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Sustainable Financing as a Mechanism to Increase Private Participation in the Development of Infrastructure Systems in the Water Sector

Juan David González Ruiz

Universidad Nacional de Colombia

Facultad de Minas, Departamento Ingeniería de la Organización

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Juan David González Ruiz

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Advisor:

D.Sc. Sergio Botero Botero

Co-Advisor:

Ph.D. Carlos Alejandro Arboleda Arango

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This thesis is especially dedicated to God, my parents, Benji, and my lovely wife.

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Abstract

This work addresses the problem of the coverage gap in the water sector in Colombia and how the creation of an eco-innovative financing mechanism aligned with Sustainable Development Objectives (particularly objectives 6 and 9) can encourage the private sector's involvement, boosting the development of a sustainable infrastructure to help bridge the coverage gap. Therefore, this project's primary objective is based on making a methodological contribution that encourages lenders to promote the development of sustainable infrastructure and the capture of financial value, as measured by the Financial Capture Value Theory, by financing water infrastructure systems with a special focus on Colombia. To create and validate the methodological proposal, it was necessary to clarify the theoretical concepts of financial eco-innovations; therefore, the main elements of sustainable financing from the financial eco-innovation perspective as a strategy to develop sustainable infrastructure were analyzed. In addition, a detailed study of the current state of Colombia's water sector and the private involvement through Public-Private Partnerships, which enabled identification of the main elements, characteristics and investment needs in the sector, was conducted. In this way, this research proposes a methodology of sustainable financing as a mechanism to increase the private participation in the development of infrastructure systems in the Colombian water sector using a mezzanine-type debt mechanism (incorporating the Water Criteria of the Climate Bonds Standard). The methodology is validated by being implemented in a project in Colombia's water sector.

Keywords: Sustainable Infrastructure; Sustainable Financing; Private Participation; Water; Mezzanine Debt; Financial Captured Value.

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List of Symbols and Abbreviations

Abbreviation	Concept
CAF	Bank for the Development of Latin America
CapEx	Capital Expenditures
CAPM	Capital Asset Pricing Model
CDM	Clean Development Mechanism
CER	Certified Emission Reductions
CFD	Cash Flow to Debt
CR	Conversion Ratio
CRA	Commission for the Regulation of Drinking Water and Sanitation
DNP	Dirección Nacional de Planeación
DSCR	Debt Service Coverage Ratio
ECF	Equity Cash Flow
EPM	Empresas Públicas de Medellín
Equity IRR	Equity Internal Return Rate
EV	Enterprise Value
FCF	Free Cash Flow
FCV	Financial Captured Value
GDP	Gross Domestic Product
GHG	Greenhouse Gas
IADB	Inter-american Development Bank
IBR	Banking Reference Indicator in Colombia
IRR	Internal Rate of Return
LLRC	Loan Life Coverage Ratio
NGO	Non-governmental Organization
NPV	Net Present Value
OCF	Operational Cash Flow
OECD	Organization for Economic Co-operation and Development
OpEx	Operating Expenses
OTC	Over the Counter
PF	Project Finance
PIPR	Private Initiative with Public Resources
PIWPR	Private Initiative without Public Resources
PPPs	Private-Public Partnerships
Project IRR	Project Internal Return Rate
PUC	Public Utility Companies
ROA	Return on Assets
ROE	Return on Equity
SDGs	Sustainable Development Goals
SIB	Social Impact Bonds
SIS	Sustainable Infrastructure Systems
SPV	Special Purpose Vehicle
TBL	Tripple Bottom-Line
UNFCCC	United Nations Framework Convention on Climate Change
USAID	The United States Agency for International Development
WACC	Weighted Average Cost of Capital

Introduction

Increasing the coverage of social investments through the development of sustainable infrastructure undeniably represents an important challenge for Colombia. Consequently, mechanisms should be implemented that encourage public-private partnerships and the creation of regulations and innovative financing mechanisms that will lead to the development of sustainable infrastructure projects (Baietti et al., 2012; González-Ruiz, Arboleda, and Botero, 2015; Ivanova, 2014; United Nations, 2015). Thus, the growing need to close coverage gaps in various sectors requires a reconsideration of what strategies promote the involvement of the private sector and, therefore, an investment and financing process for infrastructure projects that promotes sustainable development. This process should include economic, social and environmental elements in project valuation. Therefore, an adequate framework for financing and investing is essential to improve the implementation of social infrastructure.

In 2012, the Congress of Colombia enacted the Public-Private Partnerships (PPPs) Law 1508, which is based on Project Finance (PF). Its objective is to increase private participation and improve the coverage and quality of infrastructure systems, particularly in the road transport sector. This law has given rise to ambiguous or subjective procedures that have resulted in delays in the development of projects in many sectors (specifically in the social infrastructure for drinking water and sanitation). In 2015, Decree 063 was issued to regulate the particularities of the implementation of PPPs in the water sector. However, important issues such as the funding framework were not addressed.

In recent decades, the drinking water sector in Colombia has changed little with respect to its operation and relations with the private sector. As a result, the coverage gap has increased over time. This has led to various environmental, economic and public health effects. For example, in rural areas, where the poorest segments of the population live, contaminated water sources and poor distribution networks have caused gastrointestinal diseases, which are responsible for 7.3% of infant mortality (Mejía et al., 2012). Therefore, extending the service's coverage and improving its quality by implementing sustainable infrastructure represents an opportunity for the creation of new financial mechanisms.

The main contribution of this dissertation is the creation of an eco-innovative mechanism of financial subordination -mezzanine-type debt- whose main characteristic is debt service payments focused on sustainability factors. These include economic, social and environmental factors, and the mechanism also features the option to convert outstanding debt into equity participation if the objectives and commitments of the subordination agreement are met. The mechanism is based on a methodology that integrates eco-innovative financing schemes with the development of drinking water and sanitation infrastructure and current regulations in Colombia. This goal is to increase private sector participation. Consequently, this dissertation seeks to contribute to financial theory and project management literature.

Problem Statement

The level of academic knowledge on PPPs and PF, as well as the integration with eco-innovative financing mechanisms applied to the development of social infrastructure worldwide, does not match existing needs. Moreover, practical and academic work on the situation in Colombia remains underdeveloped. Thus, there is a need for more in-depth analysis of the integration between the development of social infrastructure systems and PPPs and PF; this entails establishing the foundations of research processes in this field and outlining strategies to provide solutions to real problems. Therefore, the water sector and the development of sustainable infrastructure projects provide an appropriate setting for articulating the main issues addressed by this research.

The Colombian government's insufficient investment in the rural sector in recent decades has caused significant gaps in drinking water and sanitation coverage. For example, in 2013, the country's Caribbean and Pacific regions had aqueduct coverage of 56.3% and 69.6% and sewerage coverage of 60.3% and 67.6%, respectively (Departamento Nacional de Planeación, 2014). This situation has caused a variety of public health problems.

Studies worldwide have shown that one USD invested in water and sanitation infrastructure systems has a return of between 5 and 28 USD (Mejía et. al, 2012). Moreover, existing infrastructure is deteriorating and will have to be replaced in the coming years, which implies the development of new projects (González-Ruiz et. al, 2014). In this way, the current and future demand for infrastructure requires the development of private sector projects to be strengthened in the form of schemes that allow the private sector to actively participate in developing new types of infrastructure through innovative financial mechanisms (Ivanova, 2014).

Consequently, the development of sustainable infrastructure should be an integral aspect of development plans across the world (González-Ruiz, Arboleda, and Botero, 2016; Ros, Ismail, and Hassan, 2012). This requires increasing current levels of investment by assigning greater priority to the implementation of financing instruments related to climate change and, thus, to sustainable development (Barbero et al., 2015).

According to the Inter-american Development Bank (IADB) (2013), the coverage gap in social and economic infrastructure in Colombia is a result of low investment in multiple strategic sectors. To address this gap, the IADB suggests strengthening funding processes, best practices in public-private contracting and the structuring and evaluation of projects.

