworks used in international development organizations like the World Bank allows us to examine components that are working and aspects needing improvement, especially for developing countries. Examining developing nations in Latin America is especially important, as little research has been done in these areas regarding successful urban water management. As multilateral organizations such as the World Bank have developmental ties to countries in Latin America, it is necessary to understand its urban water management framework of Integrated Water Resources Management (IWRM). Once we examine specific World Bank activities in Latin American cities, we can assess how well these projects are reporting information, and what can be done more effectively in these urban water management plans.

This thesis analyzes the World Bank's Latin America and the Caribbean (LAC) Blue Water Green Cities (BWGC) urban water development initiative implemented in 2009. This initiative is part of a larger project supported by the Water Partnership Program (WPP) to create a holistic form of planning called Integrated Urban Water Management (IUWM). The BWGC project emphasizes the dissemination of strategies for managing urban water resources across various cities in Latin America, where cities share successes and failures, and city-to-city learning. The initiative also consists of efforts to create a comprehensive IWRM approach for implementation by policymakers at both local and national levels, improving water management approaches in the BWGC cities, and disseminating data on lessons learned (IUWM 2012).

This thesis evaluates the success of the BWGC initiative by analyzing Buenos Aires and São Paulo as case studies. Each city is analyzed in two ways: through examination of the specific World Bank program and through application of a general assessment tool, the City Blueprint Framework, which was designed to evaluate Integrated Water Resources Management (IWRM) projects holistically. The thesis relies on official World Bank documents, peer-reviewed articles, a variety of data sets, and locally available documents for the two case studies. It is intended to evaluate the effectiveness both of the World Bank's urban water development projects in Latin America and of the City Blueprint Framework as an assessment tool.

This thesis' research questions are centered on the CBF. The first asks: how well does the City Blueprint Framework work to assess the sustainability of IWRM in Buenos Aires and São Paulo? The second question asks: how well are these two cities doing as part of the CBF indicator? I hypothesized that the City Blueprint Framework successfully assesses the IWRM sustainability in these two cities and potentially for other cities across Latin America, because of its incorporation of qualitative and quantitative assessments using a wide range of indicators. These indicators include assessments of water quality, solid waste treatment, basic water services, wastewater treatment, infrastructure, climate robustness, and governance. I also predict that because Buenos Aires and São Paulo are cities in developing nations comparable to another city analyzed in Brazil through the CBF, they will score low on the sustainability of IWRM.

The results and discussion chapters assess the strengths and weaknesses of Buenos Aires' and São Paulo's water resources management initiatives. Based on case study analyses of World Bank projects in these two cities, results show that all initiatives are projected to either finish on time with some funds undistributed, or be extended to a later date. In fact in São Paulo, one project has already been extended one year, while the other project closed in 2015 with only 0.5 percent of their principal amount distributed. Based on aggregated raw World Bank data, only 41 percent of projects were fully funded in Argentina with an average completion time of 6.8 years, and in Brazil only 29 percent of projects were completed with full principal funding and a 6.02 year average for project completion time.

The City Blueprint Framework results were more comprehensive in types of data found, relying on more than just quantitative information. CBF results revealed that both cities were indeed ranked low on the authors' Blue City Index, categorizing them as "wasteful cities," but not ranked in the lowest category where "cities [are] lacking basic water services" (Koop and Van Leeuwen 2016). Both cities had very low rankings in groundwater quality and water system leakages, but high scores for access to drinking water and sanitation. Additionally, wastewater treatment practices and governance factors are almost nonexistent for both cities. By examining both the World Bank documents and the extensive data collected through the City Blueprint Framework, a complete account of these two cities shows that the World Bank needs more comprehensive results from its projects, and that the CBF serves as an effective tool for analyzing the sustainability of IWRM.

Chapter 2

Background

2.1. World Bank "Blue Water Green Cities" Development Program

The World Bank initiated the Latin America and the Caribbean (LAC) Blue Water Green Cities Initiative (BWGC) in 2009. This initiative was designed to create a concrete approach to water management in Latin America to tackle mounting issues of water scarcity, poor service provisions, watershed pollution, and increased flooding (World Bank "IUWM Summary Note" 2012). Problems that exacerbate environmental issues in Latin America include rapid urbanization, vulnerability to climate change, and inefficient practices in water management. The BWGC initiative was part of a larger project supported by the Water Partnership Program (WPP) to create a holistic form of planning called Integrated Urban Water Management (IUWM). The World Bank defines IUWM as:

> "A flexible, participatory and iterative process which integrates the elements of the urban water cycle (water supply, sanitation, storm water management, and waste management) with both the city's urban development and river basin management to maximize economic, social and environmental benefits in an equitable manner" (The World Bank 2012 "IUWM," 11).

IUWM can be considered a subset of IWRM. IWRM involves managing problems at the river basin level and can include other urban and rural areas, while IUWM includes managing stormwater, wastewater, and water supply in urban ranges with set boundaries (Maheepala 2010).

Specifically in LAC, this IUWM framework was implemented in various case study cities across these regions. These flagship cities included Buenos Aires (Argentina); São Paulo (Brazil); Aracajú (Brazil); Vitória (Brazil), which was later canceled; Bogotá (Colombia); Tegucigalpa (Honduras); and Asunción (Paraguay). These cities were chosen based on their identified need for further support and technical aid related to water management and urban water issues. The World Bank recognized Phase I of the plan as choosing case study cities, planning for a variety of World Bank-funded projects, and facilitating a regional workshop in São Paulo on IUWM. Phase I ended in December 2012 with the multi-lateral workshop.

Phase II ideas were briefly discussed in a similar World Bank document on IUWM:

> Experience has demonstrated that the concept and application of IUWM has traction in the region and there is a growing demand for Bank support in this area. Depending on funding availability, the following types of activities are contemplated for Phase II of the Blue Water Green Cities Initiative:
>
> 1) Promote more city-to-city exchanges in LAC and with other regions.
> 2) Generate technical notes and training on specific best practices such as sustainable drainage, wastewater reclamation, watershed source protection, river and coastal zone restoration, etc.
> 3) Offer specialized technical assistance on an as-need-basis.
> 4) Organize another regional workshop focusing on medium-sized and less developed cities. (The World Bank 2012 “Latin America,” 3)

Phase II is only implemented once Phase I of individual city plans is complete. Below is a more detailed account of each city's project.

2.2. Blue Water Green Cities in Latin America

Buenos Aires (Argentina)

There are two BWGC-funded projects in Buenos Aires. The first project is the Matanza-Riachuelo Basin Sustainable Development Adaptable Lending Program, which was created to improve sewerage services, decrease industrial discharges, promote improved drainage and environmental planning methods, and strengthen the overall institutional framework for river basin cleanup. The second project is the Urban Flood Prevention and Drainage Project, which was intended to increase the city's resilience to flooding by improving critical infrastructure and risk management. This second project ended in 2012.

The first project closes in March 2016, and final reporting documents are therefore not available yet. Interim reports indicate, however, that very little funding has actually been dispersed since the program began in 2009, which may indicate that the project has not been fully implemented. Out of the $840 million original commitment amount, only $184.31 million has been distributed at the end of March 2016. The World Bank also identifies this project as "substantially high risk," indicating that it poses further challenges to the success of the project due to high-visibility and multifaceted issues (The World Bank 2014).

São Paulo (Brazil)

The Blue Water Green Cities program also funded a major project in São Paulo: the Adaptable Program Loan (APL) Integrated Water Management in Metropolitan São Paulo. This program, which began in July 2009 with a projected closing date of September 30, 2015, aims to improve water quality and resources, strengthen management techniques and institutional capacity, and improve the quality of life for low-income communities. Similar to the monetary dispersal in Buenos Aires, true dispersal did not happen until June 2011. Of the $104 million commitment, $57.21 has been dispersed since July 2009, with an extended end date of March 2017.

Aracaju (Brazil)

The Sergipe Water Project in Aracaju was established in January 2012 to promote sustainable water use of the Sergipe River Basin. The project incorporates water resources management, institutional development, and water for irrigation and cities. Its projected end date is June 2017 with a commitment of $70.28 million from the World Bank. About $7.74 million has been disbursed, or a little over 10 percent, as of April 2016.

Bogotá (Colombia)

Bogotá's Rio Bogotá Environmental Recuperation and Flood Control Project for Colombia began in December 2010 with a commitment amount of $250 million by June 2016. This project focuses on reducing flood risks, improving quality of water, and creating multi-functional spaces on the river. The current disbursement amount for the project is $14.47 million as of March 2016.

Tegucigalpa (Honduras)

The Blue Water Green Cities report did not explicitly mention a project name for Tegucigalpa, however, the World Bank is also undertaking related projects at a smaller scale. A project that may be associated is the Integrated Urban Water Management (IUWM) project in the Greater Tegucigalpa Area. The project's emphasis is on integrated solutions for Tegucigalpa's water quality problem through improving analytical capacities and planning, creating stakeholder communication around water issues, and designing water-related studies. This project was approved in March 2011 with an original closing date of June 2014 and a total project cost of $0.40 million. The closing date has since been revised to June 2016 with $0.24 million distributed as of March 2016.

Asuncion (Paraguay)

The Paraguay Water & Sanitation Sector Modernization project in Asunción is also closely related to the BWGC initiative, beginning in April 2009 with a projected close date of September 2017. This project's goal is to increase coverage, sustainability, and efficiency of water sanitation and supply services in Paraguay. They intend to improve sector governance and water services, as well as increase sustainable water access in rural areas. The World Bank's commitment amount is $64 million with $22.41 million disbursed as of March 2016.

Chapter 3

Literature Review

The following literature review examines approaches to the environment and development in Latin America by comparing market environmentalism and collective action approaches, providing context for the importance of water management as a development tool. It provides a brief overview of assessing sustainability and identifies Integrated Water Resources Management (IWRM) and Adaptive Management (AM) as the most prominent approaches for water management in Latin America, recognizing the strengths and weaknesses of each approach. Finally, the literature review examines new assessment tools that could be used to evaluate the effectiveness of IWRM in Latin America, focusing on the City Blueprint Framework, which was developed to assess the effectiveness of IWRM in cities across the world.

3.1. Environment and Development in Latin America

Development in Latin America has created challenges for cities, especially due to increasing urbanization rates. With higher influxes to cities comes greater pressure on resources, infrastructure, and freshwater supplies. In addition to growing urbanization rates, growing global economies are placing more pressure on Latin America to take part in commodity production. This puts further strain on natural resources such as land for agriculture and livestock. Extractive industries are contributing to environmental degradation through exploitation, causing political and social tensions between governments and grassroots organizations (Muradian and Cardenas 2015). These economic booms are not long-term solutions for Latin American exports, contributing further to unstable financial situations. Infrastructure in hydroelectricity and transportation is also expanding, but creating further tension by changing water management regimes and destroying important protected forested areas. All of these natural resource-related exploits have created expanding economies, but at the price of ecosystems.

There are a variety of methods and types of development to examine. Specifically related to water development in Latin America, previous trends in water resource research focused on irrigation, engineering, and geography, and have since transitioned to economics, regime, and management (Ren, et al. 2013). The 1980s began an era of globalization in Latin America, where environmental development was open to foreign capital and resulted in the degradation of many natural resources (Reboratti, et al. 2012). As water scarcity becomes an increasing issue with climate change in many developing Latin American nations, understanding water resource management will be of vital importance. Water's complex relationship with society, economics, culture, agriculture, and development in general make it an important, but multifaceted, issue to focus on in future research related to development.

Environmental policy, especially in developing countries, was very much influenced by an analytical framework known as "market environmentalism" beginning in the early 2000s (Muradian and Cardenas 2015). This concept emphasized environmental issues simply as failures in the market, where solutions involve internalizing the associated social costs that would normally be "free of charge." Market environmentalism would address issues like pollution as a negative, or a market failure, whereas ecosystem services would be treated as a positive product of market environmentalism. Multilateral agencies and even national governments frequently incorporated these concepts into their environmental policy, where "market instruments such as pigouvian taxes [tax on negative externalities], payments for environmental services and tradeable permits for resource extraction or for emissions became a very common set of tools" (Muradian and Cardenas 2015). Self-governance then became a method of the past for dealing with environmental development.

Academic scholarship often encouraged the market environmentalism analytical framework, considering the neoclassical economic paradigm the norm (Colander 2000; Muradian and Cardenas 2015; Lawson 2013). This permeated through policy structures, making market environmentalism dominant in environmental policy, such as the Rio + 20 Summit report by the United Nations Environment Programme (UNEP "Green Economy" 2011). The framework of ecosystem services also perpetuated the popularity of market environmentalism, because specific "services" can be extracted and separated from the environment, going directly into markets (Millennium Ecosystem Assessment 2005). For example, the water cycle effectively fits into ecosystem services, where "changes to the state of natural capital on the flows of environmental services and their impact on human wellbeing" can be expressed through water resources (Martin-Ortega, et al. 2013). More specifically, this idea can be explained through reviewing extractive and instream water supplies, cultural provisions for water, and mitigation of water damages (Martin-Ortega, et al. 2013).

The cohesion of ecosystem services with market environmentalism allows economists to assess the market value of each environmental service, determining whether or not ecosystem services are resulting in market failures, and adjusting the costs of maintaining each of these services. Additional dissemination of ecosystem services comes from both multilateral organizations like the United Nations Environmental Programme and the World Bank, and from non-governmental organizations working on global environmental issues and affecting environmental policy (Muradian and Cardenas 2015; Ecosystem Services for Poverty Alleviation program (ESPA)). In Argentina, for example, multilateral organizations like the World Bank see development as an international procedure, which comes into conflict with political actors in Argentina who frequently want national development (De Moerloose 2015). These situations then become contentious and lead to implementation problems for development projects. One shortcoming of market environmentalism includes the issue of market creation. It attempts to determine the environmental governance method for public goods in ecosystems, when in reality these public resources are managed by people and local authorities (Muradian 2013). Additionally, this analytical framework fails to address social issues that arise from resource conflicts, such as monetary compensation and social justice disenfranchisement. This is one example that perhaps explains why development issues in Latin America have frequently been divided between economists and politically focused academics (Klak 2004). In reality, many environmental problems are dealt with through public action or social agreements, rather than through market responses. This leads to a different framework for analyzing environmental issues that includes social considerations—collective action, or an institutional framework. This idea addresses environmental problems as misalignments of stakeholder interests, where solutions occur after communication and compromise between different stakeholders with a variety of policy approaches (Muradian and Rival 2012; Muradian and Cardenas 2015).

Institutional change is considered a resolution to the problems the collective action framework attempts to address, where a "governance deficit" is to blame for environmental and social issues (Muradian and Cardenas 2015; Haas 2008). This framework essentially focuses on mediating economic issues with environmental problems, searching for solutions in individual contexts and locations versus a prescriptive answer for the entire framework (Ostrom 2012). This aspect can also be argued to be a downfall of the institutional framework, as it may not have the universality of applicability that other frameworks may have for policy recommendations (Muradian and Cardenas 2015).

In comparing market environmentalism and the institutional framework further, there is a marked difference in policy tools utilized. Market environmentalism employs the idea of environmental externalities as valued by the market to determine "efficiency gains and the possibilities of trade," while collective action focuses on policy modifications through multi-stakeholder involvement and institutional changes (Muradian and Cardenas 2015).

It is important to consider how countries, cities, and stakeholders frame environmental issues in the context of analytical frameworks for policy decisions. Understanding specific analytical frameworks is vital in comprehending their effects on environmental management, as they are almost always location-specific. Fully understanding these frameworks allows for stakeholders to recognize the premises for research and various practices related to environmental resources. In looking back at the

Table 1
A comparison of two alternative framings for understanding and addressing environmental problems.

	Market environmentalism	Institutional framework (collective action)
Keyword	Externality	Coordination failure
Core source of environmental problems	Market failure	Social dilemma
Main policy principle	Efficiency gains	Efficiency gains and procedural justice
Goal of policy options	Internalization (get the prices right)	To solve the governance deficit (get the rules right)
Preferred policy tools	Market-based instruments	Policy mixes (combination of hierarchical and market instruments)

Table 1. "From Market Failures to Collective Action Dilemmas: Reframing Environmental Governance Challenges in Latin America and Beyond." *Ecological Economics*, *120*, 358–365. http://doi.org/10.1016/j.ecolecon.2015.10.001. *From: Muradian, R., & Cardenas, J. C. (2015)*.

two frameworks presented here, the premises for market environmentalism are entrenched in misallocating costs of the environment, where solutions involve altering prices via state or market interventions (Muradian and Cardenas 2015). The premise for the institutional framework, or collective action, is based on socio-environmental problems, where the solution is based much more in social values and morals instead of technical market costs. Muradian and Cardenas express the importance of analytical frameworks, stating that choosing them is "the most critical step in addressing environmental problems and socio-environmental conflicts" (2015). Therefore, examining an environmental analytical framework sheds light on the urban water issues that cities such as Buenos Aires and São Paulo might experience. It is important, then, to understand both how sustainability is assessed and what types of water management frameworks currently exist in current scholarship and management practices.

3.2. Assessing Sustainability

Sustainability, especially related to the environment and development, focuses on meeting "the needs of the present generation without compromising the ability of future generations to meet their own needs" (WCED 1987). A common method of assessing sustainability is through the use of indicators (Singh, et al. 2012). Indicators are useful tools for communicating information to the public and to policymakers regarding specific environmental, social, economic, or technological performance, creating manageable amounts of meaningful information about the environment (Knowledge Economy Indicators 2005). By examining specific indicators of sustainability, cities and countries can more effectively evaluate environmental performance to determine areas they are excelling in, as well as specific measures to improve. Results from these performance indicators can provide decision makers with information to disseminate to stakeholders and formulate further strategies.

Previous methodologies for assessing sustainability typically involved either an economic framework, or a physical science approach (Dewan 2006; Singh, et al. 2012). International efforts related to sustainability measures typically involved addressing either the social, environmental, or economic aspects, but rarely all three (Singh, et al. 2012). Effective sustainability assessments rely on constructing robust indices to assess environmental sustainability. There are a variety of sustainability indices that exist to measure sustainable development internationally, including the City Blueprint

Framework, discussed below in more detail (Singh, et al. 2012). These evaluative processes are meant to be flexible in how they are assessed and conducted in the future, especially as stakeholder interests change and other indices are integrated into management practices.

3.3. Water Management Frameworks

This research identified eight relevant and current water management frameworks in Latin America. These include: adaptive management (AM); integrated water resources management (IWRM); decision support systems (DSS); climate change adaptation framework (CCA); water demand side management; ecosystem services (ES); sustainability assessment framework; and resilience assessment in the social-ecological systems (SES) framework.

Based on a Google Scholar survey of each framework, adaptive management and integrated water resources management are the top-cited frameworks that seem to have the highest impact. Adaptive Management (AM) focuses mainly on managing for uncertainty in environments with continual experimentation and cyclical learning (Engle, et al. 2011). Integrated Water Resources Management (IWRM) involves multi-stakeholder operations across many organizations, scales, and sectors, with the goal of improving governance through an integration of resource management techniques (Medema, et al. 2008).

Engle and colleagues (2011, 2) identified some similarities between AM and IWRM, including goals to:

> (1) increase effectiveness through integration across social, ecological, and hydrological systems; (2) add legitimacy and promote public acceptance

> through stakeholder participation, cooperation, decentralization, and democratic decision making; (3) incorporate technical expertise through inclusion of different forms of knowledge and promotion of social learning; and (4) promote flexibility and adaptability through experimentation and learning in managing water resources. (Engle, et al. 2011, 2)

Although it seems there are many similarities between the two frameworks, there is also a range of academic work that is critical of comparing them (Engle, et al. 2011; Medema, et al. 2008). Table 2 compares the two frameworks and highlights their differences (Medema, et al. 2008). IWRM focuses more on governance systems through management and planning, where AM emphasizes active and organizational learning through natural resource dynamics.

It is important to compare these two prominent frameworks to examine how water resources management frameworks develop differently. Both IWRM and AM originated in the 1970s, but influenced different areas of management. IWRM affected international establishments, including multilateral organizations like the World Bank and the UN, while AM tended to stay more in the academic realm (Engle, et al. 2011). This could perhaps relate to their origins, where IWRM was adapted from a UN conference and AM originated out of resilience theory in academia (“Decade, Water for Life” 2015; Holling 1978). When the World Bank organized the Blue Water Green Cities project, IWRM concepts were the basis for its water resources management framework. Integrated water resources management is the most frequently used framework in large international development organizations including the World Bank, the Inter-American Development Bank, and the United Nations (Gallego-Ayala 2013).

	Addresses problems that ...	Is a ...	Involves ...	Is achieved by ...	Generates ...	Good examples are characterized by ...
IWRM	... are seen to be the fault of fractured planning and a lack of appreciation for the connectivity of processes	.... call for joint governance	... multiple organizations and stakehol-ders operating across sectors and scales	... reform of the existing governance system (plan-ning, manag-ement, and communication processes)	... coordinated and integrated sets of resource management plans and actions	... strong political commitment to reform and to inter-organizational, cross-sectoral management
AM	... "Big Science" and "Command and Control" approaches have failed to effectively solve, and that determinism does not adequately describe	.. theory about effective manag-ement of natural resources, and a process for organizational learning	... responsible authorities with support from different stak-eholders	... engaging in a program of active learning about natural resource dynamics and use	... a style of management that emphasizes expl-oration and learning	... a combination of hypothesis formulation, action, and analytical reflection on the outcomes of management with the emphasis on learning

Table 2. IWRM and AM water resource management comparisons. *From Medema, et al. 2008*.

3.4. Integrated Water Resources Management (IWRM)

The IWRM framework focuses on coordinated management and development of natural resources, including water and land, to maximize equitable social and economic welfare without compromising ecosystems and environmental sustainability (GWP 2000). The official start of IWRM as an international concept of water management was at the Mar del Plata United Nations Conference on Water in 1977 (Gallego-Ayala 2013). After focusing again on IWRM in the 1992 UN Dublin Conference and the Rio de Janeiro Summit, IWRM became a widespread, international water resources management framework (Gallego-Ayala 2013; Ren, et al. 2013).

A key concept in IWRM is its interdisciplinary nature, where multiple perspectives are taken into consideration, including social sciences, ecology, institutional and legal services, hydrology, and economics (Giupponi 2014). It is also considered multi-faceted in how it addresses water issues, by incorporating many regions, agendas, interests, and dimensions (Ren, et al. 2013). This frequently includes mathematical modeling tools as well as Geographic Information Science (GIS) to analyze issues like system designs and water allocation (Ren, et al. 2013; Mysiak, et al. 2005). IWRM has become the mainstream water resources management framework that organizations like the World Bank (WB), United Nations (UN), and the Inter-American Development Bank (IADB) use today (Ren, et al. 2013).

The UN Department of Economic and Social Affairs (UNDESA) explains the planning and implementation of IWRM in the flowchart below in Figure 1 ("Decade, Water for Life" 2015). The process of the IWRM framework involves identifying national goals, assessments of water resources and policies, implementation of IWRM plans and actions, and continual monitoring of progress. This continues in a cyclical manner until goals are achieved, then cities or countries change their IWRM to meet new development objectives and goals. The IWRM framework also aligns with UN's Millennium Development Goals, where investment in the development and management of water resources is the main focus for meeting the goals (Lenton, et al. 2008).

IWRM has also become a largely controversial framework, where its effectiveness and implementation have come into question. Some criticisms of IWRM include its lack of diversity in contributing knowledge influences for water management systems, its inability to successfully explain its effect on society, and its failure to incorporate its water management techniques into local and national governance (Cook and Spray 2012; Giupponi 2014). IWRM is criticized for not incorporating a range of

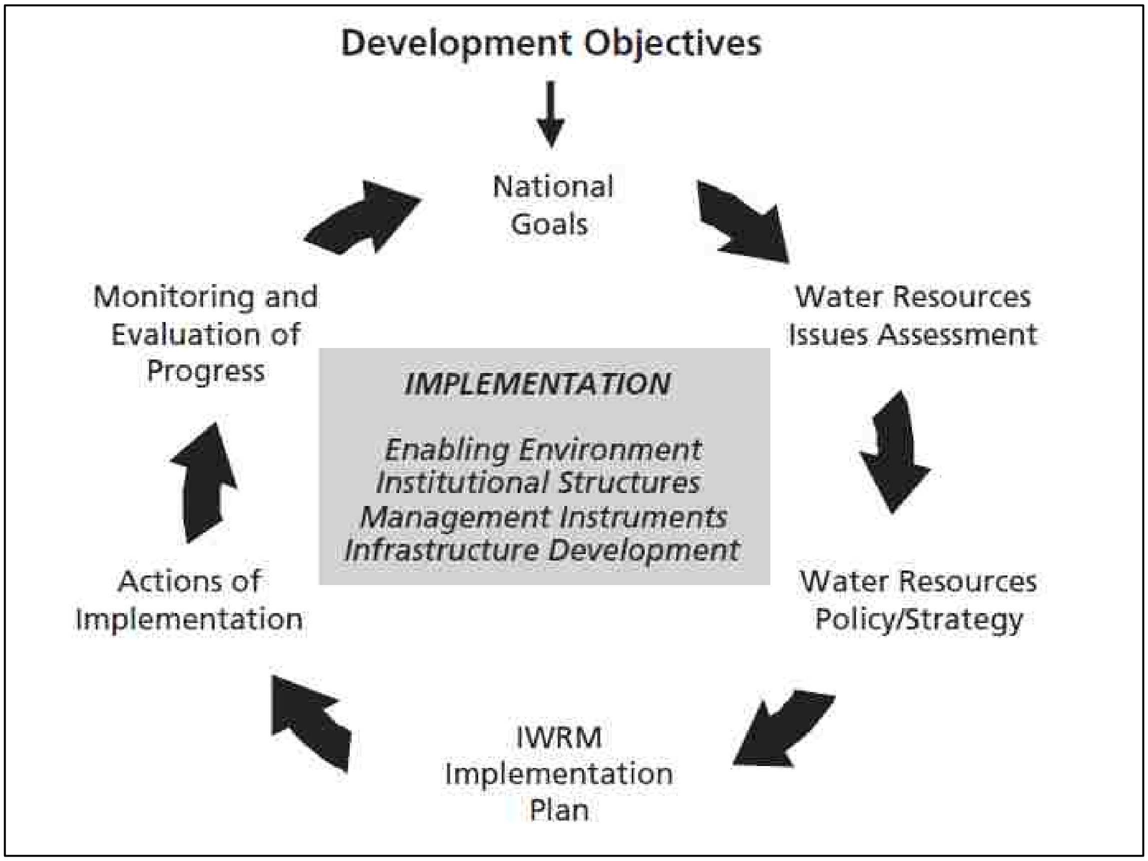

Figure 1. Integrated Water Resources Management planning and implementation flowchart. *From "Decade, Water for Life" 2015*.

knowledge systems required for managing complex environmental problems such as "equity, poverty alleviation, gender relations at multiple scales, harm reduction, food security, and health as just some of the competing issues" (Savenije and Van der Zaag, 2008). Related, complex and dynamic social influences affect environmental management, and IWRM is critiqued for not incorporating issues related to unequal power distribution, social competition, and informal cultural and social processes (Cook and Spray 2012). Lastly, IWRM is criticized for not having lasting and significantly measurable effects on governance. Many developing nations are unable to enforce IWRM due to resources and capacity issues, causing wasted natural resources where they are frequently needed most for water management (Merrey 2008).

The World Bank has been criticized for its focus on privatization regarding international water resources management in the context of IWRM (Allouche and Finger 2001). In this capacity, water is seen as an economic good. IWRM in the context of the World Bank, then, aligns more with the market environmentalism framework, as it is criticized for not fully addressing governance and social issues. To fully explore this critique, it is important to undertake an interdisciplinary assessment of World Bank development projects that utilize IWRM in Latin America.

3.5. The City Blueprint Framework

The City Blueprint is a relatively new baseline urban water system assessment (Cornelis J. Van Leeuwen, et al. 2012). The need for this new urban water evaluation framework arose from the lack of universal indicators to assess the sustainability of the urban water cycle in cities (Van Leeuwen, et al. 2012). The United Nations Millennium Declaration was adopted in 2000 by many global leaders to decrease global poverty within fifteen years through the Millennium Development Goals, many of which are linked to water (United Nations 2010). Due to this initiative, a few assessments with country-level indicators were created, including the Sustainable Society Index (SSI) using twenty-four indicators (Van de Kerk and Manuel 2008). The SSI assessment framework is a tool used widely by international organizations for country-level analyses.

Four other assessments with indicators for sustainable cities predated the City Blueprint, but fell short. These included the European Green City Index (2009), the global city indicators (Global City Indicators Facility 2008), the European common indicators (European Commission 2001), and the sustainable cities index (Australian Conservation Foundation 2010). According to Van Leeuwen, et al. these frameworks were too generic to be used on specific cities and did not include assessment of the sustainability of the urban water cycle (2012). To address this gap, the authors analyzed the above frameworks, policy documents, and Integrated Water Resources Management (IWRM) publications, determining that a main set of IWRM indicators to address urbanization and water security was needed to tackle global challenges for cities.

The City Blueprint Framework (CBF) was established as a quantitative analysis tool that incorporates twenty-four indicators to serve as a fast scan of the current urban water cycle state (Van Leeuwen, et al. 2012). This original framework approach was based on the European Green City Index approach (2009), but focused more on the sustainability of the urban water cycle. The need for this framework also originated out of the demand for a more effective way to assess the success of IWRM in cities. The Global Water Partnership, an international network of 173 countries for IWRM collaboration, defines IWRM as “a process that promotes the coordinated development and management of water, land and related resources in order to maximise the resulting economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems” (GWP 2000). IWRM also emphasizes multi-stakeholder engagement in the process of developing an urban water management scheme for each city, a process that the CBF also stresses (United Nations 1992).

The City Blueprint was designed to be a rapid scan of a city's resources and could theoretically be answered within a week. The main concept of the CBF is that it should facilitate the first step towards IWRM by involving local stakeholders and act as a practical tool that they can easily use (Van Leeuwen, et al. 2012). The outcomes of the City Blueprints were to aid in communicating Urban Water Cycle Services (UWCS) results and share information between cities; to decide upon suitable measures for sanitation and water supply strategies; and to create both non-technical and technical possibilities for water cycle alternatives (Van Leeuwen and Chandy, 2013).

The current CBF incorporates twenty-five indicators into seven categories for assessing the IWRM of a city's water resources, as shown in Table 3 (Koop and Van Leeuwen 2015, "Assessment"). All of these indicators are calculated quantitatively or qualitatively using a variety of resources with international standards. Data collection on the preliminary assessment for indicators was performed both by the authors and/or a few stakeholders, including municipality representatives, water and wastewater utilities, and water boards (Van Leeuwen, Koop, Sjerps 2015). After the preliminary assessment, final reporting occurred interactively with all water management stakeholders.

To maintain sustainable integrated water resources management, new and expensive technologies are hardly required. According to the authors, the main challenge is to actually begin discussions with all stakeholders, increase participation with the public, and use the baseline assessments for translatable actions that improve the UWCS of cities (Van Leeuwen, Sjerps 2014). Technology and improvements would no doubt be beneficial, especially in developing nations with high population growth and consequentially higher water demand, but they are not required for the CBF to be successful.

Table 3. Performance indicators of the City Blueprint Framework (CBF).	
I. Water quality	1. Secondary wastewater treatment (WWT) 2. Tertiary wastewater treatment (WWT) 3. Groundwater quality
II. Solid waste treatment	4. Solid waste collected 5. Solid waste recycled 6. Solid waste energy recovered
III. Basic water services	7. Access to drinking water 8. Access to sanitation 9. Drinking water quality
IV. Wastewater treatment	10. Nutrient recovery 11. Energy recovery 12. Sewage sludge recycling 13. WWT energy efficiency
V. Infrastructure	14. Stormwater separation 15. Average age sewer 16. Water system leakages 17. Operation cost recovery
VI. Climate robustness	18. Green space 19. Climate adaptation 20. Drinking water consumption 21. Climate-robust buildings
VII. Governance	22. Management and action plans 23. Public participation 24. Water efficiency measures 25. Attractiveness

Table 3. *Adapted from Koop and Van Leeuwen, 2015: "Assessment of the Sustainability of Water Resources Management: A Critical Review of the City Blueprint Approach."*

As the City Blueprint is a relatively new concept and the most-updated framework was just published in 2015, there are few assessments of how well the framework itself works. However, since the publication of the research in 2012, it has changed quite a bit internally via re-publications. Over about three years, the City Blueprint evolved from twenty-four indicators categorized under eight classifications to twenty-five indicators under seven categories, where eleven cities and regions in 2012 grew to forty-five municipalities in 27 countries by 2015, as shown in Figure 2 and Figure 3 (Van Leeuwen, et al. 2012; Koop and Van Leeuwen 2015, "Application").