In this context, and in accordance with Colombia's commitment to achieving the Sustainable Development Objectives (SDGs), particularly Objectives 6, 9, and 11, the government enacted Decree 0280 in 2015 with the purpose of directing institutional efforts to promote investment in infrastructure to develop sustainable infrastructure systems. This decree recommends developing innovative financial mechanisms that permit the mobilization of adequate financial resources for the implementation of the SDGs (Departamento de Planeación Nacional -DNP-, 2015).

According to Baietti et al. (2012), the problem of low investment rates and a lack of financial mechanisms results from questions of how to mobilize or channel global funding resources toward sustainable projects. The main barrier to investor participation is that many technologies and projects are not financially attractive and, therefore, do not appeal to the private sector absent a certain level of support from the public sector. Whereas investments in traditional infrastructure systems have a well-established and organized funding framework, in contrast to sustainable infrastructure financing, which is still in early development stage.

To develop a new type of infrastructure, practical solutions should be sought to accelerate the transformation of the economy through solutions that make it possible to close gaps in coverage and promote sustainable development (Baietti et al., 2012). By doing so, infrastructure investors, who generally opt for traditional construction, should be able to systematically evaluate the financial and economic benefits of sustainable infrastructure in their decision-making process, as sustainable infrastructure can represent savings large enough to justify investments, even under significant uncertainty (Talberth et. al, 2013). Similarly, Ivanova (2014) argues that in most countries, climate and investment policies have developed separately. This has adversely affected investment in sustainable infrastructure; integrating these policies within a single framework can help to improve collaboration and advance the goal of sustainable development. Financial mechanisms need to be employed in sustainable investments to ensure the latter's long-term viability.

There are many financial challenges to developing sustainable infrastructure projects in the water and sanitation sector in Colombia, which include the following:

- Generate special financing mechanisms to broaden the base of issuers and investors.
- Increase private investment through joint investment with the public sector.
- Involve specialized investors who understand the dynamics of the sector.
- Generate financial guarantees to provide confidence to investors.
- Establish profitability parameters such that investors are encouraged to participate in water infrastructure markets.
- Integrate water investment plans with housing policies.

In an effort to resolve these challenges, the research problem of this dissertation is based on the development of an eco-innovative financial mechanism that integrates the involvement of the private sector and the development of sustainable infrastructure projects in a way that satisfies current regulations in Colombia. This mechanism, which is part of a project development methodology, will allow for a better understanding of the public-private relationships that can lead to the development of sustainable infrastructure and increase private sector investment in the water sector.

Development

The development of the eco-innovate financial mechanism, under a methodology for structuring sustainable infrastructure projects for the water sector in Colombia, is based on the objectives and methodology presented below:

Hypothesis

Through an eco-innovative mezzanine-type debt mechanism for financing Sustainable Infrastructure Systems, would lenders capture financial value?

Objectives

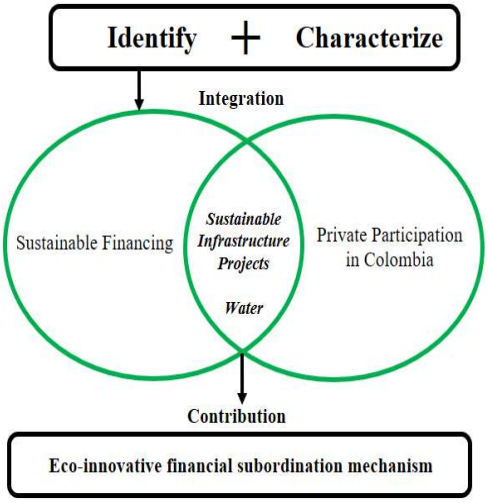
General: To develop an eco-innovative financing mechanism as an instrument to increase the private sector's involvement into the development of sustainable infrastructure in the water sector in Colombia.

Specific:

1. To identify the main elements of eco-innovative financing for sustainable infrastructure projects.
2. To characterize the private participation in the development of infrastructure systems in the drinking water and sanitation sector in Colombia.
3. To propose an eco-innovative financial mechanism subjected to factors of economic, social and environmental sustainability.
4. To apply the developed financial mechanism into a water sector project in Colombia, as a case study

A graphical representation of the objectives is shown below:

Figure 0-1: Research objectives.



Scope of Research

The objective of this research is to develop an eco-innovative financial mechanism under a structuring framework used to develop sustainable infrastructure projects that can be applied to any infrastructure project. However, Colombia's water sector is considered a case study because of the coverage gap and the need to obtain new financial mechanisms that promote the involvement of private investors through sustainable development.

Thesis Organization

The methodology begins by exploring the theoretical framework and state-of-the-art in the area of study; this activity is constantly repeated in the development of each stage. The methodology primarily consists of four stages divided into chapters, each of which follows the format of the paper and refers to the respective specific objective. Each stage provides the elements for establishing the proposed financial mechanism. Finally, chapter five describes the main conclusions, limitations, and recommendations; it also identifies future research lines. Each step is described below.

Stage 1→ Chapter 1
Through a bibliographic analysis of the primary specialized and high-impact sources (especially journals categorized in the Journal Citation Reports (JCR)), the most important elements that allow the construction of the theoretical framework, state-of-art, advances, trends and elements of theoretical and practical relevance of eco-innovative financing to develop social and sustainable infrastructure projects are identified and classified. Emphasis is placed on Public-Private Partnerships and Project Finance as mechanisms to develop infrastructure. From there, different lines of research are identified; they provide analysis and discussion elements on the reality of developing infrastructure projects.

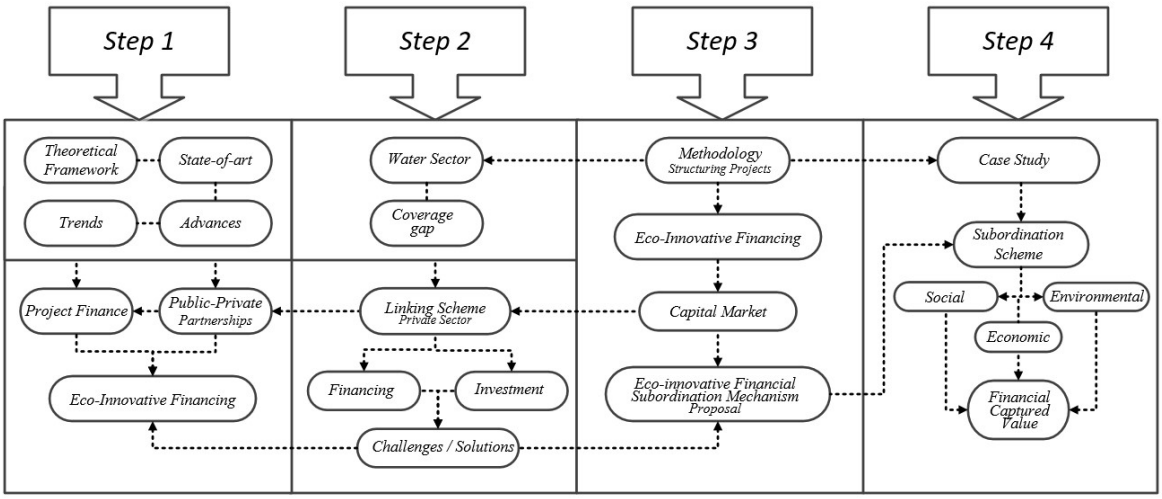
Stage 2→ Chapter 2
The current situation of Colombia's water sector is studied. An analysis of the relation between PPPs and PF is included in the development of water and sanitation infrastructure projects. In addition, solutions are proposed through the identification of the main challenges.

Stage 3→ Chapter 3
The eco-innovative financial subordination mechanism proposed is integrated under a structuring methodology for sustainable infrastructure projects. In addition, the main financial mechanism for developing Sustainable Infrastructure Systems (SIS) is analyzed. In this way, a new methodology of sustainable financing is proposed that includes the participation of the public-private sector and the capital market. In designing the mechanism, structured finance is used as an instrument for design and valuation. Therefore, the methodological contribution is prescriptive and based on the problem raised, the incorporation of quantitative and qualitative elements occurs at this stage.