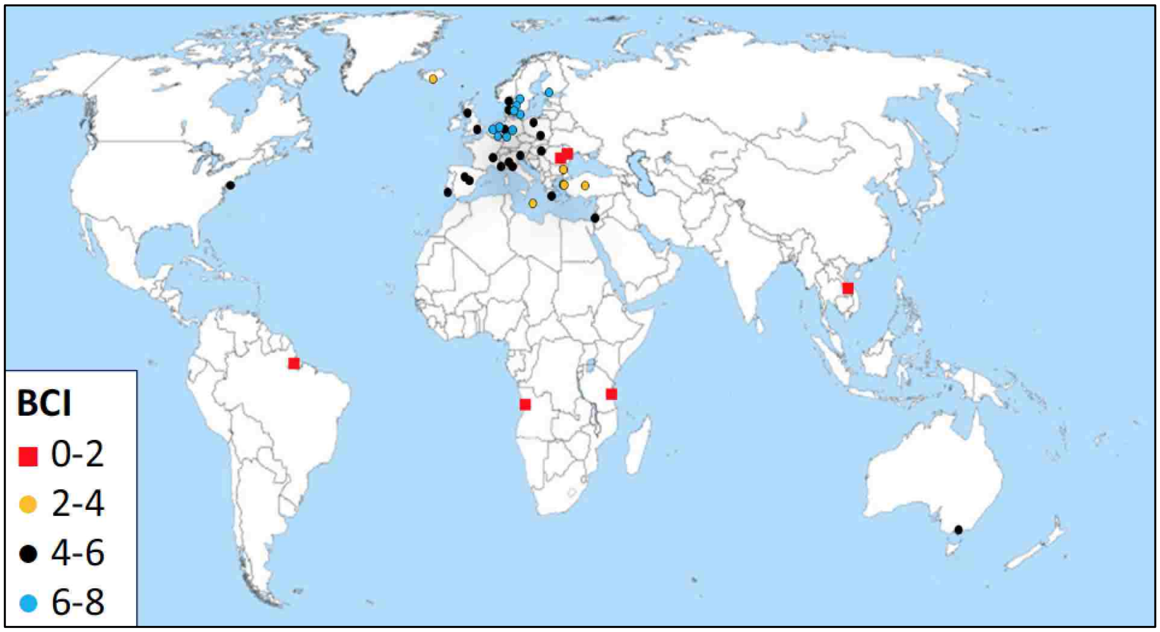

Figure 2. "Municipalities and regions that have been analyzed. Red, orange, black and blue represent municipalities and regions with an improved BCI between 0–2, 2–4, 4–6 and 6–8, respectively." *Adapted from Koop and Van Leeuwen, 2015 "Application of the Improved City Blueprint Framework in 45 Municipalities and Regions."*

They first added another framework of analysis called the Trends and Pressures Framework (TPF), which evaluates cities based on outside factors out of the control of city stakeholders, such as demographic changes. In this way, the CBF can more accurately assess IWRM performance that is within the control of water managers and "provide an overview of the most important social, environmental and financial characteristics affecting urban IWRM" (Koop and Van Leeuwen 2015). Geometric mean became the basis for the Blue City Index scoring as well. They also made changes to indicators based on new data availability and accuracy through their learning-by-doing methodology. For example, authors gathered feedback from local water managers regarding the use of the Water Footprint (WF) concept used in the "water security"

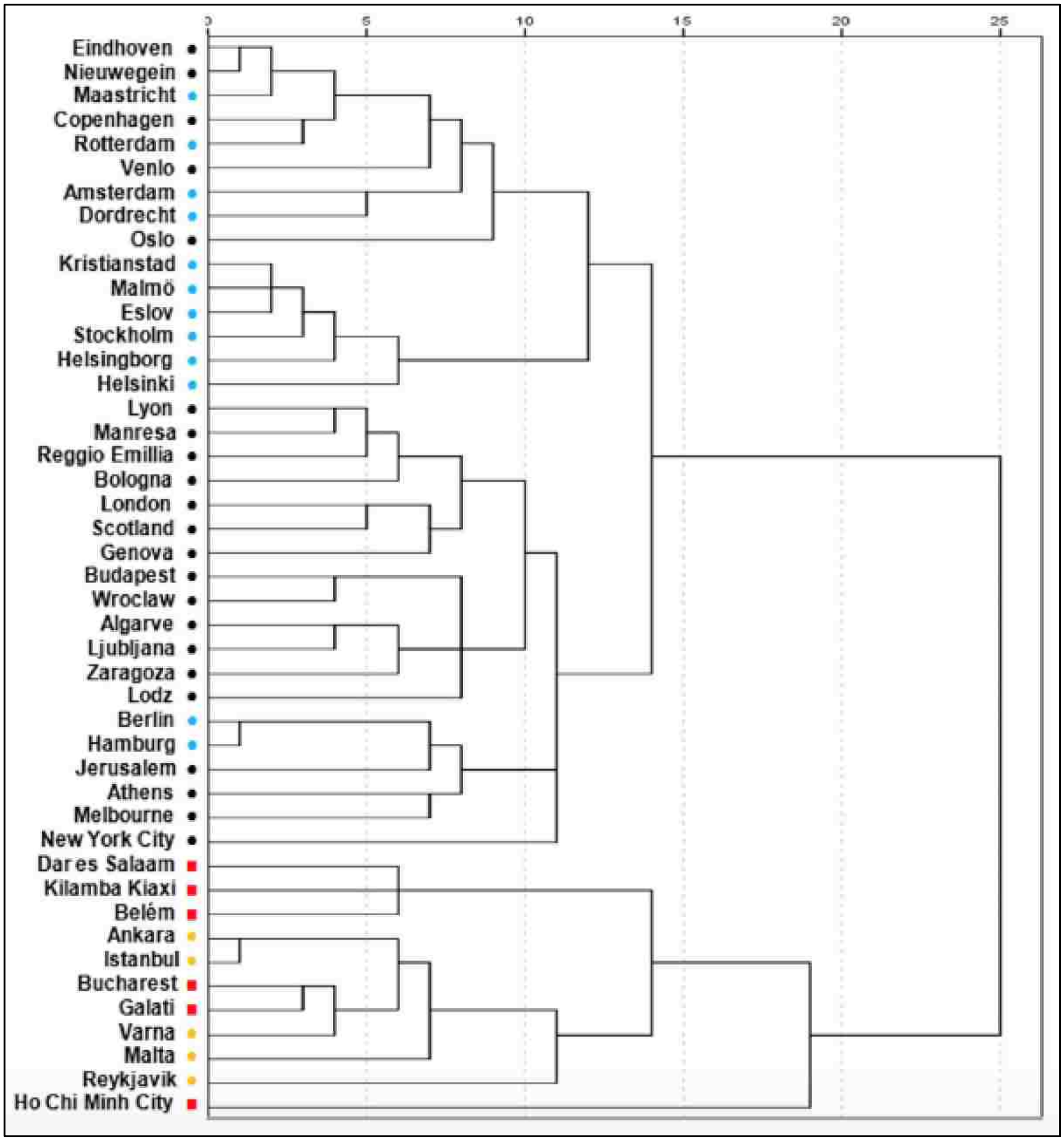

Figure 3. "Dendrogram of the City Blueprints using hierarchical clustering with the squared Euclidean distances for all 25 indicators. The cities marked red, orange, black or blue have a BCI* between 0–2, 2–4, 4–6 and 6–8, respectively. Three broad categories with squared Euclidean distance > 10, can be identified." *Adapted from Koop and Van Leeuwen, 2015: "Application of the Improved City Blueprint Framework in 45 Municipalities and Regions."*

category. Because stakeholders' constructive criticism suggested the WF was based on many socio-economic factors involved with the global market, and local decision-makers had negligible control over the outcome, managers suggested removing the WF and consequently the "water security" indicator.

One issue the authors recognize as a problem for future water managers who want to use this framework is data availability. City-level data were difficult to attain regarding urban IWRM. Authors found that information did actually exist; it simply wasn't publicly or readily available (Koop and Van Leeuwen 2015, "Assessment"). This makes city-to-city sharing very difficult to achieve, hindering the authors' ultimate goal of information sharing to create more sustainable IWRM cities. Because city-level data were not available, national-level data were used more often, which potentially skewed the results and accuracy of city information. Using national data could lead to overestimations of indicators, resulting in a more optimistic reading of the current state of cities (Van Leeuwen, Koop, Sjerps 2015). Authors indicated city-level data were not available for "water security, surface and groundwater quality, biodiversity and public participation," suggesting that environmental quality for some cities is actually much lower than estimated (Van Leeuwen, Sjerps 2014).

An issue of complete lack of data did arise for the authors for the City of Pisa, because too many specific data points were missing (Van Leeuwen, Sjerps 2014). They included Pisa in their report, but did not include it in their aggregate calculations of cities. Interestingly, they did not specify any further details as to why that information may not be available or what specifically determined Pisa could not be used in their calculations.

As only one city in Latin America has been analyzed for its IWRM sustainability using the City Blueprint Framework, an analysis of how well the CBF can be applied to World Bank IWRM projects in São Paulo, Brazil and Buenos Aires, Argentina will contribute to the overall information base of the CBF and will, in turn, augment our understanding of IWRM implementations in Latin America. It will contribute to knowledge of IWRM and its prediction of success, both because the CBF specifically analyzes IWRM, and because these two World Bank projects are framed using IWRM. Looking at IWRM from two different forms of analyses will contribute to the literature and its applicability for future water management, especially in developing Latin American countries. This contribution would aid in making some CBF indicators more applicable for Latin American cities.

Chapter 4

Methodology

The main research questions of this thesis were: how well does the City Blueprint Framework work to assess the sustainability of IWRM in Buenos Aires and São Paulo? And how well are these two cities doing as part of the CBF indicator? The basic research design used to answer these questions is as follows. (1) Selection of two case study cities where the World Bank has implemented BWGC initiatives (described more thoroughly in section 4.1). (2) Analysis of these specific World Bank projects using a variety of data sources to determine whether each is successful (described in more detail in section 4.2). (3) Application of the City Blueprint Framework to each city to determine its general success, or prospects of success, with IWRM (outlined more thoroughly in section 4.3). (4) Comparison of the second and third methods above, to determine how these different approaches might provide insight into water management projects in Latin America (found in more detail in Chapter 5, Results).

4.1. Case Study Selection

For this study, two cities have been chosen for comparative analysis: Buenos Aires and São Paulo. These cities were selected because information is more readily available about their water programs, and because they represent two ends of the spectrum. Buenos Aires is ranked well below average on water performance, while São Paulo ranks above average according to another international green city index done by the Economist Intelligence Unit and sponsored by Siemens (Siemens "Latin American Green City

Index," 2010). This index was designed to compare seventeen different urban cities across Latin America based on environmental performance using 31 indicators under eight categories for each city. Buenos Aires ranks highest on water consumption levels, compared to all other cities analyzed in Latin America with 669 liters of water consumed per person per day, over twice as much as the 246 liter average for other Latin American cities. The city also loses an average of 41 percent of its water through leakages, while other Latin American cities' average a loss of 35 percent. São Paulo consumes water below the average, at 220 liters per person per day with a 31 percent leakage rate.

4.2. Analysis of Blue Water Green Cities Implementations

The World Bank projects were analyzed using a variety of resources. These included official World Bank reports and documents, communication with Latin American researchers, and international research on environmental development in these cities. Official World Bank reports included city case studies, project information documents (PID), integrated safeguards datasheets, project appraisals, environmental assessments, loan agreements, and implementation status and results reports. These documents included project backgrounds, environmental evaluations based on project implementation, and quantitative information on the cost of the project, monetary allocation, and the progress of project implementation and financial distribution. In order to augment these official World Bank reports with other sources, I contacted researchers with experience in Latin America. These specialists included a Latin American economist from Argentina, a sociologist specializing in development sociology in Latin America, and a law researcher from Universidad Austral in Buenos Aires who specifically assessed a law and development approach in the World Bank's Riachuelo-Matanza Basin Sustainable Development Project. All researchers mentioned the difficulty in finding outside information on the success of World Bank projects, as well as issues of implementing World Bank projects in Latin America. Finally, international studies on environmental development in these cities produced research around sustainability issues in megacities, water problems through urbanization, and other status reports on natural resources. There was, indeed, a scarcity of resources regarding World Bank results. Those that were found challenged World Bank results, stating that progress had not occurred, and rivers and river basins were just as contaminated as before.

4.3. Application of City Blueprint Framework

The City Blueprint Framework provides a comprehensive and robust set of analyses to assess the efficacy of an urban water system. To apply this framework to Buenos Aires and São Paulo, 25 qualitative and quantitative analyses were conducted for each city (Table 4), using the exact methodologies from the CBF to the extent possible. The data necessary to complete these analyses were drawn from a variety of sources, including a United Nations Environment Programme report (Jordán et al. 2010), a Siemens report on green cities in Latin America (Siemens 2010), news articles, national and local reports, various research articles, and a resource provided by the City Blueprint authors. For three indicators, no quantitative data could be found for either city, but all other indicators were calculated and included in an overall CBF score. The CBF identified the Blue City Index (BCI) as the scoring tool to provide a ranking on a 0 to 10 point scale for each indicator after analyses are completed.

Table 4. Performance indicators of the City Blueprint Framework (CBF).	
I. Water quality	1. Secondary wastewater treatment (WWT) 2. Tertiary wastewater treatment (WWT) 3. Groundwater quality
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VI. Climate robustness	18. Green space 19. Climate adaptation 20. Drinking water consumption 21. Climate-robust buildings
VII. Governance	22. Management and action plans *23. Public participation* 24. Water efficiency measures 25. Attractiveness

Table 4. *Adapted from Koop and Van Leeuwen, 2015: "Assessment of the Sustainability of Water Resources Management: A Critical Review of the City Blueprint Approach."*

This CBF is theoretically supposed to be completed in about a week or two by city officials. Presumably, these administrators would have full access to city-level data and statistics. As an independent researcher, however, it became necessary to use sources from outside reports and researchers. Data from more than one-third of the indicators were acquired from international organizations that compile data from a variety of cities in Latin America. The UNEP report was very comprehensive, but the origins of the data were telling. For example, the data for Indicator 18: green space were found because of the UNEP author's own analyses of satellite images (UNEP 2011). The UNEP report and the Siemens report indicate how difficult it is to obtain city-specific information without major international organizations funding the research data.

Despite the time required to find data that were not publicly available, the information collected was quite comprehensive. It had an even balance between qualitative and quantitative analyses to provide a variation of data and source type. This led to a satisfactory analysis. After the final calculation, each city's results indicated that they are currently at risk for water management capabilities. Buenos Aires' final BCI score was 2.59, while São Paulo's score was 3.04. Much of the data showed that both cities lacked infrastructure and funds to alter many of performance indicators, for a variety of reasons outlined below. Van Leeuwen, et al. address this same issue by saying that "cities with pressing needs to improve their IWRM also face the highest environmental, financial and/or social limitations" (2015). These analyses are important first in determining the vulnerability of a city to climate change, and second in pointing out specific areas they can target to slowly improve their city's resilience.

The results section includes summaries and calculation explanations of each performance indicator to provide a more holistic picture of each city's need for more developed water management. Formulas and further numeric calculations for indicators are provided in the appendix.

Chapter 5

Results

The results section is organized first by analyzing the World Bank project results specifically in each city, and then analyzing the City Blueprint Framework results for both case studies. CBF results show that Buenos Aires and São Paulo are not sustainable IWRM cities and, instead, are considered “wasteful cities” (Koop and Van Leeuwen 2016). Wastewater treatment practices and governance factors were found to be almost entirely absent from both cities. World Bank documents analyzed using the CBF show that they provide only a few indicator scores through official reports, resulting in an incomplete picture for city projects and outcomes. Based on World Bank data accumulated from comprehensive analyses on all projects done in both Argentina and Brazil, it is likely that these projects will either be extended beyond their original completion date and/or left with undistributed funds when each project is closed.

5.1. World Bank Case Studies

World Bank Case Study #1: Buenos Aires, Argentina: Matanza-Riachuelo Basin

The Matanza-Riachuelo Basin Sustainable Development Adaptable Lending Program was implemented to improve sewerage services, decrease industrial discharges, promote improved drainage and environmental planning methods, and strengthen the overall institutional framework for river basin cleanup. The Matanza-Riachuelo River is a tributary of the larger Rio de la Plata running from the southwest of the Province of

Buenos Aires (PBA) to the northeast and discharging back into the Rio de la Plata. It is one of the most polluted rivers in all of Latin America (Cattaneo and Sardi, 2013).

The initiation of this World Bank project in August 2009 seemed very timely, beginning just one year after the Argentinian Supreme Court ordered three defendant States to clean the Matanza-Riachuelo. This order began after a lawsuit was filed in 2004 against the government and almost forty-five companies accused of polluting the Riachuelo. The borrower of the loan is the Government of Argentina, while the implementing agency is the Autoridad de Cuenca Matanza-Riachuelo (ACUMAR).

Out of the $840 million original commitment amount, only $184.31 million has been distributed at the end of March 2016. This amount is less than 22 percent of the total commitment amount. The amount left to disburse is about $533,830,000 from the original $840,000,000. Later I will explain the trends in disbursal rates and amount of time it takes for projects to be completed in Argentina using raw data from the World Bank since 1990.

The project has obviously not gone according to plan, as actual funding disbursements are well below the original World Bank commitment and a large cancellation was processed three years into the project. This may be tied to risk factors that the WB identified early on.

The World Bank identifies this project as substantially high risk: “Complex and high-visibility projects always pose additional challenges. At the same time, these are high-reward projects. The Bank should continue to provide substantial implementation support to such projects with sufficient resources (e.g., Matanza-Riachuelo River Basin)” (The World Bank 2014). The loan agreement from August 2009 contains two authorized representatives, including Amado Boudou, Vice President of the Argentine Republic, and Pedro Alba, representing the International Bank for Reconstruction and Development, the original World Bank institution (*Loan Agreement* 2009). It is possible that the Bank cancelled funds because Vice President Boudou was charged with bribery and corruption in 2010, while he was the economic minister of Argentina. This may have factored into the credibility of the Government of Argentina in repaying its loans to the Bank.

Detailed Project Information

This project was approved for funding on August 25, 2009 through a loan agreement between the Argentine Republic (the borrower) and the International Bank for Reconstruction and Development (the World Bank). All information in this section comes from (*Loan Agreement, Matanza-Riachuelo Basin* 2009), unless otherwise stated. There are currently fifteen mapped locations where the Matanza-Riachuelo Basin Sustainable Development Adaptable Lending Program is being implemented, according to the World Bank. The following list includes the location and corresponding map locations in Argentina:

Arroyo Riachuelo, Argentina	Partido de Lanús, Argentina
Departamento de General Belgrano, Argentina	Partido de Avellaneda, Argentina
Apeadero Boca del Tigre, Argentina	Riachuelo, Argentina
Provincia de Buenos Aires, Argentina	Río de la Matanza, Argentina
All cities following are centralized in the Buenos Aires metropolitan area:	Buenos Aires, Argentina
Partido de Berazategui, Argentina	Buenos Aires, Argentina
Partido de Quilmes, Argentina	Partido de Lomas de Zamora, Argentina
Laferrere, Argentina	Partido de Almirante Brown, Argentina

NOTE: Each site is located in the “Water, sanitation and flood protection” categorization (The World Bank: Projects, 2015).

Figure 4. Expanded mapped view of locations for Matanza-Riachuelo Basin project. *From the World Bank Projects, 2015*.

Figure 5. Zoomed-in view of map locations in Buenos Aires area. *From the World Bank Projects, 2015*.

The main objective for this project is to eliminate point source releases to the Matanza-Riachuelo River, improving water quality in a timeframe of fifteen to twenty years. The World Bank and the Argentine Republic also included the following objectives:

1) improve Matanza-Riachuelo River Basin sewerage services, expanding transportation and treatment capability;
2) help reduce industrial discharges to the river by establishing specific grants;
3) promote improved drainage and land-use planning decision-making, and spearhead investments in land use and urban drainage;
4) improve the Matanza-Riachuelo Basin Authority's (ACUMAR) institutional framework for M-R River Basin cleanup.

ACUMAR is a public legal entity created by a Supreme Court ruling for controlling, regulating, and promoting all industrial-related activities on the M-R River Basin, as well as providing sanitation and water issues related to the Basin. ACUMAR is responsible for general coordination of the project, managing the Argentina Water and Sanitation Department (AySA), which is in charge of the sanitation implementation. ACUMAR would also be responsible for the industrial pollution component and territorial management (The World Bank, 2009).

There were initially two phases to this project with the projected timeline from 2009 to 2019. The organizations are currently in Phase I, which was originally slated to run from 2009 to 2015, but was later extended through March 31, 2016. The total committed loan amount for the first phase is $840 million, while the Phase II's total loan amount is $1.160 million. Phase II is expected to start after targets in the first phase have been achieved.

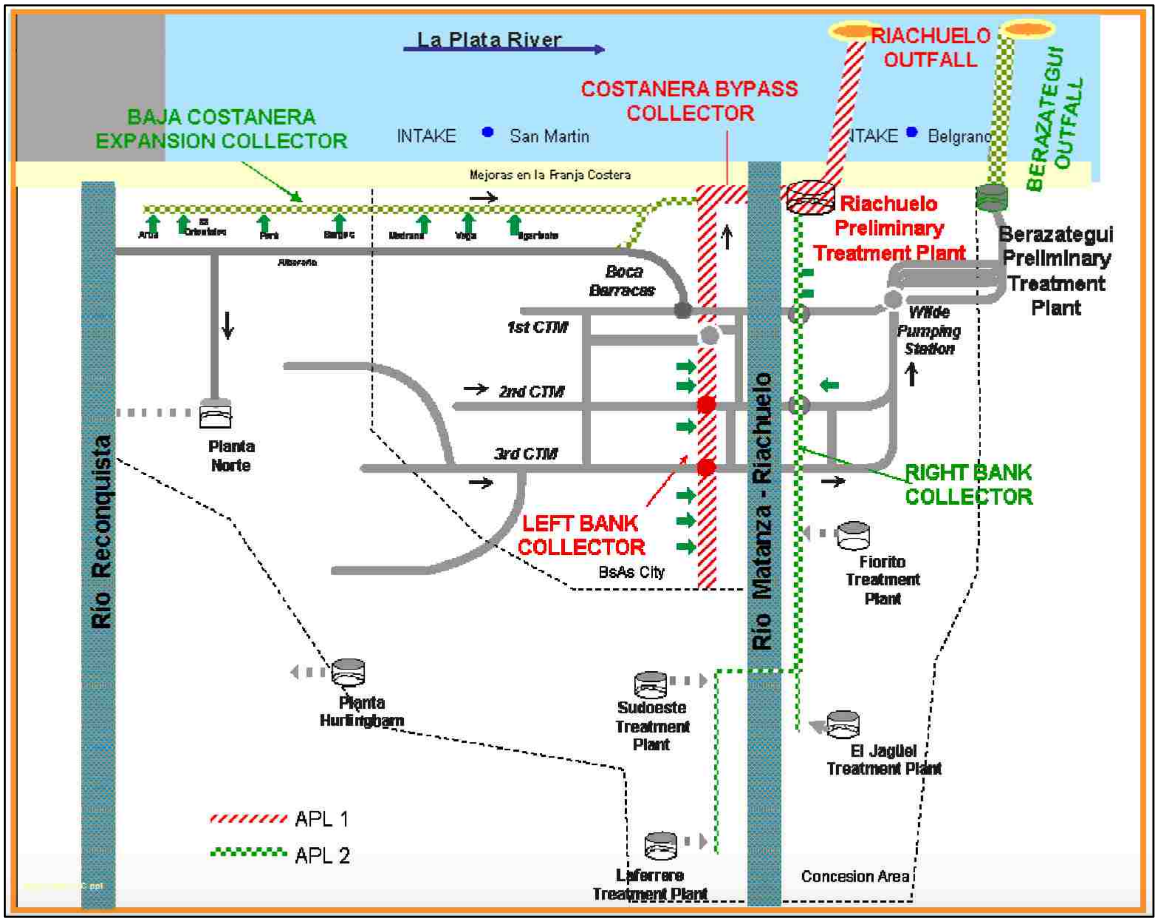

Figure 6. Schematic provides a visual representation of what is planned for Phase I (previously known as APL 1) and Phase II (APL 2). *From the World Bank, Argentina, 2008*.

Phase I is comprised of four parts, including sanitation, industrial pollution abatement, environmental territorial management, and institutional strengthening and project management. Part one's sanitation includes investments in sanitation infrastructure including technical supervision. This consists of construction of left and right bank collectors on the M-R River of 12 kilometers on the left and 37 km on the right; construction of the Riachuelo preliminary treatment plant with outflow and inflow pumping stations; data collection, modeling, and analyses supporting engineering designs; and capacity development activities to prepare for the engineering designs. The amount of the total loan that is promised for allocation to part one is $630,000,000.

Part two, industrial pollution abatement, includes a variety of components, including pollution diagnostics using geographic information systems (GIS), social impact analyses of industrial conversion along the river, collecting water consumption and flow discharge samples of industrial effluents, and designing a framework to determine appropriate effluent industrial loads. Part two also includes improved industrial waste system monitoring with provision of laboratory equipment, training, and technical audits. Additionally, a corporate environmental responsibility program will be designed and implemented. Parts two and three are promised $55,000,000 in eligible expenditures incurred by the Secretariat of the Environment and Sustainable Development (SAyDS) from Buenos Aires, ACUMAR, or the Borrower.

Part three of Phase I incorporates environmental territorial management. This includes creating a regional planning scheme with updated recommendations based on territorial studies, designing technical tools, holding workshops for crucial stakeholders on priority programs and issues, and pursuing such studies related to priority issues. Additionally, monitoring of the M-R River Basin will be implemented through a geographic information system in support of ACUMAR'S decision-making and planning. Part three also includes designing and applying a flood control system, updating the hydrological master plan, obtaining real-time emergency management information through meteorological and hydrological systems, designing flood contingency emergency plans, and following through on investments. These investments include improving urban infrastructure in low-income areas, expanding sanitation and water secondary networks, constructing micro-drainage systems, and flood control.

Part four of Phase I is institutional strengthening and project management, which strengthens operational and institutional capacity of ACUMAR. Included in this institutional strengthening is communication strategy design and implementation, establishing a public information office for technical assistance, and improving the office space and technical training for UEP and UCOFI. Part four is also designed for carrying out and establishing:

1) analytical work, data collection, and modeling for water quality monitoring of the Rio de la Plata and M-R River;
2) groundwater studies to expand knowledge on groundwater tables in the M-R River Basin;
3) any other Bank-approved studies on M-R River Basin clean up; and
4) an independent panel of experts providing project advice.

Part four is promised $14,000,000. Outstanding funds that are planned for allocation are $40,000,000 for Cash Recovery Index (CRI) Subprojects including consultants' services and goods, $98,900,000 unallocated funds, and $2,100,000 in front-end fees. The Matanza-Riachuelo Basin (MRB) Sustainable Development Adaptable Lending Program ends in March 2016. As of April 2016, the World Bank has only distributed a little over 25 percent of its commitment amount. The amount left to disburse is $533,825,781 from the original $840,000,000. A recent World Bank report indicated plans for restructuring the original program, providing a one-year extension to the project (The World Bank "Integrated Safeguards" 2015).

Matanza-Riachuelo Basin Sustainable Development Adaptable Lending Program	**Part (I – III)**	**Type of Program**
Phase I	Part I	Sanitation
	Part II	Industrial pollution abatement
	Part III	Environmental territorial management
	Part IV	Institutional strengthening and project management
Phase II	Not developed until Phase I is completed	

Table 5. São Bernardo do Campo Project organization. *Created from data in Loan Agreement, Matanza-Riachuelo Basin 2009*.

Results and Outlooks

There seem to be some noticeable results in Buenos Aires at this time compared to when the project began (Staveland-Sæter 2012; Valente 2012). The Matanza-Riachuelo River Basin was incredibly polluted in 2009, contributing to human and biodiversity health problems. Improvements may be more superficial than expected, but have improved riverbank visibility where it had previously been covered in trash, debris, and other pollutants. Additionally, sunken ships have been removed, 30 of 117 garbage dumps were eradicated, and about 575 of 1,500 families living in slums along the river have been relocated (Valente 2012; Riachuelo 2015). But most sources confirm that the actual river is just as contaminated as it has ever been and there is little sewage treatment occurring (Greenpeace Argentina 2013; Riachuelo 2015; Staveland-Sæter 2012; Valente 2012). Many authorities agree that controlling industrial discharge into the river and improving sewage treatment are of utmost importance to improving river quality and overall public health related to the river (Greenpeace 2013; Riachuelo 2015; Valente 2012). The sewage treatment project was a major portion of the World Bank's Part I project, officially authorized in 2013 with schematics, and promised to begin sometime in 2015 without specifics on dates (Riachuelo 2015). It is unclear whether these plans and schematics have been implemented yet.

To provide further context for the potential success of this project in Argentina, I aggregated raw data from the World Bank beginning in 1990 and determined that the average time it takes to complete a project in Argentina is about 6.8 years. That is also the current projected amount of time for the completion of the Matanza-Riacheulo development project with a completion date of March 31, 2016. Out of all of the completed Argentinian World Bank projects on file, almost $1.7 billion was left undistributed. Of the 198 completed projects, 117 were left with undistributed funds, totaling to 59 percent of projects without their total amount funded. With this in mind, it is likely that the Matanza-Riachuelo River Basin project will either finish on time but with funds undistributed, or be extended to a later date. It is unclear at this point why so many funds go undistributed and why so many projects finish without their total amount funded.

World Bank Case Study #2: São Paulo, Brazil: Adaptable Program Loan (APL) Integrated Water Management

São Paulo’s Adaptable Program Loan (APL) Integrated Water Management in Metropolitan São Paulo was first proposed in December 2006 and approved in July 2009 with a projected closing date of September 30, 2015. It has since been renewed with a new closing date of March 30, 2017. In 1992 the World Bank funded another project, known as the Guarapiranga project. This served as the catalyst for further urban water projects in the São Paulo area, including this integrated water management project. The World Bank's perspective is that the bank is uniquely positioned to tackle complex urban, water resources, and land use issues due to its international experience, assisting state and municipal governments in "moving forward the agenda of metropolitan coordination, management and planning in the areas of land-use, water pollution and related urban-environmental service delivery – issues that are among the major paradigmatic challenges facing Brazilian cities today" (The World Bank, 2007).

This current project aims to improve water quality and resources, strengthen management techniques and institutional capacity for land-use planning and water resources, and improve the quality of life for low-income communities. The São Paulo Metropolitan Region's (SPMR) river basin is known as Alto Tiête, or Upper Tiête, (Figure 7) and has a similar problem to the Matanza-Riachuelo River Basin in that it is among one of the most polluted in the world and frequently goes untreated (Romero, 2012).

Unlike in Buenos Aires, project reports for the Integrated Water Management in Metropolitan São Paulo project are to be carried out by the Borrowing agency rather than by the World Bank. This means that all reported data are provided by the São Paulo State Water Utility (SABESP), the State of São Paulo, the Municipality of São Bernardo do Campo, or the Municipality of Guarulhos. These reports include the monitoring and evaluating of project progress, as interpreted by the Borrowers. As these reports are not World Bank-reported, they may be seen as further credible sources to the progress and actual state of this area on the ground.

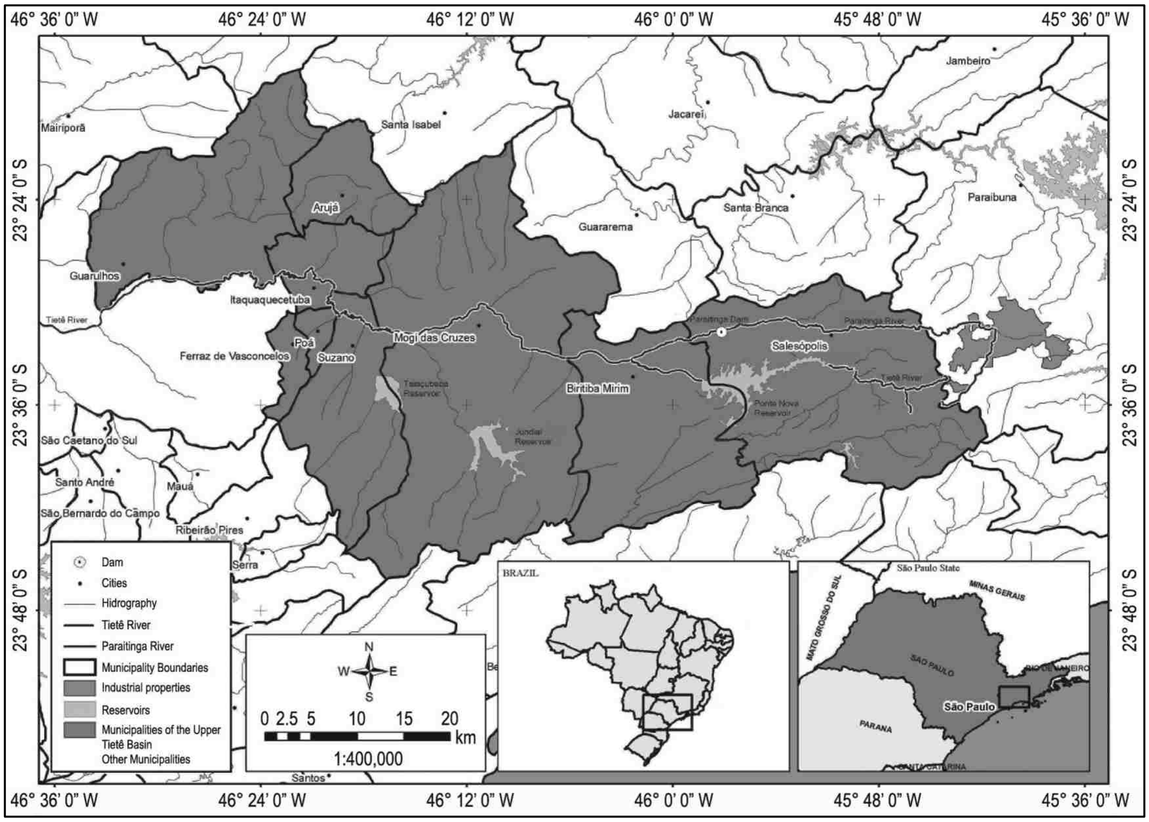

Figure 7. Upper Tietê River Basin in São Paulo, Brazil. *From Esteves, et. al. 2015*.