Stage 4→ Chapter 4
A case study is used to describe the integration between the eco-innovative financing mechanism and Colombia's water sector.

The methodology used in this research is shown below.

Figure 0-2: Research Methodology



Source: Author's elaboration

Expected results

Contribution to the Financial Area
The financial mechanism framed in the development of sustainable infrastructure projects will help to the expansion of the private sector financing/investment strategies. In addition, this research contributes to the knowledge area on the relations of structured finances as sustainable financing mechanisms leading to advances in the state-of-art, regarding the development of infrastructure projects. The proposed contribution, according to the revised literature, is unprecedented and innovative.

Contribution to the Water Sector
The research's proposed financial mechanism contributes to the water sector in Colombia with the objective of increasing the private sector's participation. It will also help a large population to have access to water and sanitation services. This mechanism could be extrapolated to other countries. Likewise, the proposed methodology can help the public-private relation by establishing best practices in structuring infrastructure projects.

Contribution to Sustainable Development

The financial mechanism will allow the development of sustainable infrastructure projects to be promoted, which follow the current eco-friendly investment trends.

Academic Contributions

The findings within this dissertation will contribute to literature including the publication of scientific papers, book chapters, and presentations at important academic events. The following table shows the results obtained during the research process.

Table 0-1: Academic contributions

Product	Title	Journal/Event	Authors
Paper	Financial eco-innovation as a mechanism for fostering the development of sustainable infrastructure: The Colombian case	Sustainability: Science, Practice, and Policy Indexed by: Scopus. SJR: 0.636 Quartile: Q1. A1 Category - Colciencias. In Peer Review Process.	Juan D. González, Carlos A. Arboleda Sergio Botero
Paper	A Proposal for Green Financing as a Mechanism to Increase Private Participation in Sustainable Water Infrastructure Systems: The Colombian Case	Procedia Engineering – Elsevier. 2016. Vol. 145. Pag. 180-187 Indexed by: ScienceDirect. Scopus. SJR: 0.238. A2 Category - Colciencias.	Juan D. González, Carlos A. Arboleda Sergio Botero
Conference Paper	Financiación de Proyectos de Infraestructura Sostenible Bajo Asociaciones Público-Privadas: Caso Colombia	VI Congreso Iberoamericano de Proyectos 2015. Organize: Red Iberoamericana de Ingeniería de Proyecto - RIIPRO	Juan D. González, Carlos A. Arboleda Sergio Botero
Paper[1]	Social Infrastructure Development: The Case for Private Participation in Potable Water Supply in Colombia	PM World Journal. Vol. IV. Issue X. October. 2015. Indexed by: EBSCO. Affiliate: Project Management Institute (PMI)	Juan D. González, Carlos A. Arboleda Sergio Botero
Conference Paper[1]	Social Infrastructure Development: The Case for Private Participation in Potable Water Supply in Colombia	Project Management Symposium Organize: University of Maryland. 2015 Accredited Program: Project Management Institute (PMI)	Juan D. González, Carlos A. Arboleda Sergio Botero
Paper	Project Finance y Asociaciones Público-Privada para la provisión de servicios de infraestructura en Colombia	Obras y Proyectos. Chile. No. 16. Pag. 61-82. Diciembre 2014. Indexed by: Web of Science – Thomson. Scielo. Latindex y Dialnet. A1 Category Colciencias. Impact Factor: 0.03	Juan D. González Miguel D. Rojas Carlos A. Arboleda Sergio Botero
Conference	Project Finance: Estrategia para Financiar Proyectos de Inversión.	Seminario Financiero. 2014. Organize: Facultad de Ciencias Económicas. Universidad de Antioquia.	Juan D. González
Conference	Situación Actual y Tendencias en Project Finance y Asociaciones Público- Privadas	VI Simposio Internacional de Economía y Finanzas. 2014. Organize: Escuela de Economía y Finanzas. Universidad EAFIT	Juan D. González, Carlos A. Arboleda Sergio Botero
Conference	Inversión en Infraestructura Social. Project Finance y Asociaciones Público-Privadas. Oportunidades de Inversión en Agua y Saneamiento.	XI Salón del Inversionista. 2014. Organize: Facultad de Ingeniería. Universidad de Medellín.	Juan D. González, Carlos A. Arboleda Sergio Botero
Conference	Asociaciones Público-Privadas y Project Finance Una Introducción	Course: Gestión Pública. 2013. Organize: Universidad Nacional de Colombia. Facultad de Minas.	Juan D. González

[1] This paper was presented at the Project Management Symposium 2015 - University of Maryland and republished by PM World Journal as one of the best papers presented.

Other products related to the development of infrastructure projects and derivatives of the research process are shown in the following table; it constitutes a continuation of Table 0-1.

Product	Title	Journal/Event	Authors
Paper	Current Situation of the Funding Process of Highway Projects in Colombia: Outlook and Challenges	ITE Journal. Institute of Transportation Engineers. (2017). 96(10). Indexed: IB-SCI, Scopus. SJR: 0.137. Quartile: Q3. A2 Category - Colciencias.	Juan D. González Eduardo Duque Sergio Botero
Paper	A conceptual framework for the financing of rural highways in Colombia through shadow toll schemes	Advances in Transportation Studies (ATS). 2017. XLI April. Indexed: Scopus. SJR: 0.285. Quartile: Q2. Categoría A2 Colciencias.	Juan D. González Carlos A. Arboleda Sergio Botero Eduardo Duque Javier Rojo
Paper	Green Airport Infrastructure in Colombia: Opportunities for Public-Private Partnerships Schemes	Pertanika Journal of Science & Technology. 2017. Indexed: Scopus, ISI Web of Science Thomson, EBSCO, DOAJ. SJR: 0.153. Quartile: Q3 A2 Category - Colciencias.	Juan D. González, Eduardo Duque Juan Carlos Restrepo
Paper	Modelo de decisión multicriterio difuso para la selección de contratista en proyectos de infraestructura: Caso Colombia	Obras y Proyectos. Chile. No. 20. Diciembre 2016. Indexed: ISI Web of Science – Thomson. Scielo. Latindex y Dialnet. A1 Category Colciencias. Impact Factor: 0.03	Julián Mayor Sergio Botero Juan D. González
Paper	Developing Sustainable Infrastructure for Small Hydro Power Plants through Clean Development Mechanisms in Colombia.	Procedia Engineering – Elsevier. 2016. Vol. 145. Pág. 224-233 Indexed: ScienceDirect. Scopus. SJR: 0.238. A2 Category - Colciencias.	Eduardo Duque Juan D. González, Juan Carlos Restrepo
Book Chapter	Clean Development Mechanism in Airports: The Colombian Case	Advancement of Construction Management and Real Estate 2016. Published by: Springer. Top Category - Colciencias. Editor: Chinese Research Institute of Construction Management (CRIOCM)	Juan D. González, Eduardo Duque Juan Carlos Restrepo
Book Chapter	Project Finance y Capital Riesgo: Aplicación en la Financiación de Proyectos de infraestructura	Finanzas y Modelación Vol. II. Pag. 91-119. Editorial Universidad de Medellín. 2015. Top Category - Colciencias.	Juan D. González, Eduardo Duque Leonel Arango
Sector Report	Lecciones Internacionales y Retos Locales en Proyectos de Infraestructura	Colcapital Report Section: Estudios Económicos. 2015.	Juan D. González Colcapital. Asociación Colombiana de Fondos de Capital Privado.
Paper	Propuesta de un Modelo Financiero para la Evaluación de la Inversión de un Aeropuerto bajo Asociación Público-Privada	Lámpsakos. 2014. Vol. 11. Pág. 29-37. Indexed: DOAJ. Latindex. Dialnet. CiteFactor. EBSCO. C Category - Colciencias.	Juan D. González Sebastián Echeverry Diego Ospina

1. FINANCIAL ECO-INNOVATION AS A MECHANISM FOR FOSTERING THE DEVELOPMENT OF SUSTAINABLE INFRASTRUCTURE

First-class arrangements and a consistent framework for financing sustainable infrastructure are fundamental for closing coverage gaps in infrastructure systems worldwide. Hence, formulating innovation in the financial context makes it possible to characterize the main aspects of funding process for developing infrastructure systems. Therefore, this paper aims to provide the fundamentals for analyzing sustainable financing from the financial eco-innovation perspective as a strategy to develop sustainable infrastructure, particularly in the Colombian water sector, where the largest gaps are found. This process is to pertinent to understanding the relations between eco-innovation and sustainable infrastructure financing. Furthermore, existing trends in PPPs and PF schemes are taken into consideration for developing sustainable infrastructure systems. To address this need, this paper holistically analyzes how the Triple Bottom-Line, as an aspect of financial eco-innovation, could boost the development of sustainable infrastructure. Thus, this paper will contribute to providing a foundation for new research topics.

Keywords: Eco-innovation; Sustainable Infrastructure; Financing Process; Projects; Investment.

1.1 Introduction

There is a growing need to develop sustainable projects and address coverage gaps in social infrastructure in Colombia. The empirical evidence obtained thus far regarding the positive relationship between Public-Private Partnerships (PPPs) and Project Finance (PF), as reported by Farquharson et al. (2011), Arundel and Kemp (2009), Andersen (2002), Yescombe (2007), Esty (2003, 2004) and Gatti (2013), suggests a need for more detailed analyses of the financing process. Doing so would allow for the characterization of strategies and the creation of eco-innovative financing mechanisms aligned with the Sustainable Development Objectives (SDGs). Seeking to increase coverage and quality in infrastructure systems, the Colombian government enacted the PPPs Law 1508 in 2012. Based on Project Finance (PF) schemes, it established the mechanisms for private sector participation and involvement in the development of public infrastructure. The law also seeks to maintain and operate existing infrastructure.

However, the development of social infrastructure projects in Colombia will require not only the inclusion of the private sector, the mobilization of financial resources and the development of the capital markets but also the creation of financial mechanisms that account for environmental, social and economic variables in the financing process.

According to the quarterly report from the Single Registry of Public-Private Partnerships, which was published in December 2016, the private sector is highly involved in the structuring of economic infrastructure projects. For example, for roads, trains and airports 83, 18 and 9 PPPs, respectively; for social infrastructure, water and sanitation projects, sports and education have 23, 5 and 12 PPPs, respectively (Dirección Nacional de Planeación - DNP -, 2016a). There are significant gaps in the drinking water and sanitation sector, especially in rural areas where there is 73% aqueduct coverage and 70% sewerage coverage. This coverage gap, coupled with low private sector investment (20% in recent years) (Dirección Nacional de Planeación - DNP -, 2017), highlights the need to improve the inclusion of the private sector through new financial mechanisms.

As a result, efforts to close the coverage gap and develop sustainable infrastructure should seek to transform policies to target the inclusion of the private sector; doing so will lead to a reorientation of the investment and financing process toward market mechanisms to promote sustainable development. Therefore, increasing social infrastructure coverage through eco-innovative mechanisms represents an important challenge for Colombia.

Additionally, as financial investment decision-makers are increasingly incorporating sustainability criteria, the relatively new concept of sustainable finance, which falls under the umbrella of eco-innovation, is progressively becoming more important in the financing process (Wilson, 2010). The idea of conceptualizing and deepening the relationship between sustainability and finance is supported by Schumpeter (1942); who argues that finance is vital for technological innovation and economic development.

Since the PPPs and PF approaches to social infrastructure is a relatively recent trend (Jefferies and Mcgeorge, 2009), there is an opportunity for the creation and characterization of eco-innovative financing strategies to help to measure the impact of economic, environmental and social sustainability factors on financial results. Thus, exploring eco-innovation mechanisms can generate new insights into the drivers of environmental innovation at the enterprise level (Triguero, Moreno-Mondéjar, and Davia, 2013); therefore, it is necessary to encourage research in this field (del Río, 2009).

In general terms, infrastructure systems encompass a set of engineering structures, equipment, and facilities with a long service life that constitute the basis on which services are provided to productive sectors and households. These systems can be classified according to their function: social or economic. The former makes it possible to meet basic needs related to education, health, and recreation, while the latter focuses on economically productive sectors (Perrotti and Sánchez, 2011).

Table 1-1: Type of infrastructure, sector, and projects.

Infrastructure	Sector	Projects
Social	Water and Sanitation	Aqueduct, sewage, solid waste, sewage treatment, and reservoirs.
	Education and Health.	Schools, universities, hospitals, and health centers
	Justice	Prisons and courts
	Public Buildings	Public sector and judiciary offices
	Sports and culture	Museums, parks, recreation, and cultural center
Economic	Energy	Power generation and supply.
	Transport	Toll roads, ports, airports, railway systems, bridges, and tunnels.
	Telecommunications	Telephony, networks, and satellites

Source: Author's elaboration based on Grimsey and Lewis (2002) and Perroti and Sánchez (2011).

According to Jefferies and McGeorge (2009), as social infrastructure projects are smaller in scale and more complex to operate than are economic infrastructure projects (particularly because of the amount of money invested and community participation), the private sector often finds that the financial rewards do not meet the operational requirements.

Additionally, although these typically have smaller contract sums than economic PPPs, they pose proportionally higher legal costs; as a consequence, the private sector can be deterred from participation by the high transaction costs of social PPPs (Jefferies and McGeorge, 2009). This is why they require more attractive inclusion processes and greater risk transfer to the public sector (Curnow, Jefferies, and Chen, 2005; Jefferies and McGeorge, 2009).

The present research has been conducted under the assumption that, due to the increasing development of both social and economic infrastructure, it is vital to develop eco-innovative financing schemes that allow for operational viability, an equitable distribution of risks, and greater benefits for stakeholders (Jefferies and Mcgeorge, 2009) through sustainable financing schemes. In this context, it is important to note that the fiscal constraints faced by developing countries, in particular, preclude the private sector from developing public infrastructure (González-Ruiz, Arboleda, and Botero, 2015b).

Thus, to establish a stronger relationship between sustainability and finance, this research also seeks to explain how to develop the principles of eco-innovative financing with an emphasis on social infrastructure in response to the growing interest of the scientific and business world in this emerging field (Karakaya, Hidalgo, and Nuur, 2014). The present work will also improve understandings of the relationship between sustainability and finance (Boons and Wagner, 2009; Przychodzen and Przychodzen, 2015).

The main contribution of this paper is to theoretically identify the foundations of financial eco-innovation and articulate them to advance the development of social and sustainable infrastructure. In addition, it presents the basis for developing a capital market through the creation of investment / financing products for social infrastructure projects.

Consequently, based on a systematic search methodology, this paper analyzes the scientific literature on the main components of financial eco-innovation and their relation to the development of sustainable infrastructure in the water sector in Colombia. In addition, this paper presents potential future research topics derived from the analysis.

The paper is organized as follows: after this introduction, eco-innovation is presented in the financial context of infrastructure development. Next, the paper analyzes the financing of sustainable infrastructure for the water sector in Colombia. Then, the main elements of PPPs and PF relevant to infrastructure development are presented, particularly social infrastructure, and describes the current situation and trends in financing. Finally, conclusions are presented along with future research topics derived from the analysis.

1.2 Financial eco-innovation

According to Mostafavi, Abraham, and DeLaurentis (2011) and Mostafavi et al. (2012), financial innovation emerged to complement traditional financing structures that had already become insufficient to meet the growing need to maintain and restore infrastructure and close the financing gap. Furthermore, those authors note that sustainable financial innovations are based on the analysis of policies and the integration of various participants; they argue that the financing process includes various activities including interactions among governments, local agencies, and public-private sectors.

Similarly, innovative financing (such as securitization, one of the most commonly applied innovations in the 1980s), has been intended to expand the supply of financial instruments to complement traditional sources and meet existing needs (Fabozzi, 2001); it also provides mechanisms to capitalize projects when traditional sources are unavailable because of high investment risk (Blanch, 2011).

An innovative financing instrument is characterized by introducing or improving a product that allows for the creation of new markets and, therefore, attracts new entrants (Dalberg, 2014). According to Blanch (2011), financial innovations are defined as any development, combination or modification of financial instruments or any element of the financial system (institution, regulation, or market).