Funding and Detailed Project Information

The objectives of both the São Bernardo do Campo Project and the SABESP Project include protecting and preserving water resource quality and reliability of the São Paulo Metropolitan Region (SPMR), and to improve the quality of life for low-income communities. All information in this section comes from (*The World Bank "Loan Agreement," 2009*), unless otherwise stated. The SABESP Project has three parts: Part I: institutional development, Part II: environmental protection and recovery, and Part III: integrated water supply and sanitation.

Part I, institutional development, expands and improves management and operational capacities in order to supervise hydrodynamic conditions and water quality.

This involves implanting studies, water resources monitoring systems, and improved software for laboratory analyses related to water quality. Education programs related to environment and sanitation will also be executed.

Part II, environmental protection and recovery, involves rehabilitation and consequent protection of reservoirs through conservation, reducing pollution loads in the public water supply, expanding green areas, preparing management plans, and improve reservoir capacity through dredging and desilting.

Part III is integrated water supply and sanitation, which incorporates both wastewater management system improvements and water supply system improvements. Wastewater management improvements include construction and enhancements of pumping stations, wastewater lifting, sewerage networks, and wastewater treatment plants. Water supply improvements are manufacturing and developing water supply systems in low-income communities, water treatment to reduce pollution loads, and implementing studies and analyses on different water treatment technologies for decreasing chemical products used.

	Part (I – III)	**Type of Program**
São Paulo State Water Utility (SABESP) Project	Part I	Institutional development
	Part II	Environmental protection and recovery
	Part II	Integrated water supply and sanitation

Table 6. São Paulo State Water Utility (SABESP) Project organization. *Created from data in the World Bank "Loan Agreement" 2009*.

Similar to the Buenos Aires project's phases, the São Bernardo do Campo Project has two sub-programs (The World Bank "Project Appraisal" 2012). The first, Sub-Program A, emphasizes institutional strengthening and management, which includes Part I. The second, Sub-Program B, focuses on integrated urban upgrading, land regularization, and environmental recovery of selected irregular and precarious settlements, which includes Parts II and III. The amount of the loan going to various works, training, and non-consulting services totals to $12,117,950. Adding the allocation of consultants' services of $8.65 million with a $52,050 front-end fee totals to $20.82 million.

Part I of Sub-Program A is institutional capacity building. This includes improving IWRM and land-use management and coordination through development plans, field studies, and creating information systems for indicator monitoring. It also incorporates developing an environmental education program including training for local stakeholders and community leaders. And lastly, it integrates project management, monitoring, assessment, and dissemination through providing technical assistance.

Part II of Sub-Program B addresses urban upgrading. This can include engineering designs, civil works related to urbanization of slums and temporary settlements, housing construction for relocated families, and converting degraded urban regions into public spaces through engineering designs and civil works. Family resettlement is also included in Part 2 with creating and implementing detailed resettlement plans with engineering designs, monitoring and evaluating the resettlement process, and providing social guidance and outreach initiatives during all resettlement stages. Also included are plans for establishing a citizenship and ecology center in São

Paulo, as well as preparing and implementing community participation and social work plans related to resettlements.

Part III is also in Sub-Program B, covering environmental protection and recovery. One specific project includes starting and implementing programs for tree planting in settlements that are considered irregular and precarious. Additionally, plans for urbanizing public areas by creating leisure and green spaces for community use are incorporated into Part 3. These plans include engineering designs and implementing civil works.

São Bernardo do Campo Project	Part (I – III)	Type of Program
Sub-Program A	Part I	Institutional capacity building: improving IWRM and land-use management and coordination
Sub-Program B	Part II, Part III	Part II: urban upgrading Part III: environmental protection and recovery

Table 7. São Bernardo do Campo Project organization. *Created from data in the World Bank "Project Appraisal" 2012*.

In financial terms, the BR APL Integrated Water Management in Metropolitan São Paulo project is interesting for a couple of reasons. First, there seem to be three financiers in the financial activity details, although the project originally listed only included two: the International Bank for Reconstruction and Development and the Borrower, who in this case is a joint borrow: São Paulo State, the State water company, and the municipal government, all of whom are also the implementing agencies. Second, the commitment amounts originally stated do not align with the financial activity. The IBRD was originally committed to $104 million, but in the financial activity only commit to $100 million. The borrower was originally committed to $129.5 million, but seems in the financial activity to commit simply to $4 million. Even more perplexing is the third financier who commits to $20.82 million, but no information is available regarding the financier's affiliation. Of the total $100 million committed, $99.75 million is allocated for goods, works, and consultants' and non-consultants' services. A front-end fee of $250,000 completes the total loan amount.

One issue that seems to be somewhat unclear is the difference between the two (or potentially three) different loans related to this project. One loan agreement is for $100 million between the International Bank for Reconstruction and Development and the State's Water and Sanitation Utility (SABESP) identified as the SABESP Project. The other loan agreement is between the International Bank for Reconstruction and Development and the Municipality of São Bernardo do Campo for $20.82 million, identified as the São Bernardo do Campo Project. The latter project's closing date was September 30, 2015 with less than $110,000 distributed out of $20.82 million, totaling to about 0.5 percent actually distributed. The Bank only grants extension of this loan after the Ministry of Finance from the Municipality of São Bernardo do Campo has agreed to the extension. The project, however, indicated that it would close, because there was a small likelihood that it could complete its objectives due to uncertainties related to involuntary resettlement and procurement.

Results and Outlook

According to the World Bank's "Implementation Status and Results Report" compiled by the São Paulo State Water Utility (SABESP), the State of São Paulo, the Municipality of

São Bernardo do Campo, or the Municipality of Guarulhos, the current projects have faced considerable delays in their initial years. In this report, they indicated that the projects were extended until March 2017 because of the ongoing drought crisis.

This same report indicates that since the implementation of the project, there have been improvements in the volume of pollution load removed with 2,441 tons removed since 2007. Their results also show improvements in water production capacity, increasing parks and public areas by 54 hectares, establishing an integrated citizenship center, creating four hydrodynamic models to monitor reservoirs, and improving public access to better sanitation facilities and water sources. The end targets for almost all of these components are higher than the current amounts, so there is much room for improvement.

It is very difficult to evaluate these claims and numbers into outcomes on the ground. Sources external to the project indicate that the Alto Tiête River Basin still has the same amount of pollution, but such assertion includes hardly any quantifiable statistics (Romero, 2012; Pollution in Brazil, 2011). By 2018, it is predicted that almost 85 percent of São Paulo's sewage will be treated (compared to only 55 percent in 2011) (Pollution in Brazil, 2011). At that point, results should be visible for improvement. Adding further context for the potential outcome of this project in Brazil, I aggregated raw data from the World Bank beginning in 1987 and determined that the average time it takes to complete a project in Brazil is about 6 years. The current projected time for the São Paulo Integrated Water Management development project with a new completion date of March 30, 2017 is 7.73 years, almost two years more than the average completion time for other Brazilian World Bank projects. Out of all of the completed Brazilian

World Bank projects on file, over $7.2 billion was left undistributed. Of the 406 completed projects, 289 were left with undistributed funds, totaling to 71 percent of projects without their total amount funded. With this in mind and knowing that the São Paulo project has already been extended a year, it is likely that it will finish with undistributed funds. It is unclear at this point why so many projects are extended and finish without their total amount funded.

5.2. City Blueprint Framework Results

The City Blueprint Framework results are organized by CBF categories, including results from both Buenos Aires and São Paulo in sections. Each category table includes specific indicators, original data points collected for each city, and the Blue City Index (BCI) ranking calculated using formulas provided by CBF authors. A short assessment of each city is included after the CBF results.

I. Case Study Cities' Scores for Indicators in the "Water Quality" Section of the City Blueprint Framework

	Buenos Aires, Argentina		**São Paulo, Brazil**	
Indicator	**Data Point**	**Blue City Index (BCI) Ranking**	**Data Point**	**Blue City Index (BCI) Ranking**
1. Secondary wastewater treatment (WWT)	10% treated via secondary WWT	1.0	13.6% treated via secondary WWT	1.36
2. Tertiary wastewater treatment (WWT)	0% treated via secondary WWT	0	0% treated via secondary WWT	0
3. Groundwater Quality	Poor status samples: 53% Good status samples: 47%	4.7	Poor status samples: 93% Good status samples: 7%	0.7

Levels for both Indicator 1: secondary and Indicator 2: tertiary wastewater treatment are measured at the national level. The United Nations Environment Programme indicated that only 10 percent of Argentina's urban sewage is treated before discharge with 100 percent treated to the secondary level (UNEP 2011). Indicator 1: secondary wastewater treatment involves "biological treatment with a secondary settlement or other process, with a BOD removal of at least 70% and a COD removal of at least 75%" (Suhogusoff, et al. 2013). Interestingly, the same UNEP source noted that Buenos Aires treated 80 percent of their sewage, but did not indicate how much was being treated to the secondary or tertiary level. Another source, however, indicated that only 10 percent was being treated in Buenos Aires (Morales, et al. 2014). Because no information was available on Buenos Aires' secondary or tertiary levels of wastewater treatment, national-level data was used from the UNEP report. Argentina's Indicator 1 score then becomes 1.0 with a 10 percent secondary treatment rate, and 0 with a 0 percent tertiary treatment rate for Indicator 2.

Brazil's proportion of sewage treated was 20 percent with an Indicator 1: secondary treatment rate of 68 percent. Therefore their total Indicator 1: secondary treatment percentage is 13.6, leaving them with an Indicator 1 score of 1.36. As there was no indication Brazil had any levels of tertiary treatment, their score for Indicator 2 is zero (UNEP 2011).

In regards to groundwater quality, a recent 2015 study of the Buenos Aires Province by found elevated levels of manganese and iron, both of which are indicators for groundwater quality (Carretero and Kruse 2015). Although their study site was in San Clemente del Tuyú, about 330 kilometers from the City of Buenos Aires, similar groundwater quality and extraction habits can be found throughout the whole coastal area of the Buenos Aires Province. The aquifer supply remains untreated throughout this area, so groundwater measurements are equitable. Various standards are set for safe groundwater sampling, where the "Código Alimentario Argentino (CAA; Argentine Food Code) sets the standards at 0.3 mg/L for iron and 0.10 mg/L for manganese. The iron content is similar to the one suggested by the USEPA, but it tolerates twice as much manganese as the international guidelines" (Carretero and Kruse 2015). The sampling results showed that according to the CAA standards, 33 percent of the iron samples exceeded set standards and 38 percent of the manganese well samples exceeding national standards. Under international standards, 38 percent of iron samples and 53 percent of manganese samples exceeded international standards of the European Union (EU) and US Environmental Protection Agency (USEPA). As many other measurements in the Blue City Index are originating from international standards, the samples here will also be assessed through international standards. Therefore, 38 percent of iron well samples and 53 percent of manganese samples do not meet international standards. To make indicator-ranking calculations equitable, I chose the higher contamination percentage from both Buenos Aires and São Paulo, as the lowest contamination level was not representative of the samples in the case of São Paulo. Therefore, I used 53 percent as the ranking for Buenos Aires' poor chemical status sample number, resulting in an Indicator 3: groundwater quality score of 4.7.

An assessment on Indicator 3: groundwater quality in wells of São Paulo from the Upper Tietê Watershed done by Suhogusoff, et al. in 2013 examined contaminated groundwater levels (Suhogusoff, et al. 2013). The authors found pathogen and nitrate contaminants in samples from 53 dug wells. Specifically, 18 percent of wells had nitrate levels at or above the established safe drinking levels of 45 mg/L. An alarming 93 percent of wells showed colony forming units (CFU) of bacterial contamination for coliforms, not in accordance with Brazilian regulation (Regulation MS N. 518/2004). The authors' results showed that more anthropogenic interactions with the wells caused more interference and higher levels of nitrates and pathogens. The only wells with no bacterial contamination were located in areas less likely to encounter human interference. As explained above, the higher contamination level was chosen to be representative of groundwater samples in São Paulo, resulting in 93 percent for the number of samples with poor chemical status and an Indicator 3: groundwater quality score of 0.7.

II. Case Study Cities' Scores for Indicators in the "Solid Waste Treatment" Section of the City Blueprint Framework

	Buenos Aires, Argentina		**São Paulo, Brazil**	
Indicator	**Data Point**	**Blue City Index (BCI) Ranking**	**Data Point**	**Blue City Index (BCI) Ranking**
4. Solid waste collected	606.1 kg/capita/year	1.503	550 kg/capita/year	2.518
5. Solid waste recycled	16.7 percent	1.67	3.6 percent	0.36
6. Solid waste energy recovered	0 percent	0	0 percent	0

According to a Latin American report, Buenos Aires collects 606.1 kilograms/capita/year of solid waste, while São Paulo collects 550 kilograms/capita/year (Siemens "Buenos Aires" 2010; Siemens "São Paulo" 2010). After calculating Indicator

4: solid waste collected, Buenos Aires received a score of 1.503 and São Paulo received a ranking of 2.518 for the Blue City Index. Both cities were reported to have excellent solid waste collection facilities, but the amount of solid waste produced was still quite substantial.

In 2014 Buenos Aires was reported to have recycled around one sixth of its solid waste, or about 16.7 percent (Robinson 2014). As there were no existing sources documenting Buenos Aires' use of incineration for energy recovery, I assumed that factor was zero in indicator five's calculation, resulting in an Indicator 5: solid waste recycled score of 1.67. São Paulo has recorded recycling 3.6 percent of their solid waste, but similarly had no form of energy recovery related to incineration (Jacobi 2011). Therefore, São Paulo's Indicator 5: solid waste recycled score was 0.36.

Indicator 6: solid waste energy recovery in both Buenos Aires and São Paulo seemed to be nonexistent at this point in time. Argentina looks like it may be considering biomass for energy purposes, as well as a specific waste-to-energy wastewater treatment plant, but those have not been implemented yet (Currie 2015). What's more, Buenos Aires has not shown any signs of solid waste energy recovery plans for the city. Two separate sources from 2015 indicate that São Paulo and Brazil at large are considering energy recovery techniques from solid waste in the near future, but have not yet executed any measures (Barradas 2015; Messina 2015). Another article explains why energy recovery technologies fail in cities like São Paulo, pointing to technological, political, and economic barriers, as well as an overall neglect of solid wastewater management in its beginning (Mercedesa, et al. 1999). Because there is no implementation of solid waste energy recovery, both Buenos Aires and São Paulo receive an Indicator 6: solid waste energy recovery score of zero.

III. Case Study Cities' Scores for Indicators in the "Basic Water Services" Section of the City Blueprint Framework

	Buenos Aires, Argentina		**São Paulo, Brazil**	
Indicator	**Data Point**	**Blue City Index (BCI) Ranking**	**Data Point**	**Blue City Index (BCI) Ranking**
7. Access to drinking water	100 percent	10	99.2 percent	9.92
8. Access to sanitation	99.3 percent	9.93	99.1 percent	9.91
9. Drinking water quality	65.5 of 117 total samples meeting standards	5.60	155 of 276 total samples meeting standards	5.62

In the Siemens' Latin America reports, access to drinking water and sanitation were also included (Siemens "Buenos Aires" 2010; Siemens "São Paulo" 2010). Buenos Aires' reported improved drinking water sources were 100 percent, or an Indicator 7: access to drinking water score of 10. São Paulo's drinking water access was 99.2 percent, or a 9.92 Indicator 7 score. Access to sanitation was also reported in high numbers, where Buenos Aires was at 99.3 percent, or a 9.93 Indicator 8: access to sanitation BCI score, and São Paulo had 99.1 percent sanitation access, or a BCI score of 9.91.

Indicator 9: the drinking water quality score required the amount of water samples meeting applicable standards (Van Leeuwen, et al. 2015 "Indicators of the City Blueprint"). In a 2013 study looking at the Matanza-Riachuelo Basin in Buenos Aires, 65.5 samples were considered meeting standards (based on 56 percent of 117 samples), which translated to an Indicator 9: drinking water quality score of 5.60 on the Blue City Index after calculations (Monteverde, et al. 2013). In São Paulo, Indicator 9: drinking water quality was tested in both wells and community plastic tanks, resulting in 155 of 276 samples meeting standards, or an indicator score of 5.62 (Razzolini, et al. 2011).