Thus, mechanisms such as PPPs, credit enhancement tools and fixed-income financing instruments (such as bonds) have emerged to complement traditional approaches such as leaseback, expected revenues and availability-based payment mechanisms (Mostafavi et al., 2012); the latter is included in Law 1508 (2012), which regulates the use of PPPs in Colombia (Congreso de Colombia, 2012b). Other approaches categorized as green financial products include eco-leases and climate mortgages (Arundel and Kemp, 2009; Ozusaglam, 2012).

From an economic-financial perspective, the role of innovation is one of the main areas of study for researchers from various disciplines; nevertheless, theoretical and methodological approaches to understanding eco-innovations remain limited (Faber and Frenken, 2009; Rennings, 2000), and discussions on these topics are based on the neoclassical tradition, namely, on environmental economics, innovation economics and ecological economics (Karakaya et al., 2014).

Although the definition of eco-innovation has been widely discussed in various disciplines, there is no common definition of the concept in literature (Carrillo-Hermosilla et al., 2010; Hojnik and Ruzzier, 2016). At present, due to the multidisciplinary nature of the term, which has led to the use of different terminologies for the same approach or subject (Bossle et al., 2016), eco-innovation is used as a synonym for "green innovation", “sustainable innovation” and “environmental innovation” (Hojnik and Ruzzier, 2016; Schiederig, Tietze, and Herstatt, 2012). The most prominent definitions of these concepts in the literature share elements related to eco-innovative financing, which are shown in Table 1-2.

Table 1-2: Relations on financing eco-innovation with the most definitions

Authors / Element	Green financial innovation	Creation of a new market, product, process or service	Processes of innovation towards the sustainable development
Arundel and Kemp (2009)	x	x	x
Andersen (2002)	x	x	
Rennings (2000)	x	x	x
Little (2005)		x	x
Porter and Linde (1995)			x
Karakaya et al. (2014)		x	x
Yang and Yang (2015)		x	x
Polzin et al. (2016)		x	x
European Commission (2007)		x	x

Source: Author’s elaboration

In one of the more explicit definitions, Rennings (2000) emphasizes that eco-innovation can be present at a technological, organizational, social or institutional level in companies or non-profit organizations. Given its interdisciplinary approach, it can be located between economic innovation and environmental economics. However, according to some ethical and responsible investment theorists (Heinkel, Kraus, and Zechner, 2001; Renneboog, Ter, and Zhang, 2008), sustainable investments (which involve financial eco-innovations) make it possible to broaden the population of investors beyond traditional investors, who only consider financial criteria in making investment decisions, to include socially responsible investors, who also consider non-financial criteria.

Thus, the availability of sustainable investments will demand the inclusion and, therefore, development of socially responsible financial products (Przychodzen and Przychodzen, 2015). This is highlighted by Linnenluecke et al. (2016), who note that investments with an environmental component are becoming a trend in empirical research. In response to this, and with the aim of validating the "it pays to be green" hypothesis, a growing empirical literature has demonstrated (using econometric techniques) that strong environmental results are associated with better financial results (King and Lenox, 2001).

This finding is echoed in an in-depth study by Przychodzen and Przychodzen (2015), who report that eco-innovative companies generally have higher Returns on Assets (ROA) and Returns on Equity (ROE). Similarly, Clarkson et al. (2011) emphasize that improved environmental performance should lead to better future financial performance, as reflected in the ROA and the Operational Cash Flow (OCF), as well as in a higher value of the firm as measured by Enterprise Value (EV). They further note that good environmental performance reduces regulatory risks. Therefore, pursuing such improvements directly affects corporate valuation through a lower discount rate (Clarkson et al., 2011). An approximation of the above appears in a work by González Ruiz, Arboleda, and Botero (2016), who incorporate the green benefits derived from sustainable financing into the calculation of the Weighted Average Cost of Capital (WACC).

Consequently, because of the transition toward low-carbon economies, the intersection of environment and finance is emerging as an interdisciplinary field of research (Linnenluecke et al., 2016). It provides opportunities for future research on how economic, social and environmental sustainability elements can lead to the development of new financing mechanisms. Therefore, innovating in green products can be a key factor in achieving higher growth rates for companies and a better quality of life for societies (Dangelico and Pujari, 2010).

From the perspective of generating new business models, the development of sustainable infrastructure offers a relevant setting for conducting new research that interrelates infrastructure, sustainability and finance seeking to close the coverage gap through business models that generate lower environmental impacts (and greater social and economic benefits than do traditional models) (Carrillo-Hermosilla et al., 2010). Therefore, the development of new business models and the appearance of green capital sources are considered the most important reasons for companies to turn toward eco-friendly investments (Laszlo, 2003).

Sustainable innovation can be understood as a process that includes environmental, social and financial sustainability factors and integrates them into the business development system, generating new business models and forms of organization. Thus, there is a demand for business models that link value creation with social and ecological consciousness in a balanced way (Martens and Carvalho, 2016).

Innovating financing instruments will enable the numerous cities that face difficulties obtaining financial resources to find options that will facilitate the development of projects that incorporate attractive climatic objectives for investors. In this respect, development banks play a critical role as fund providers to overcome existing monetary barriers (García, 2016). Thus, the development of financial mechanisms represents a means of alleviating financial constraints (Polzin et al., 2016), and therefore, it is important to have policies and regulatory frameworks that will address the financial gap and solve long-term financing problems (Kern et al., 2016).

Similarly, the debate on climate change and sustainable development has driven research processes to develop eco-innovations capable of reducing carbon emissions and promoting green economic growth (Polzin et al., 2016). However, financial barriers such as imperfect financial markets, scalability, the absence of financial assets and weak regulatory environments have stymied the generation and introduction of eco-innovations into the market (Marcus, Malen, and Ellis, 2013; Polzin et al., 2016). The main barriers are shown in Table 1-3.

Table 1-3: Main barriers and instruments to develop financial innovations

Barrier	Instrument	References
Associativity	PPPs and PF	Polzin et al. (2016) González-Ruiz et al. (2014)
Investment in Research and Development	Tax credits	Foxon and Pearson (2008) Czarnitzki (2011) González-Ruiz et al. (2016)
Institutional weakness	Regulation	Foxon and Pearson (2008)
Capital market development	Development of financing mechanisms Expand the base of issuers	Barbero et al. (2015) Polzin et al. (2016), Mostafavi et al. (2014) González-Ruiz et al. (2014) Marcus et al. (2013)
Funding sources	Private equity funds, Angeles Investors, Banks, PF, Mezzanine	Kern et al., (2016) González-Ruiz et al. (2016) Polzin et al. (2016) Weber and Rohracher (2012) Haley and Schuler (2011) Hendry et al. (2010)

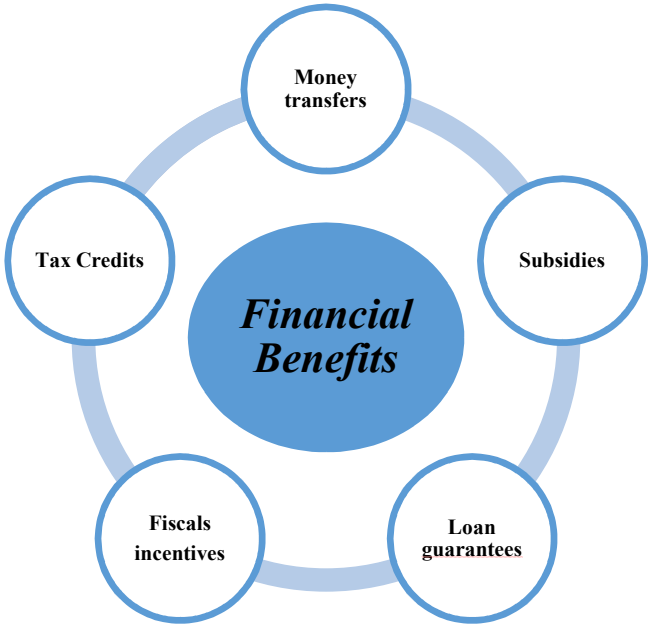
Source: Author's elaboration

The findings presented by Przychodzen and Przychodzen (2015), indicate that the ability to innovate in the financial field is relevant for the development of eco-innovations, as it broadens understandings of the implications of financial performance resulting from innovation. The larger a company is, the greater the extent to which the application and development of eco-innovations can reduce its environmental impact while satisfying interest groups (Hojnik and Ruzzier, 2016). Furthermore, the implementation of green practices by companies can satisfy and maintain financial support from interest groups (Govindan et al., 2015).