IV. Case Study Cities' Scores for Indicators in the "Wastewater Treatment" Section of the City Blueprint Framework

	Buenos Aires, Argentina		**São Paulo, Brazil**	
Indicator	**Data Point**	**Blue City Index (BCI) Ranking**	**Data Point**	**Blue City Index (BCI) Ranking**
10. Nutrient recovery	0 nutrient recovering techniques	0	0 nutrient recovering techniques	0
11. Energy recovery	0 energy recovery from WWT	0	0 energy recovery from WWT	0
12. Sewage sludge recycling	0 sewage sludge recycled or re-used	0	0 sewage sludge recycled or re-used	0
13. Wastewater treatment (WWT) energy efficiency	Policy plans available to public via local website	6	Addressed at national and local level, but no policy plan	4

For both Buenos Aires and São Paulo, it first appeared that there was a major gap of information regarding wastewater treatment, but further research indicated that in fact neither city has implemented any recycling or recovery techniques as part of its wastewater treatment processes. Upon examining the existing research, most is published on the *potential* of resource recovery, including nutrient and energy recovery, and sewage sludge recycling. There are currently no citywide practices to quantify resource recovery methods in either city. However, some qualitative analyses provide explanation as to why these wastewater treatment methods have not been implemented in Buenos Aires and São Paulo, as well as why they should.

A possible explanation for Buenos Aires' lack of resource recovery in their wastewater treatment management is both public perception of sewage as waste and the city's infrastructure (Öberg et al., 2014). Because sewage is publicly seen as waste, quickly getting rid of it becomes priority, rather than reusing it for potential resources in energy, nutrients, and recycling. If a change in wastewater treatment and capturing energy from sewage were to occur, it would require a major change in the sewage system already in place in Buenos Aires. Because of the unevenly developed areas of the city through urban growth patterns, many sewage lines were haphazardly created, resulting in disjointed sewage lines that frequently do not connect or do not even access some areas. Existing sewage infrastructure cannot keep up with development and changes to the city, excluding many areas from access to sewage lines. And because this indiscriminate growth is likely to continue in Buenos Aires, there is little chance resource recovery from wastewater treatment will occur in the near future.

In a 2013 study attempting to streamline urban sustainability indicators for urban water and sewage systems, Venkatesh and Brattebø address how São Paulo fares. According to a specialist from the Federal University of Itajuba, Brazil, the city does not implement any wastewater reuse methods or have any energy recovery from wastewater (Venkatesh and Brattebø 2013). Their research also indicates that São Paulo is in critical condition, needing high attention in the following aspects of its water and wastewater:

- Freshwater eutrophication potential related to wastewater discharge
- Intensity of water stress (qualitative indicator) related to upstream water withdrawal

- Solids in sludge generated per capita services per year related to wastewater treatment and byproduct reutilization
- Biogas captured and utilized per kilogram of solids in sludge generated related to resource recovery from waste
- Total energy (heat plus electricity) recovered and used, from biogas per kilogram of solids in sludge generated related to resource recovery from waste
- Treated wastewater reused, related to reutilization of waste
- Heat energy recovered from wastewater per capita per year related to resource recovery from waste. (Venkatesh and Brattebø 2013; 773, 780)

As water scarcity, environmental degradation, urbanization, and overuse of resources will likely continue to occur in São Paulo, more pressure will be placed on available resources and generation of energy. Because of these looming pressures, it makes sense for the city to invest in first measuring and recording the above indicators, then using the results to influence future decision-making for sustainable development.

As both of these studies have shown, resource recovery from wastewater treatment is incredibly lacking in both Buenos Aires and São Paulo. Because of this, and because there are no city-wide practices of nutrient and energy recovery or sewage sludge recycling, these three indicator areas (Indicators 10, 11, 12) have all been given a score of zero.

Indicator 13: wastewater treatment energy efficiency was measured through a self-assessment "based on the plans, measures and their implementation to improve the efficiency of wastewater treatment…based on information from public sources" (Van Leeuwen, et al. 2015). There were many city-level documents available with policy plans, regulations, laws, research articles, and historical plans all surrounding wastewater treatment in Buenos Aires (Buenos Aires City; Government of Argentina). A wide array of departments and agencies were represented in results related to wastewater, including the Ministry of Urban Development, the national Environmental Protection Agency, and the Ministry of Justice and Security. There were versions of local policy plans available to the public on their website, but once plans are at the stage of implementation, it seems that execution becomes the main problem. As wastewater treatment is publicly available, but plans are not always implemented or clearly communicated to the public, I assigned a score of 6 to Buenos Aires for Indicator 13: the energy efficiency of wastewater treatment indicator.

The available data on Indicator 13: the efficiency of wastewater treatment in São Paulo appear to be more limited than Buenos Aires' city-level data. São Paulo has information addressed in news and technical reports at both the city and national level, but does not seem to have local policy plans readily available outlining the wastewater treatment of the city (State Government of São Paulo; Brazil: National System of Sanitation Information; Environmental Company of the State of São Paulo). Because these data are addressed in reports at the local and national level, but policy plans are not readily available, I assigned an Indicator 13: efficiency of wastewater treatment score of 4 for São Paulo.

V. Case Study Cities' Scores for Indicators in the "Infrastructure" Section of the City Blueprint Framework

	Buenos Aires, Argentina		**São Paulo, Brazil**	
Indicator	**Data Point**	**Blue City Index (BCI) Ranking**	**Data Point**	**Blue City Index (BCI) Ranking**
14. Stormwater separation	11,878 km sewer network 1,400 km stormwater sewers 0 km sanitary sewers	1.054	42,921 km of sewer network 0 km stormwater sewers 0 km sanitary sewers	0
15. Average age sewer	97 years old	0	76 years old	0
16. Water system leakages	41 percent	1.8	30.8 percent	3.84
17. Operation cost recovery	56 percent operating costs recovered	1.144	144 percent operating costs recovered	5.522

Data on Indicator 14: stormwater separation, was difficult to find, as most available information discusses the amount of water flowing through the pipes and the amount of people with access to sewage systems, rather than the length of the specific sanitary, stormwater, and combined sewers. Buenos Aires's total "distribution network" measured at 11,878 kilometers, while its stormwater conveyance ran 1,400 km (Water and Waste 2015; Aradas et al. 2003). There was no measurement for the sanitary sewers, so that indicator component was zero. After calculating the indicator for stormwater and combined sewers, Indicator 14: stormwater separation score was 1.054. Indicator 15, the sewer age for Buenos Aires was 97 years, resulting in a less than zero indicator score and therefore a score of zero ("System Modeling…" 2004).

A few resources were available for São Paulo indicating the “sewage” or “wastewater” networks were 44,600 km to 41,242 km in length (“Under Brazil” 2012; Pauliuk et al. 2014). I averaged the two lengths for a total of 42,921 km of sewer network. Both sources indicated that many pipelines are badly deteriorated and many have become combined sewer systems over the years. As there were no sources for non-combined sewer lengths, I recorded zero km for Indicator 14: both stormwater sewers and sanitary sewers, resulting in an indicator score of zero. Indicator 15: the sewer age for São Paulo was 76 years, also resulting in an indicator score of less than zero after calculations (Fix et al. 2003).

Indicator 16: water system leakages measure the amount of water lost due to leaks as it travels through the distribution system. This measurement is taken as a percentage, provided by Siemens’ Latin American Green City Index for both cities. Buenos Aires had a loss of 41 percent while São Paulo lost 30.8 percent, resulting in Indicator 16: water system leakages scores of 1.8 and 3.84, respectively (Siemens “Buenos Aires” 2010; Siemens “São Paulo” 2010).

Indicator 17: the operating costs recovery ratio measures the cost and income balance for water services operating costs. A higher ratio translates to more available funds for water services. The ratios provided by the International Benchmarking Network for Water and Sanitation Utilities (IBNET) are national levels (IBNET 2013). Argentina’s ratio is 0.56, while Brazil’s is 1.44, resulting in 1.144 and 5.522 Indicator 17 scores, respectively.

VI. Case Study Cities' Scores for Indicators in the "Climate Robustness" Section of the City Blueprint Framework

	Buenos Aires, Argentina		**São Paulo, Brazil**	
Indicator	**Data Point**	**Blue City Index (BCI) Ranking**	**Data Point**	**Blue City Index (BCI) Ranking**
18. Green space	31.6 percent covering of soil (Metro area)	4.875	36.7 percent covering of soil (Metro area)	6.469
19. Climate Adaptation	Provides detailed plans clearly communicated to the public	6.5	Local policy plan provided on government website	6
20. Drinking water consumption	244.258 m^3/person/year	0.9847	80.483 m^3/person/year	8.402
21. Climate-robust buildings	Public plans and subsidies available for energy efficiency	8	Addressed at national and local levels	4

A United Nations report on megacities included information detailing green space in both Buenos Aires and São Paulo. (Jordán, et al. 2010). According to the authors' green space estimations using his own analyses of satellite imagery, Buenos Aires had 31.6 percent Indicator 18: green space soil coverage and São Paulo had 36.7 percent soil coverage. After doing the calculations according to Indicator 18, Buenos Aires' indicator score was 4.875, while São Paulo's score was 6.469.

Indicator 19: climate adaptation in cities is determined by measures and implementation to protect cities and citizens against climate change issues such as water scarcity and flooding, such as safety plans and green roofs (Van Leeuwen, et al. 2015). The city of Buenos Aires had many resources available on its local website, including a law specifically named “Adaptation and Mitigation Plan of Climate Change” that required consistent updating at least every five years (Buenos Aires City). A specific action plan was in place called the Buenos Aires Green Plan that detailed to the public how the city will implement its action plan, including building large parks, green roofs, and new plazas with lots of green space (“Details of the Buenos Aires Green Plan” 2014). This appeared to generally be a good plan, as it was comprehensive in its solutions to add green space in a feasible manner to many locations within the city. Because the project was proposed in 2014, it seems too early in the process to determine whether plans have been implemented yet, so I gave Buenos Aires a score of 6.5 for Indicator 19: climate adaptation. São Paulo had data on state- and national-level climate change policies, both available to the public (Environmental Company of the State of São Paulo; State Government of São Paulo). There was even a recent period in 2013 when the city solicited public comment and recommendations on its policy plan regarding climate change (“State of Climate Change Policy” 2013). This plan appeared to be comprehensive in both its ability to address climate change as a city and its efforts to create a space for multi-stakeholder participation. As it was unclear whether any of these potential policy plans have been implemented and documented, I assigned São Paulo an Indicator 19: climate adaptation score of 6.

Indicator 20: drinking water consumption data was available via the Siemen’s Latin American Green City Index. Buenos Aires’ water consumption was 244.258 m^3/person/year, resulting in an Indicator 20 score of 0.9847 (Siemens “Buenos Aires” 2010). São Paulo’s water consumption was significantly lower at 80.483 m^3/person/year and a subsequent Indicator 20 score of 8.402 (Siemens “São Paulo” 2010).

Indicator 21: climate-robust buildings are rated in relationship to their contribution to alleviate climate change, primarily through energy efficiency methods (Van Leeuwen, et al. 2015). Buenos Aires had energy efficient programs for public buildings, even providing some loan subsidies as incentives to improve environmental performance and energy efficiency for environmental improvement plans including infrastructure and technology projects (City of Buenos Aires: Sustainable Production 2016). Although these plans are communicated to the public and subsidies are made available to various organizations, it is unclear if annual reports exist on the implementation of these individual subsidies. I therefore assigned Buenos Aires an Indicator 21: climate-robust buildings score of 8. São Paulo began doing energy efficiency labeling for buildings in 2009, where buildings are assessed for heat reduction, use of natural lighting and ventilation, reduced power consumption, use of solar energy, and reduction of water consumption (Alves 2009). Aside from this mention of energy efficiency labeling, there are no other accessible policy plans available on the issue. Therefore, I gave São Paulo an Indicator 21: climate-robust buildings score of 4, as it is still addressed in some informal capacities at the national and local levels.

VII. Case Study Cities' Scores for Indicators in the "Governance" Section of the City Blueprint Framework

	Buenos Aires, Argentina		**São Paulo, Brazil**	
Indicator	**Data Point**	**Blue City Index (BCI) Ranking**	**Data Point**	**Blue City Index (BCI) Ranking**
22. Management and action plans	No data available on IWRM	0	IWRM addressed at local and national level	4
23. Public participation	18.27 Rule of Law score	0	55.29 Rule of Law score	1.849
24. Water efficiency measures	No information is available on this subject	0	Limited information available in national doc.	1
25. Attractiveness	No info. available in national doc.	0	No info. available in national doc.; some info. on tourist site	0.5

Indicator 22: management and action plans are based on cities applying concepts of Integrated Water Resources Management (IWRM) (Van Leeuwen, et al. 2015). As Buenos Aires did not have any available data documenting their use of IWRM, I gave them an Indicator 21 score of 0. As early as 1973 São Paulo has records of IWRM in their laws, citing the need for institutional development of IWRM with technical and managerial training (Environmental Company of the State of São Paulo). All IWRM efforts up to 1995 revolved around legal frameworks and not much occurred until management training began in 2007 (State Government of São Paulo: IWRM). Since then, there have not been any significant policy plans or applications of IWRM in local or national documents. I assigned São Paulo an Indicator 21: management and action plans score of 4, as there was initial information available at both levels.

Indicator 23: public participation measured the amount of people doing unpaid work (Van Leeuwen, et al. 2015). The data for both cities came from the World Bank's Worldwide Governance Indicators, as provided by the CBF authors. These data were only available on a national scale. Argentina's rule of law score was 18.27, while Brazil's was 55.29. After calculations, Argentina's Indicator 23 score came out as a negative number, and was subsequently rounded up to zero, as per the CBF authors' direction. Brazil's rule of law score translated to a 1.849 Indicator 23: public participation score.

Indicator 24: water efficiency measures examined the different types of water saving measures to improve the efficiency of water use in cities. Buenos Aires, perhaps not surprisingly, had no information available on water efficiency improvements or plans, either nationally or locally, consequentially resulting in an Indicator 24 score of zero. If you look back at Indicator 20: drinking water consumption, you see that Buenos Aires' consumption is very high, resulting in a very low indicator score there as well. São Paulo was also lacking in available information. Most sources either focused on agriculture and irrigation, or wastewater. One source, however, examined conserving and reusing water in buildings, albeit briefly (State Government of São Paulo). Because limited information was available only in a national document, I assigned São Paulo an Indicator 24: water efficiency measures score of 1.

Indicator 25: attractiveness was a difficult indicator to assess, because it attempted to measure how surface water features contribute to public perception of attractiveness, especially related to tourism. There were no data available on any of the local or national sites for Buenos Aires and São Paulo. The only reason I assigned a 0.5 indicator score to

São Paulo was due to a Trip Advisor site specifically addressing tourist locations for bodies of water in the city ("The Top São Paulo Bodies of Water").

Buenos Aires, Argentina

Buenos Aires is a developing city, hindering both the amount of publicly available data and water management techniques that are employed in the city. There were limits on data I was able to find, but the results still show that the city does not rank lowest on the BCF categorization of IWRM sustainability levels in cities shown in Table 8 below (Koop and Van Leeuwen 2016). Buenos Aires' final CBF score was 2.59, falling in the category of "wasteful cities" with a BCI score between 2 and 4. Perhaps this moderately low ranking is reflective of water management that is currently being improved, as well as the amount of developments that still need to happen.

IWRM category	Description
Cities lacking basic water services (BCI 0–2)	Access to potable drinking water of sufficient quality and access to sanitation facilities are insufficient. Typically, water pollution is high due to a lack of wastewater treatment (WWT). Solid waste production is relatively low but is only partially collected and, if collected, almost exclusively put in landfills. Water consumption is low, but water system leakages are high due to serious infrastructure investment deficits. Basic water services cannot be expanded or improved due to rapid urbanization. Improvements are hindered due to governance capacity and funding gaps
Wasteful cities (BCI 2–4)	Basic water services are largely met but flood risk can be high and WWT is poorly covered. Often, only primary and a small portion of secondary WWT is applied, leading to large-scale pollution. Water consumption and infrastructure leakages are high due to the lack of environmental awareness and infrastructure maintenance. Solid waste production is high, and waste is almost completely dumped in landfills. Governance is reactive, and community involvement is low
Water-efficient cities (BCI 4–6)	Cities implementing centralized, well-known, technological solutions to increase water efficiency and to control pollution. Secondary WWT coverage is high, and the share of tertiary WWT is rising. Water-efficient technologies are partially applied; infrastructure leakages are substantially reduced, but water consumption is still high. Energy recovery from WWT is relatively high, while nutrient recovery is limited. Both solid waste recycling and energy recovery are partially applied. These cities are often vulnerable to climate change, e.g. urban heat islands and drainage flooding, due to poor adaptation strategies, limited storm water separation and low green surface ratios. Governance and community involvement has improved
Resource-efficient and adaptive cities (BCI 6–8)	WWT techniques to recover energy and nutrients are often applied. Solid waste recycling and energy recovery are largely covered, whereas solid waste production has not yet been reduced. Water-efficient techniques are widely applied, and water consumption has been reduced. Climate adaptation in urban planning is applied, e.g. incorporation of green infrastructures and storm water separation. Integrative, centralized and decentralized as well as long-term planning, community involvement and sustainability initiatives are established to cope with limited resources and climate change
Water-wise cities (BCI 8–10)	There is no BCI score that is within this category so far. These cities apply full resource and energy recovery in their WWT and solid waste treatment, fully integrate water into urban planning, have multi-functional and adaptive infrastructures, and local communities promote sustainable integrated decision-making and behaviour. Cities are largely water self-sufficient, attractive, innovative and circular by applying multiple (de)centralized solutions

Table 8. "Categorization of different levels of sustainable IWRM in cities." *From Koop and Van Leeuwen 2016*.

The City Blueprint Framework results for Buenos Aires show that overall it is not a sustainable city in its water management practices, as shown in individual indicator scores in Table 9. In comparing Buenos Aires' results to Belém, Brazil, the scores fall within the same "wasteful cities" category, where Belém received a final BCI score of 3.6 (Van Leeuwen, et al. "City Blueprints" 2015). As Belém was the only other Latin American city analyzed by City Blueprint Framework authors and is also considered a developing city, my results are comparable. A great deal of research went into analyzing each indicator, including a fair amount of information found in international research, both through academic scholarship and international organizations. My calculations are, therefore, as accurate as the available data allowed.

In comparing both the World Bank documented information and the City Blueprint Framework results, it is clear that the two compare very different aspects of water management success. The World Bank relies mainly on financial data and self-generated technical documents. These current results do not show much in the way of tangible outcomes for improvements related to the Matanza-Riachuelo development project. Although the sewage treatment plan was a main portion of this project, outside sources indicate that sewage treatment has not improved for the Matanza-Riachuelo river basin, and it has the same amounts of contamination (Greenpeace Argentina 2013; Riachuelo 2015; Staveland-Sæter 2012; Valente 2012). As of April 2016, less than 22 percent of the total commitment amount has been distributed (only $184.31 million of $840 million). It is likely that the Matanza-Riachuelo River Basin project will either finish on time but with funds undistributed, or be extended to a later date. The City Blueprint Framework uses a variety of resources and results, incorporating both quantitative and qualitative assessments through international research and reports, news resources, and national or local documentation.

Buenos Aires, Argentina	
Indicator	***Blue City Index (BCI) Ranking***
1. Secondary wastewater treatment (WWT)	1.0
2. Tertiary wastewater treatment (WWT)	0
3. Ground-water quality	4.7
4. Solid waste collected	1.503
5. Solid waste recycled	1.67
6. Solid waste energy recovered	0
7. Access to drinking water	10
8. Access to sanitation	9.93
9. Drinking water quality	5.60
10. Nutrient recovery	0
11. Energy recovery	0
12. Sewage sludge recycling	0
13. WWT energy efficiency	6
14. Storm-water separation	1.054
15. Average age sewer	0
16. Water system leakages	1.8
17. Operation cost recovery	1.144
18. Green space	4.875
19. Climate Adaptation	6.5
20. Drinking water consumption	0.9847
21. Climate-robust buildings	8
22. Management and action plans	0
23. Public participation	0
24. Water efficiency measures	0
25. Attractiveness	0
TOTAL BCI SCORE	**2.59**

Table 9. City Blueprint Framework analysis indicator scores of Buenos Aires, Argentina.

São Paulo, Brazil

The City Blueprint Framework BCI scores for São Paulo were slightly higher than Buenos Aires' scores, at 3.04. This score still categorizes São Paulo as a "wasteful city" with a BCI score between 2 and 4 (Table 6). Like Buenos Aires, the amount of data available for São Paulo was quite limited, especially in publicly available national and local documents. Quantitative data was scarce as well, outside of international reports. The CBF becomes difficult to use when data is not available from national or local public data, as this tool greatly relies on data being readily accessible to calculate many of the indicators.

The City Blueprint Framework results for São Paulo also indicate that overall the city is not sustainable in its water management practices, as shown through specific indicator scores in Table 10. Comparing São Paulo's results to Belém, Brazil, is a more accurate comparison than examining cities outside of Brazil. Belém received a final BCI score of 3.6 (Van Leeuwen, et al. "City Blueprints" 2015), falling within the same "wasteful cities" category. Like São Paulo, Belém is a coastal city, so it is likely that the two cities have comparable results related to water data.

São Paulo, Brazil	
Indicator	***Blue City Index (BCI) Ranking***
1. Secondary wastewater treatment (WWT)	1.36
2. Tertiary wastewater treatment (WWT)	0
3. Ground-water quality	0.7
4. Solid waste collected	2.518
5. Solid waste recycled	0.36
6. Solid waste energy recovered	0
7. Access to drinking water	9.92
8. Access to sanitation	9.91
9. Drinking water quality	5.62
10. Nutrient recovery	0
11. Energy recovery	0
12. Sewage sludge recycling	0
13. WWT energy efficiency	4
14. Storm-water separation	0
15. Average age sewer	0
16. Water system leakages	3.84
17. Operation cost recovery	5.522
18. Green space	6.469
19. Climate Adaptation	6
20. Drinking water consumption	8.402
21. Climate-robust buildings	4
22. Management and action plans	4
23. Public participation	1.849
24. Water efficiency measures	1
25. Attractiveness	0.5
TOTAL BCI SCORE	**3.04**

Table 10. City Blueprint Framework analysis indicator scores of São Paulo, Brazil.

As with Buenos Aires' World Bank results, São Paulo's also show conflicting reports. The World Bank reports improved pollution loads, water production capacity, and creating hydrodynamic models for reservoir monitoring, among other improvements (*The World Bank "Loan Agreement," 2009*). Other sources, however, suggest that no pollution remediation has taken place in the Alto Tiête River Basin (Romero 2012; Pollution in Brazil 2011). With little to no quantifiable statistics on either side, it is very difficult to determine improvements on this World Bank project. The City Blueprint Framework results for São Paulo are very similar to Belém's final BCI score, implying that my results are accurate through comparing these two developing cities in Brazil.

City Blueprint Framework Analysis of World Bank Documents

Using the CBF, I analyzed four official World Bank reports including an executive summary, a loan agreement, a project appraisal document, and a country partnership strategy (The World Bank "Argentina Environmental Assessment" 2008; The World Bank "Loan Agreement" 2009; The World Bank "Project Appraisal Document" 2012; The World Bank 2014). These CBF results are reflected in Table 11. Any indicators with rankings of "---" signify that no data were available in the World Bank documents.

	Buenos Aires, Argentina	***São Paulo, Brazil***
Indicator	***Blue City Index (BCI) Ranking***	***Blue City Index (BCI) Ranking***
1. Secondary wastewater treatment (WWT)	---	---
2. Tertiary wastewater treatment (WWT)	---	---
3. Ground-water quality	---	---
4. Solid waste collected	---	---
5. Solid waste recycled	---	---
6. Solid waste energy recovered	---	---
7. Access to drinking water	6.5	---
8. Access to sanitation	3.3	---
9. Drinking water quality	---	---
10. Nutrient recovery	---	---
11. Energy recovery	---	---
12. Sewage sludge recycling	---	---
13. WWT energy efficiency	0	0
14. Storm-water separation	---	---
15. Average age sewer	---	---
16. Water system leakages	---	---
17. Operation cost recovery	---	---
18. Green space	---	---
19. Climate Adaptation	1	0
20. Drinking water consumption	---	---
21. Climate-robust buildings	0	0
22. Management and action plans	0	0
23. Public participation	---	---
24. Water efficiency measures	0	0
25. Attractiveness	0	0
TOTAL BCI SCORE	1.54	0

Table 11. City Blueprint Framework analysis indicator scores of World Bank documents for Buenos Aires and São Paulo.

The first indicator with data available was Indicator 7: access to drinking water. Buenos Aires received a BCI score of 6.5, because 65 percent of the city's population had potable water access (The World Bank "Argentina Environmental Assessment" 2008). There were no data available for São Paulo's drinking water access. Indicator 8: access to sanitation was also available for Buenos Aires with a 33 percent population access rate, resulting in a 3.3 BCI score (The World Bank 2014). São Paulo's information was lacking, providing more of a financial view of the costs of implementing projects. Indicator 13: wastewater treatment energy efficiency received a score of 0, because it is a qualitative assessment and resulted in no information available in any of the documents. For Indicator 19: climate adaptation, World Bank documents had limited information available on measures to adapt to climate change. Buenos Aires documents addressed it briefly, resulting in a score of 1, but there was no evidence of climate change measures in the São Paulo documents, so it received a zero. Based on further qualitative assessments, Indicator 21: climate robust buildings, Indicator 22: management and action plans, Indicator 24: water efficiency measures, and Indicator 25: attractiveness results showed that there was no information available in either of the two cities for any of these indicators, so they received scores of 0. I then aggregated and averaged the BCI scores I could find data for, resulting in final scores of 1.54 for Buenos Aires and 0 for São Paulo.

The majority of data in Table 11 show that there was hardly any information available in these official World Bank reports on indicators for water management. The World Bank reports were especially lacking in quantitative information, which determined more than half of the CBF indicators. The background information provided in these documents about Buenos Aires and São Paulo was generally cursory and did not include specific data required to calculate individual indicators.

Because there were so few data available for these indicators, the World Bank documents prove to be lacking in the amount of information provided. The focus of the reports was much more monetarily based, even when providing background and context for both of these cities. World Bank progress reports that are done during later stages of project implementation are showing that lots of progress is being made in these cities. However, if there is no baseline data or a variety of information available at the initiation of these projects, then it becomes extraordinarily difficult to determine if progress has indeed been made. This issue becomes even more convoluted when the type of data used for progress reports reveals that only monetary progress is being assessed. Since data for the City Blueprint Framework indicators was almost completely absent in World Bank documents, it is clear that these World Bank assessments are not sufficient to determine progress and sustainability in water management projects.

Chapter 6

Discussion

6.1. Applicability of City Blueprint Framework in Latin America

The World Bank results and the City Blueprint Framework results appear to differ greatly. While the World Bank indicates it is making progress in its technical reports (or does not report anything), the City Blueprint Framework and other outside sources of analyses on Buenos Aires and São Paulo show these cities are still ranked low on sustainability, and perhaps no water management changes have been made. If the only information available on the IWRM of these cities was based on the World Bank documents, it could be assumed that improvements were happening, even if funding was slow. Now that the City Blueprint Framework assessments are finalized, the picture of these cities becomes much more complete. While access to drinking water and sanitation scores are high for both Buenos Aires and São Paulo, groundwater quality and water system leakages are scored incredibly low. Wastewater treatment practices are virtually nonexistent, and governance factors are almost completely absent from both cities. Once specific indicators of sustainability are analyzed with more scrutiny, it is clear that the World Bank is not providing holistic-enough results. What is also clear is that the City Blueprint Framework served as an effective tool to analyze a variety of water management factors for Integrated Water Resources Management.

One central focus of this research was to assess whether the City Blueprint Framework was appropriate for Latin America. The answer to that becomes complex, because there are many factors determining its success. A key factor that would determine CBF success anywhere is the amount of available data. If we consider the cities assessed here—Buenos Aires and São Paulo—and compare them with other cities in Latin America, they are considered mega-cities (Jordán, et al. 2010). If cities of this size and scale do not have many publicly available resources through national and local information, then it would be extremely difficult to find data for cities elsewhere in Latin America that are much smaller in size. In this way, the CBF is difficult to apply to cities with little to no publicly available information. More specifically, after taking time to find the data and calculate each indicator, I would conclude that the CBF was definitely not a quick first pass assessment of each city's viability for IWRM. Because it is so comprehensive in its analyses and relies on publicly available data, the CBF took about a month to complete.

Conversely, I was still able to find some sort of data on every indicator, whether or not these cities were implementing specific practices, such as Indicators 10 – 12: nutrient recovery, energy recovery, and sewage sludge recycling. These data showed that Buenos Aires and São Paulo were not employing any of these sustainable practices, but that they were perhaps on the horizon in the future for sustainable IWRM. The answer to the main research question, then, is yes, we can use the City Blueprint Framework, but with some caveats. In any case, the results from this water management assessment tool show the pressing need to understand and analyze specific water resources management practices in Latin America.

6.2. Contribution to Greater Literature

By comparing the City Blueprint Framework results from Buenos Aires and São Paulo to other cities analyzed by CBF authors in Table 12, an even stronger depiction of this research project is established. These three additional cities were chosen for comparison for two reasons. First, Ho Chi Minh City and Istanbul were chosen because they are developing and transitioning cities, respectively, providing apt comparisons across the world that may be in similar transitional states. Amsterdam was chosen because it is one of the highest-scoring cities analyzed by the CBF, providing a contrasting city. Second, these cities were the only cities with analytical reports written about each of them individually, and providing scores for each indicator.

Ho Chi Minh City, Amsterdam, and Istanbul results were all published prior to the modified City Blueprint Framework that was published in late 2015, so some indicators have been modified and were either classified differently or not included in the prior version (Van Leeuwen, et al. “Challenges of Water Governance” 2015; Van Leeuwen and Sjerps “Amsterdam” 2015; Van Leeuwen and Sjerps “Istanbul” 2015). Italicized indicators are indicators from the old City Blueprint Framework that were slightly modified in the new CBF. Highlighted indicators are indicators that have essentially stayed the same throughout the CBF transition. Indicators that do not have a score for Ho Chi Minh City, Amsterdam, and Istanbul are completely new indicators either modified significantly from old indicators, or changed entirely. These scores are not available for cities assessed using the old CBF.

	Buenos Aires, Argentina	*São Paulo, Brazil*	*Ho Chi Minh City, Vietnam*	*Amsterdam, Netherlands*	*Istanbul, Turkey*
Indicator	***BCI Score***	***BCI Score***	***BCI Score***	***BCI Score***	***BCI Score***
1. Secondary wastewater treatment (WWT)	1.0	1.36	--	--	--
2. Tertiary wastewater treatment (WWT)	0	0	--	--	--
3. Ground-water quality	4.7	0.7	2.0	6.1	4.0
4. Solid waste collected	1.503	2.518	--	--	--
5. Solid waste recycled	1.67	0.36	--	--	--
6. Solid waste energy recovered	0	0	--	--	--
7. Access to drinking water (*Sufficient to drink*)	10	9.92	8.4	10	10
8. Access to sanitation (*Safe sanitation*)	9.93	9.91	1.2	10	9.5
9. Drinking water quality (*Surface water quality*)	5.60	5.62	3.0	7.3	5.8
10. Nutrient recovery	0	0	0	10	0
11. Energy recovery	0	0	0	10	1.0
12. Sewage sludge recycling	0	0	0	10	0
13. WWT energy efficiency (*Energy efficiency*)	6.0	4.0	5.0	10	5.0
14. Storm-water separation (*Infrastructure separation*)	1.054	0	0.1	8.3	7.0
15. Average age sewer	0	0	8.5	7.2	5.0
16. Water system leakages	1.8	3.84	5.9	9.5	7.6
17. Operation cost recovery	1.144	5.522	--	--	--
18. Green space	4.875	6.469	--	--	--
19. Climate adaptation (*Adaptation strategies*)	6.5	6.0	7.0	10	4.0
20. Drinking water consumption	0.9847	8.402	9.3	9.8	8.9
21. Climate-robust buildings	8.0	4.0	7.0	7.0	3.0
22. Management and action plans	0	4.0	7.0	7.0	5.0
23. Public participation	0	1.849	0.3	7.7	0.5
24. Water efficiency measures	0	1	4.0	10	5.0
25. Attractiveness	0	0.5	8.0	9.0	7.0
TOTAL BCI SCORE	**2.59**	**3.04**	**5.4**	**8.0**	**5.3**

Table 12. City Blueprint Framework Results for five cities. *Adapted from data in Van Leeuwen, et al. "Challenges of Water Governance" 2015; Van Leeuwen and Sjerps "Amsterdam" 2015; Van Leeuwen and Sjerps "Istanbul" 2015.*

In comparing the five cities, it is clear that both Buenos Aires and São Paulo rank significantly lower than the three other cities. Amsterdam not only ranks among the top cities in this comparison, but in the comparison between the forty-four other cities analyzed by CBF authors (Van Leeuwen, et al. 2015, “City Blueprints: Baseline Assessments”). Amsterdam, then, can serve as a point of comparison for the highest ranked city examined under the CBF, or a resource-efficient and adaptive city, ranked between 6 and 8 on the BCI (Koop and Van Leeuwen 2016). A city with a BCI of 8 frequently employs wastewater treatment techniques for energy and nutrient recovery, solid waste recycling, reduction of water consumption, urban planning climate adaptation, integrative and long-term planning, public participation, and sustainability initiatives. It is important to note that none of the cities authors examined fall in the “water-wise cities” category with a BCI of 8-10 (Koop and Van Leeuwen 2016).