Thus, further research is needed to explore how the underlying characteristics of financing processes impact the relationship between companies' sustainable and financial performance (King and Lenox, 2001), as innovation could deliver both financial (based on fiscal incentives) and environmental benefits (based on reduced carbon emissions, as well as subsidies, money transfer, loan guarantees or tax credits) for boosting the development of sustainable infrastructure (Ozorhon, 2013; Polzin et al., 2016). Figure 1-1 presents the main financial incentives for boosting the development of sustainable infrastructure through private participation

Although the transition to a greener economy has highlighted the importance of financial innovations, these have not been fully addressed (Polzin et al., 2016). Therefore, a funding framework that includes PPPs and PF schemes is crucial in the transition toward the development of eco-innovations (Leete, Xu, and Wheeler, 2013; Moore, Westley, and Nicholls, 2012; Polzin et al., 2016)

Figure 1-1: Main incentives to encourage private participation



Source: Author's elaboration based on Polzin et al. (2016) and Ozorhon (2013).

Based on this review, it is unclear whether the literature includes criteria to determine whether there is any relative subordination of economic, social or environmental sustainability elements in the structure of financing schemes, particularly with respect to paying debt service or transforming debt into equity shares. Thus, the development of new innovative financial instruments that articulate such variables will allow for the expansion of the investment population in the social infrastructure sector (in which coverage gaps are broad and there are no incentives to promote the involvement of the private sector).

1.2.1 Sustainable infrastructure: the water sector in Colombia

To satisfy the SDGs related to the construction of sustainable infrastructure (Objective 9), clean water and sanitation availability (Objective 6) and increasing investments in rural infrastructure (Objective 2), it is necessary to mobilize national and international financial resources in cooperation between the public and private sectors (Naciones Unidas, 2015). In the contemporary world, sustainable investment practices are transforming private equity, demonstrating that positive returns and social, environmental and economic impacts can be jointly considered.

In the operation of water and sewer systems in Colombia, energy consumption can range from 10% to 40% of the total costs, and as a whole, these systems represent nearly 9% of national energy demand; as a result, the government is greatly motivated to develop energy efficiency mechanisms, which allow projects to generate energy from unconventional sources such as solar. Doing so will improve the country's sustainability and competitiveness, which is an objective of the Colombian Low Carbon Development Strategy Framework (Ministerio de Ambiente de Colombia, 2016; Ministerio de Vivienda de Colombia and Andesco, 2016).

Furthermore, inefficiency in machinery and equipment, water losses, and operational inefficiencies can increase energy consumption and, in turn, greenhouse gas production, which adversely impacts the country's carbon footprint. Therefore, investment in modernization and the implementation of renewable energy technologies in potable water and sanitation services would contribute to obtaining operational and financial benefits with a high impact on sustainability and service quality in addition to generating a return on investment within months or a few years (Ministerio de Vivienda de Colombia and Andesco, 2016). Recognizing these considerations, in 2004, Law 1715 allowed the implementation of unconventional energy projects to power water transmission.

The following are the main tax incentives to develop non-conventional energy (Ministerio de Vivienda de Colombia and Andesco, 2016), which would impact the development of sustainable infrastructure for the water sector in Colombia:

- A 5-year income tax reduction of 50% on such investment, not to exceed 50% of net income.
- A VAT exemption on domestic or imported equipment, machinery and services for the generation, measurement and evaluation of promising projects.
- A tariff exemption for imported equipment, materials and supplies.
- An accelerated depreciation rate greater than 20% per year.

As infrastructure can affect carbon emissions (Serebrisky, 2014), Colombian faces the challenge of developing investment and financing mechanisms that allow for the development of infrastructure that will generate lower greenhouse gas emissions without compromising financial viability. This goal is supported by the National Development Plan of Colombia 2014-2018, which proposes conducting research and development on products that contribute to sustainable development and green growth through new mechanisms and instruments (Congreso de Colombia, 2015a). It is crucial that developing countries take actions to guarantee environmental and financial sustainability, independent of developed countries' economic and policy conditions (Ventura et al., 2015).

In pursuit of these objectives, it is necessary to adjust the investment and financing process such that actors with high credit ratings can participate by consolidating the funding requests into groups and structuring debt securities (possibly bonds designed to adapt to regulatory conditions) (Barbero et al., 2015). Consequently, the creation of financial products to develop sustainable infrastructure in Colombia's water sector would create the opportunity to open a climate futures market. In Colombia, there is no organized market or Over the Counter (OTC) market for climate derivatives (Hernández, 2013).

Therefore, the failure to integrate the environmental and social dimensions into the process of generating infrastructure (beginning with planning) would be an error with long-term consequences, given the long life-cycle of infrastructure (Serebrisky, 2014).

As a real-world example, the La Guajira region (which is characterized by geographical and social difficulties) currently uses unconventional mechanisms to generate detailed energy from 124 water sources: 59 solar, 39 wind, 5 regular and 20 mixed (regular and solar) projects (Ministerio de Vivienda de Colombia and Andesco, 2016). The first pilot plant is an innovative water purification system that uses solar energy to treat salt water and make it fit for human consumption. It is located in the Kamusuchiwo indigenous community, located north of La Guajira, 30 minutes from the Cabo de la Vela and home to around 100 people. It has 12 distillers, 6 solar panels, a solar pump and a raised tank. It is capable of holding 500 liters of seawater, which is processed to produce 100 liters of drinking water. The investment made in this pilot plant amounted to COP 200 million pesos and was financed by the Cerrejón Foundation and USAID (The United States Agency for International Development) (UPME, 2015).

Furthermore, the construction of sustainable water treatment plants will allow for the capture of methane gas to generate energy. This will mitigate emissions related to climate change and, in turn, have positive effects on the operational efficiencies of the infrastructure projects.

For example, in the "Aguas Claras" Wastewater Treatment Plant (WTP) Project, which is being built by Aguas Nacionales SA, in the municipality of Bello - Antioquia, up to 30% of the electricity will be generated from methane gas; moreover, the action of its turbines, will generate energy equal to 53% of the total necessary for the WTP to operate at maximum capacity. As a result, approximately 83% of the total energy required will be produced by self-generation. In this way, the inclusion of biological processes in the generation of energy in the WTPs is designed to reproduce, in a controlled way, natural mechanisms, for example, microorganisms that decompose organic matter into inert mineral products. Thus, there are aspects of the design and operation of a WTP that substantially influence its environmental performance, particularly with respect to greenhouse gas (GHG) emissions. There are three factors that determine the carbon footprint of this type of project (Nolasco, 2010):

- Methane emissions
- Nitrous oxide emissions
- Energy consumption from external sources (which entail GHG-emitting power generation systems).

Table 1-4 reports the methodologies approved by the United Nations Framework Convention on Climate Change (UNFCCC) for mitigating the effects of climate change using WTPs. Table 1-4 provides examples of WTPs that have applied the AMS III.H methodology.

Table 1-4: Methodologies approved by the UNFCCC.

Methodology	Baseline	Potential Projects
AMS III.E – Abatement of methane production by degradation of biomass through controlled combustion, gasification or mechanical/thermal treatment.	Organic waste (e.g. biological sludge) is disposed of in landfills with no methane capture system.	Controlled combustion - Gasification - Mechanical / thermal treatment.
AMS III.F – Abatement of methane emission by controlled biological treatment of biomass.	Organic waste (e.g. biological sludge) is disposed of in landfills with no methane capture system.	Aerobic composting · Anaerobic digestion (with methane capture system).
	Anaerobic wastewater treatment.	Aerobic co-composting of wastewater with organic solid waste.
AMS III.H – Methane recovery in wastewater treatment.	Anaerobic treatment of wastewater or sludge, without methane capture system.	The addition of a sequential stage based on an anaerobic reactor with a methane capture system to the existing anaerobic lagoon system. Installation of a methane capture system in the existing treatment system.
	Untreated wastewater is discharged into a water course with low dissolved oxygen contents.	Installation of an anaerobic treatment system with a methane capture system.
	Untreated sludge	Installation of an anaerobic treatment system with a methane capture system.

Source: Author's elaboration based on the UNFCCC (2017).

1.2.2 PPPs and PF to develop social and sustainable infrastructure

According to Guasch (2004) and Saussier (2013), the participation of the private sector through PPPs in the development of social and economic infrastructure is motivated by the need to improve the functioning and coverage of goods and services. Given the scarcity of public funds and restricted debt capacity, some countries have elected to transfer the provision of infrastructure to the private sector (Alonso-Conde et al., 2007; Jin y Zhang, 2011; Thomson et al., 2005; Zhang y Durango-Cohen, 2012). This action contributes to improving levels of quality and coverage, which have a substantial effect on economic growth and poverty reduction.

In order to achieve the SDGs, public-private investment is necessary at all levels and in all sectors, particularly to develop social infrastructure, where the greatest gaps in coverage exist (González Ruiz et al., 2016; Naciones Unidas, 2015). Thus, infrastructure that incorporates sustainability elements in regions with insufficient development must be implemented through public-private participation mechanisms (González-Ruiz, Arboleda, and Botero, 2015a; Ponomarenko et al., 2016). Therefore, social infrastructure development is expected to benefit from PPPs (Presidencia de la República de Colombia, 2015).

According to Martens and Carvalho (2016), the most widely applied concept related to sustainable development is known as the Triple Bottom-Line (TBL), developed by Elkington (1998). It integrates the economic, environmental and social dimensions. The TBL concept suggests that organizations should devote attention not only to financial behavior but also to the social and environmental benefits that can be obtained from a project (Martens and Carvalho, 2016). Thus, when the TBL is used, the economic, social and environmental aspects of a project are better integrated (Martens and Carvalho, 2016).

Regarding the project management field, Carvalho and Rabechini (2011) discuss the importance of incorporating these sustainability dimensions into the practice of project management. In this way, the intersection of project management and sustainable development has been attracting attention from scholars and practitioners (Silvius, Schipper, and Nedeski, 2013). A sound funding framework for SDGs should be based on a clear understanding of the complementary roles of public and private funding and how the two can be combined to achieve complex long-term social objectives (Schmidt-Traub and Sachs, 2015). Previous work on PPPs and PF indicates that it is essential to use financial mechanisms that include public and private funds such as PPPs based on the risk/return profile combined with grants and various other funding sources (Polzin et al., 2016).

Although the first PPPs and PF guides to sustainable development were developed several years ago (in 2002), while they integrated environmental considerations into the different stages of projects (Zhou, Keivani, and Kurul, 2013), they did not directly include aspects related to financing. Thus, the broad field of PPPs allows for the development of complex innovations characterized by substantial uncertainty, such as eco-innovations (Polzin et al., 2016). Then, PPPs mechanisms, which are innovative by nature, play a fundamental role in financing development since they leverage private funding sources to support the provision of public utilities (Schmidt-Traub and Sachs, 2015). Note that PF offers real possibilities to promote sustainable development (Zhou et al., 2013).

As a result of the above (and thanks to climate change), there is enormous potential for linking public support and private finance to developing eco-innovations (Mowery, Nelson, and Martin, 2010). However, lenders, such as private equity funds and banks, are unable to incorporate the complexity of eco-innovation processes to develop infrastructure due, in particular, to the underdevelopment of capital markets (Polzin et al., 2016). Therefore, the development of new financial products should be aligned with the development of capital markets.

Accordingly, Estache, Serebrisky, and Wren-Lewis (2015) argue that a common problem reported in economic research is that financing infrastructure projects has remained a secondary consideration. Such aspects (for example, how to design funding structures) are among the main concerns of literature on PF. More detailed research on this subject is reported by Gatti (2013). Whereas the public sector has recognized the obvious relationship between PF and sustainable development, effective tools to assist decision makers in the integration and measurement of sustainability throughout project processes are insufficient (Zhou et al., 2013).

Therefore, it is necessary to increase the current levels of investment by promoting improvements in infrastructure and assigning greater priority to the implementation of financing mechanisms linked to climate change and sustainable development (Barbero et al., 2015).

1.3 The current situation and trends in financing

In financing PPPs developed through PF, the scope of financial institutions is not limited to providing financial resources, and financial advising has become more important (González, 2006). Financial institutions act as both lenders and as counselors that provide knowledge and experience. Regarding capital structure, in the infrastructure projects studied by Esty (2000), which were financed using PF schemes, the debt participation represented between 65% and 90% of total investment, while the corresponding figure for typical industrial firms varied between 25% and 35%.

In the Colombian case, a study by González-Ruiz et al. (2015a) conducted in the transport sector indicates that debt participation as a share of total investment was 71% while in the potable water sector, the corresponding figure was 29.7% (Comisión de Regulación de Agua Potable y Saneamiento - CRA, 2014). This demonstrates that it is necessary to strengthen financing processes in the water sector to allow for greater financial benefits, and doing so requires improvements in existing debt instruments and the development new ones that allow for an increase in private participation. These facts endorse the main purpose of the present work.

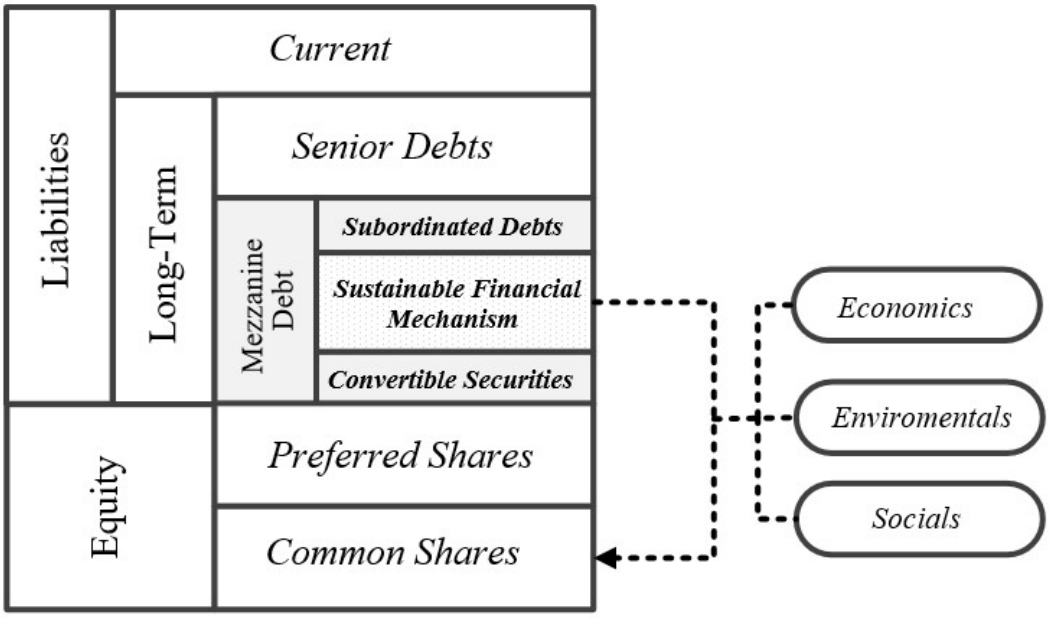
In this way, Hoon et al. (2009) state that the capital structures of most PPPs developed through PF have a high degree of leverage representing debts between 90% to 70% and equity capital between 10% and 30% of total project cost. Furthermore, Akintoye and Beck (2009) affirm that PPPs are usually financed through a combination of capital and debt in various proportions; however, debt financing usually exceeds 70%, and sometimes, it reaches 100%.