Conversely, cities that receive a BCI score between 2 and 4 are considered wasteful cities in the context of the sustainability of IWRM in cities. In cities like Buenos Aires and São Paulo, basic water services are frequently unmet; wastewater treatment is carried out only on small scales and often poorly covered; environmental awareness is low, resulting in high water consumption; infrastructure maintenance is lacking, producing high amounts of infrastructure leakages; solid waste and landfill dumping are high; and there are few preventative governance measures or community involvement (Koop and Van Leeuwen 2016).

Ho Chi Minh City and Istanbul are developing and transition cities, both scoring relatively low on the BCI scale. Cities with low BCI scores, or scores low for IWRM, typically experience increased levels of environmental, social, and/or financial pressures

(Koop and Van Leeuwen 2015, "Application of the Improved CBF"). Individual BCI scores indicate staggeringly low numbers related to environmental protection and basic water services, with less than 30 percent secondary wastewater treatment coverage (Koop and Van Leeuwen 2015, "Application of the Improved CBF").

Below are multiple small tables (Table 13) of all 45 cities that have been assessed by City Blueprint Framework authors (Van Leeuwen, et al. "City Blueprints" 2015). These were organized by global region. As is very clear, most CBF cities analyzed were in Europe, specifically Northwestern Europe and East-Central Europe.

East-Central Europe

City	*BCI Score*
Athens (Greece)	6.4
Bologna (Italy)	6.3
Bucharest (Romania)	5.2
Budapest (Hungary)	6.9
Galati (Romania)	5.5
Genova (Italy)	5.7
Ljubljana (Slovenia)	7.0
Lodz (Poland)	6.7
Malta (Malta)	4.9
Reggio Emilia (Italy)	6.6
Varna (Bulgaria)	5.3
Wroclaw (Poland)	6.1

Middle East

Ankara (Turkey)	6.0
Istanbul (Turkey)	5.3
Jerusalem (Israel)	7.6

Western Europe

City	*BCI Score*
Algarve (Portugal)	6.1
Manresa (Spain)	6.6
Zaragoza (Spain)	6.6

South America

Belém (Brazil)	3.6

North America

New York (USA)	7.5

Asia

Ho Chi Minh City (Vietnam)	5.4

Africa

Dar es Salaam (Tanzania)	4.1
Kilamba Kiaxi (Angola)	3.5

Australia

Melbourne (Australia)	7.0

Northwestern Europe

City	*BCI Score*
Amsterdam (The Netherlands)	8.0
Berlin (Germany)	7.8
Copenhagen (Denmark)	7.0
Dordrecht (The Netherlands)	7.5
Eindhoven (The Netherlands)	6.4
Eslöv (Sweden)	7.4
Hamburg (Germany)	7.6
Helsingborg (Sweden)	8.5
Helsinki (Finland)	7.9
Kristianstad (Sweden)	8.0
London (UK)	7.1
Lyon (France)	7.2
Maastricht (The Netherlands)	6.9
Malmö (Sweden)	8.0
Nieuwegein (The Netherlands)	6.3
Oslo (Norway)	7.4
Reykjavic (Iceland)	7.0
Rotterdam (The Netherlands)	7.0
Scotland (UK)	6.6
Stockholm (Sweden)	7.7
Venlo (The Netherlands)	6.2

Table 13. All Blue City Indicator scores from cities assessed using the City Blueprint Framework. *Adapted from Van Leeuwen, et al. "City Blueprints" 2015.*

The importance of comparing BCI scores of cities comes down to creating city-learning alliances between cities to "improve awareness, communication, community involvement, governance, and accelerate the transition towards water wise cities" (Koop and Van Leeuwen 2015, "Application of the Improved CBF"). By creating awareness of methods that improve water management, cities are able to evaluate and compare their own management systems to cities with higher BCI scores, and then implement sustainable strategies for IWRM.

Authors of the Blue City Framework identify the ongoing need to not only share information among cities, but to expand their assessments beyond the cities mostly central to Europe (Koop and Van Leeuwen 2015, "Application of the Improved CBF"). As there are many challenges to creating adaptive, sustainable urban IWRM in cities, it is first important to understand a baseline assessment of current IWRM practices. Therefore, it is vital for more assessments to be done in cities across the world, especially developing cities that are most vulnerable to issues related to climate change and environmental degradation, such as Buenos Aires and São Paulo.

6.3. Critical Evaluation of City Blueprint Framework

The City Blueprint Framework was evaluated based on executing the CBF, preexisting gaps in natural resources management frameworks, opportunities to improve the CBF, and possible biases of the CBF. In analyzing each indicator for the CBF, some were easier to assess than others, and most of that information was based on availability of resources at the local and national level. Other limitations addressed here include social factors that are missing from other preexisting natural resources management frameworks, and potential biases of the CBF. Addressing these gaps and incorporating social analyses into water management frameworks are important for understanding how to shape future assessments.

Many of the Blue City Indicators proved very difficult to determine through the resources provided by the authors of the City Blueprint Framework (Van Leeuwen, et al. 2015). Many indicators were based on quantitative information that was incredibly difficult to attain and would most likely be suitable for city managers that have direct access to that data. Because much of these data were collected by outside the researchers and were not publicly available, this City Blueprint Framework tool becomes somewhat undermined in terms of its original intent to be done as a quick first pass that can be answered by local officials. Seeing how the CBF is a first-pass assessment tool to determine the sustainability for IWRM analyses later, however, it is useful for city- or municipal-level stakeholders.

Theoretically, the City Blueprint Framework excludes social factors affecting water management. Issues such as environmental justice and gender representation in natural resources management are important to address in frameworks that will affect how water resources are managed in cities. The United States Environmental Protection Agency currently defines environmental justice as “the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies” (Environmental Justice, 2015). Scale of governance is important in environmental policy, as it can frequently cause disparities in power distribution, but also create issues where large-scale federal governance does not have positive consequences on state regulatory implementation (Konisky, 2009). The CBF could incorporate a rescaling of governance to assess distribution of power to local communities to make management decisions (Cohen and McCarthy, 2015). Looking at governance scales allows for the analysis of power distribution and effective water management decisions.

Addressing gender representation in water resources management is important for determining stakeholder engagement and representation in IWRM practices. By including women in water resources strategies, both water management and gender identities can be shaped to be more inclusive and liberating (O'Reilly, 2006; Reed and Christie, 2008). Planners, policy makers, and development workers need to enhance their understanding of shifting, subjective gender roles in natural resources management, incorporating decision-making, access to resources, division of labor, and traditional practices and knowledge in order to create a sustainable system of resource consumption (Upadhyay, 2005). Gender inclusion methods in water management may not be straightforward processes, but will have lasting effects on water policies, especially if they utilize a variety of resource management methods and involve many stakeholders (Reed and Christie, 2008).

Both environmental justice and gender representation would be valuable issues to assess as indicators for sustainable Integrated Water Resources Management in future versions of the City Blueprint Framework. Further resources to address capacities of developing cities, specifically in Latin America, would be important to improve in order to confront the lack of publicly available data.

It is also important to examine the CBF's potential biases. First, because authors are both based in Europe and doing most CBF analyses in European cities, there is an inherent bias to geographical preference. As authors' main foci were prejudiced towards Europe, not only were more cities analyzed in that area, but those cities also received the highest scores reported. It is unclear whether this has to do with those cities being mostly developed and therefore receiving higher scores as a result of resources and infrastructure, or if the authors did have an inherent bias to rank European cities higher. As these European cities seemed to be starting points for the relatively new CBF and authors have already addressed their geographical bias towards Europe, future analyses should not be concentrated in Europe to fully determine potential biases.

The second potential bias is between national- versus local-level data. CBF authors reported that some of their cities required national-level data, resulting in some inflated BCI scores. While this may be true for some European cities with a variety of economic variance, this may not be true for megacities in Latin America like Buenos Aires and São Paulo. Large, more developed cities typically have much higher scores than smaller, developing cities. And although Buenos Aires and São Paulo are not considered "developed," they have many more resources and infrastructure development than most smaller cities in Latin America. These cities are essentially defining their whole countries with potentially elevating CBF scores. Using national-level data in these cases might skew the data in the opposite direction as what authors experienced in European cities. It is important to look at the comparison of developed versus developing cities, especially in the context of megacities and Latin America. Lastly, the CBF indicators do not appear to be weighted in any level of importance. As water management differs greatly across geographic regions, it is necessary to examine the importance of different factors that define CBF indicators. By authors not weighting the indicators, they are making an assumption of a location's hierarchy of needs when it comes to water management.

6.4. Limitations of Study

Some limitations of this thesis include the absence of site visits and interviews in Latin America. Visiting both of these cities would have benefited my findings to examine what is really occurring on the ground with the World Bank projects. With time constraints and funding limitations, I was simply unable to incorporate fieldwork into this analysis. Another limitation was the qualitative indicators of the City Blueprint Framework, as all of the information on the two cities was either in Spanish or Portuguese. I used my current knowledge of both languages to assess the availability of documents, but my assessment was somewhat hindered by my lack of fluency in both languages.

My use of the CBF was limited for reasons of access to data and lack of fieldwork. If I were to assess these World Bank projects and use the CBF again, I would go to both cities and directly contact city officials. With access to local knowledge on these projects and more data, I believe the CBF assessment would have been completed in a much timelier manner. If that were the case, then I could have also conducted interviews surrounding public perception or participation related to the specific World Bank projects and urban water management in Buenos Aires and São Paulo.

Appendix
City Blueprint Framework Calculations for Case Study Cities

	Buenos Aires, Argentina			São Paulo, Brazil		
Indicator	***Calculation***	***Data Point***	***Blue City Index (BCI) Ranking***	***Calculation***	***Data Point***	***Blue City Index (BCI) Ranking***
1. Secondary wastewater treatment (WWT)	**Indicator 1 = X/10** [10%] / 10 = 1.0 BCI score	10 percent treated via secondary WWT	1.0	**Indicator 1 = X/10 .68 (secondary level) * 20 (total treated) = 13.6 percent** [13.6%] / 10 = 1.36 BCI score	13.6 percent treated via secondary WWT	1.36
2. Tertiary wastewater treatment (WWT)	**Indicator 2 = X/10** 0/10 = 0 BCI score	0 percent treated via secondary WWT	0	**Indicator 2 = X/10** 0/10 = 0 BCI score	0 percent treated via secondary WWT	0
3. Ground-water quality	**Indicator 3 = X / (X+Y) * 10** (47/(47+53))*10 = 4.7	Good status samples: 47% Poor status samples: 53%	4.7	**Indicator 3 = X / (X+Y) * 10** (7/(7+93)) *10 = 0.7	Good status samples: 7% Poor status samples: 93%	0.7
4. Solid waste collected	**Indicator 4 = [1 – (X−136.4)/(689.2−136.4)] * 10** [1-((606.1-136.4)/ (689.2-136.4))]*10 = 1.503	606.1 kg/capita/year	1.503	**Indicator 4 = [1 – (X−136.4)/(689.2−136.4)] * 10** [1-((550-136.4)/ (689.2-136.4))]*10 = 2.518	550 kg/capita/year	2.518
5. Solid waste recycled	**Indicator 5 = (% recycled / 100 − % energy recovery incineration) *10** (16.7/(100-0))*10 = 1.67	16.7 percent	1.67	**Indicator 5 = (% recycled / 100 − % energy recovery incineration)* 10** (3.6/(100-0))*10 = 0.36	3.6 percent	0.36
6. Solid waste energy recovered	**Indicator 6 = (%energy recover□□ incineration / 100 − % recycled)*10** (0/(100-3))*10 = 0	0 percent	0	**Indicator 6 = (%energy recovery incineration/ 100 − % recycled)*10** (0/(100-3))*10 = 0	0 percent	0
7. Access to drinking water	**Indicator 7 = X/10** 100/10 = 10	100 percent	10	**Indicator 7 = X/10** 99.2/10 = 9.92	99.2 percent	9.92

Appendix Continued
City Blueprint Framework Calculations for Case Study Cities

	Buenos Aires, Argentina			São Paulo, Brazil		
Indicator	*Calculation*	*Data Point*	*Blue City Index (BCI) Ranking*	*Calculation*	*Data Point*	*Blue City Index (BCI) Ranking*
8. Access to sanitation	**Indicator 8 = X/10** 99.3/10 = 9.93	99.3 percent	9.93	**Indicator 8 = X/10** 99.1/10 = 9.91	99.1 percent	9.91
9. Drinking water quality	**Indicator 9=(X/Y)*10** (65.5/117)*10 = 5.60	65.5 of 117 total samples meeting standards	5.60	**Indicator 9=(X/Y)*10** (155/276)*10 = 5.62	155 of 276 total samples meeting standards	5.62
10. Nutrient recovery	**Indicator 10 = (A/B) * (% secondary WW[illegible] coverage/100) * 10**	0 nutrient recovering techniques	0	**Indicator 10 = (A/B) * (% secondary WWT coverage/100) * 10**	0 nutrient recovering techniques	0
11. Energy recovery	**Indicator 11 = (C/D) * (% secondary WWT coverage/100) * 10**	0 energy recovery from WWT	0	**Indicator 11 = (C/D) * (% secondary WWT coverage/100) * 10**	0 energy recovery from WWT	0
12. Sewage sludge recycling	**Indicator 12 = ((C+D)/A) * (% secondary WWT coverage/100) * 10**	0 sewage sludge recycled or re-used	0	**Indicator 12 = ((C+D)/A) * (% secondary WWT coverage/100) * 10**	0 sewage sludge recycled or re-used	0
14. Storm-water separation	**Indicator 14 = ((B+C)/(A+B+C))*10** ((1400+0)/(11,878+1400+0))*10 = 1.054	11,878 km sewer network 1,400 km stormwater sewers 0 km sanitary sewers	1.054	**Indicator 14 = ((B+C)/(A+B+C))*10** ((0+0)/(42,921+0+0))*10 = 0	42,921 km of sewer network 0 km stormwater sewers 0 km sanitary sewers	0
15. Average age sewer	**Indicator 15 = ((60−X)/(60−10))*10** ((60-97)/(60-10))*10 = -7.4, so 0	97 years old	0	**Indicator 15 = ((60−X)/(60−10))*10** ((60-76)/(60-10))*10 = -3.2, so 0	76 years old	0

Appendix Continued
City Blueprint Framework Calculations for Case Study Cities

	Buenos Aires, Argentina			São Paulo, Brazil		
Indicator	*Calculation*	*Data Point*	*Blue City Index (BCI) Ranking*	*Calculation*	*Data Point*	*Blue City Index (BCI) Ranking*
16. Water system leakages	**Indicator 16 =** $((50-X)/(50-0))*10$ ((50-41)/(50-0))*10 = 1.8	41 percent	1.8	**Indicator 16 =** $((50-X)/(50-0))*10$ ((50-30.8)/(50-0))*10 = 3.84	30.8 percent	3.84
17. Operation cost recovery	**Indicator 17 =** $((X-0.33)/(2.34-0.33))*10$ ((0.56-.33)/(2.34-.33))*10 = 1.144	56 percent operating costs recovered	1.144	**Indicator 17 =** $((X-0.33)/(2.34-0.33))*10$ ((1.44-.33)/(2.34-.33))*10 = 5.522	144 percent operating costs recovered	5.522
18. Green space	Indicator 18 = $((X-16)/(48-16))*10$ ((31.6-16)/(48-16))*10 = 4.875	31.6 percent covering of soil (Metro area)	4.875	Indicator 18 = $((X-16)/(48-16))*10$ ((36.7-16)/(48-16))*10 = 6.469	36.7 percent covering of soil (Metro area)	6.469
20. Drinking water consumption	**Indicator 20 =** $[1-((X-45.2)/(266-45.2))]*10$ [1-((244.258-45.2)/(266-45.2))]*10 = 0.9847	244.258 m^3/person/year	0.9847	**Indicator 20 =** $[1-((X-45.2)/(266-45.2))]*10$ [1-((80.483-45.2)/(266-45.2))]*10 = 8.402	80.483 m^3/person/year	8.402

Appendix Continued
City Blueprint Framework Calculations for Case Study Cities

	Buenos Aires, Argentina			São Paulo, Brazil		
Indicator	***Calculation***	***Data Point***	***Blue City Index (BCI) Ranking***	***Calculation***	***Data Point***	***Blue City Index (BCI) Ranking***
23. Public participation	**Y = Rule of law score** **X = 0.6573*Y – 22.278** **Indicator 23 = ((X−5)/(53−5)) * 10** Rule of law score: 18.27 X= (0.6573*18.27) - 22.278 = -10.269129 *So here, scored below 5%, so set at 5%, resulting in an BCI score of 0 ((-10.269129-5)/(53-5))*10 = -3.1811 → so 0	18.27 Rule of Law score	0	**Y = Rule of law score** **X = 0.6573*Y – 22.278** **Indicator 23 = ((X−5)/(53−5)) * 10** Rule of law score: 55.29 X= (0.6573*55.29) - 22.278 = 13.8735 ((13.8735-5)/(53-5))*10 = 1.849	55.29 Rule of Law score	1.849

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