The trend in financing is to incorporate mezzanine debt into leverage structures (Croce and Gatti, 2014; Gatti, 2013; Mascareñas, 2011; Nijs, 2014). Mezzanine debt (also called mezzanine financing) is a form of subordinated debt because its payments are subject to payments to senior debt holders having been satisfied; this makes it riskier than senior debt but less risky than equity invested in by sponsors. Thus, payment is made after the senior debt and before dividends are distributed (Gatti, 2013; Mascareñas, 2011; Nijs, 2014). These resources can be provided by sponsors, institutional investors, specialized funds and even multilateral agencies (World Bank, 2014), and although they are used in other forms of structured finance, they have not been widely used in PF (Yescombe, 2007).

Figure 1-2 depicts an initial proposal for how mezzanine debt could work in this context. A sustainable financial asset is structured in a way that includes elements of both subordinated debt and convertible security, and thus, it is located between these two products. Consequently, the payment of interest and capital will be subordinated to sustainability criteria and, if present, the

senior debt payment. Likewise, the conversion of outstanding debt into equity shares will be subordinated to sustainability criteria; lenders will be able to exercise this option when the goals and covenants related to the sustainable criteria are accomplished, which must be specified in the deal.

Figure 1-2: Proposal for mezzanine debt subordinated to sustainability criteria



Source: Author's elaboration

For Colombia, this approach represents an opportunity to explore and develop structured financial products that promote the diversification of funding sources and sustainable development and, thus, promote the involvement of private investors. However, migrating to new forms of financing entails challenges related to the development of capital markets and the introduction of specialized investors. Successfully completing these objectives would close the coverage gap, mitigate the effects of climate change (based on reductions in CO_2 emissions) and develop capital markets. Therefore, it would also be possible to create a securities market indexed to sustainable infrastructure projects.

Thus, structuring a capital market for sustainable infrastructure projects is a considerable challenge for Latin America, particularly for Colombia, due to the absence of a solid financing framework and the limited numbers of issuers and investors. These limitations hamper the circulation of capital and the development of investment and divestment strategies by the private sector (Barbero et al., 2015; Del Valle, 2015; González-Ruiz et al., 2016). The present research contributes to expanding existing knowledge on and expanding funding frontiers for infrastructure projects.

1.4 Conclusions

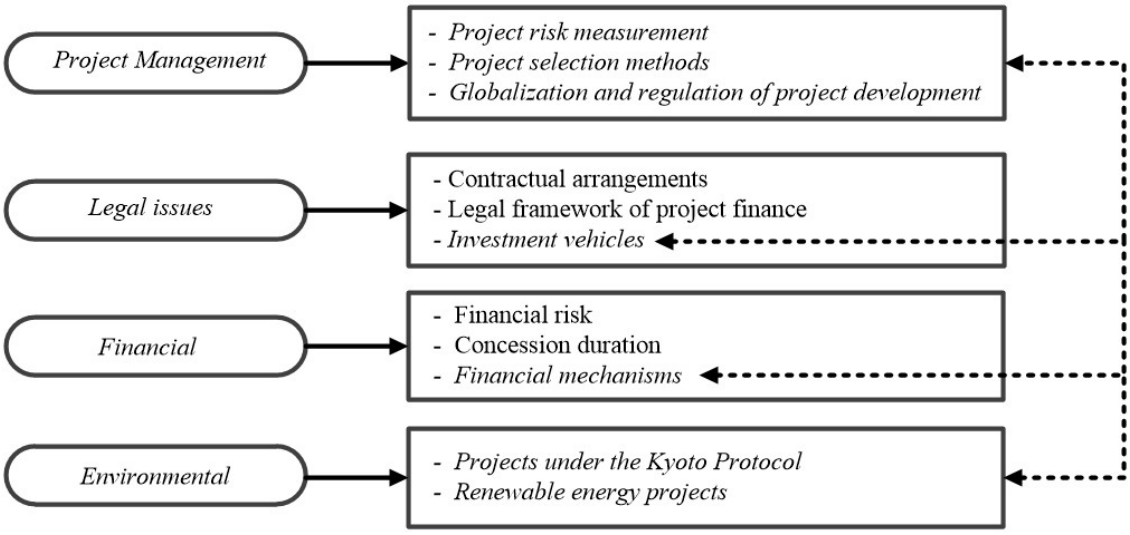
According to Kleimeier (1995) and Gatti (2013), research on developments in finance related to PPPs and PF remains limited in both theory and empirical application. To highlight the importance of research on these subjects, Esty (2004) notes the academic and practical benefits that could be obtained through the capacity to conduct research in a productive and informative environment. A review of the literature indicates that there are few publications on PF or corporate finance texts that include this topic.

Research on PPPs and PF is encouraged by the potential for developing new financial theories; there is considerable potential in this field for quantitative and descriptive research, particularly in developing economies (Esty, 2004) such as Colombia, where infrastructure projects are developing at an exponential pace. Given the necessity of identifying innovative solutions and new approaches to financing infrastructure projects (in particular social projects), such advances may include identifying new ways of blending different financing mechanisms with approaches capable of closing the financial viability gap through the creation of more innovative mechanisms that incorporate economic, social and environmental variables (World Bank, 2012a).

Therefore, since research on large infrastructure projects can generate an academic vision that contributes to improving current practice (Esty, 2004), accurately identifying the effect of PF and PPPs' efficiency in the infrastructure sector offers an important pathway for future research (Kleimeier and Versteeg, 2010) . Furthermore, from an academic perspective, PPPs have not been extensively studied (Sausser, 2013). Despite the growing international importance of PF for financing large-scale projects, there is a shortage of studies in this area (Girardone and Snaith, 2011). In short, there is a need for research to construct theories related to innovations in infrastructure financing as a strategic step toward the creation of new financing systems, as confirmed by Mostafavi et al. (2014). The trend in infrastructure financing processes centers on the development of hybrid financial mechanisms, based on a mezzanine-type debt, that allow for the joint consideration of economic, social and economic variables. These mechanisms will make it possible to expand the population of investors to those who consider, in addition to financial returns, other considerations based on sustainability issues.

Finally, and according to the research trend regarding PF and PPPs, Figure 1-3 summarizes the main topics (assembled into categories) present in the majority of publications, and it provides relevant ideas for the design of future research programs. This figure demonstrates the relevance of articulating (through research projects) project management, the creation of investment vehicles, the development of financing strategies and the construction of sustainable projects in accordance with the Kyoto Protocol and the SDGs. Therefore, developing eco-innovative financing mechanisms that will promote the construction of sustainable infrastructure and the involvement of private investors represents the future of research on PF and PPPs.

Figure 1-3: Topics and categories related to PF and PPPs for further research focused on SIS



Source: Author's elaboration based on Kayser (2013) and Tang, Shen, and Cheng (2010).

2. CURRENT STATUS OF PUBLIC-PRIVATE PARTNERSHIPS IN THE COLOMBIAN WATER SECTOR: PERSPECTIVES AND CHALLENGES

In order to close the coverage gap in the drinking water and sanitation sector and to address the growing need for the development of social infrastructure in Colombia, support from the private sector is fundamental. This paper analyzes and evaluates the conditions of the water sector in Colombia and proposes solutions to the main challenges, especially financial challenges. In this context, water and sanitation services are considered important components of social infrastructure according to the existing public utility standards in Colombia and Law 1508/2012 on PPPs. This analysis will provide the authorities with insights to implement new policies to encourage new private investors in social infrastructure projects. In addition, new funding mechanisms could be explored to diversify the provision of financial resources, including capital markets and multilateral agencies.

Keywords: Public-Private Partnerships; Water Sector; Infrastructure Projects; Financing; Colombia

2.1 Introduction

In recent decades, the drinking water supply sector in Colombia has experienced little change in how it operates and how it involves the private sector in the provision of this essential service. As a result, the coverage gap in drinking water supply has not been reduced. The consequence has been several deleterious environmental, economic and public health effects. For example, in rural areas (inhabited by the poorest segments of the population), polluted water sources and poor distribution networks have produced various gastrointestinal disorders, which have been responsible for 7.3% of infant mortality (Mejía et al., 2012).

Due to the coverage gap in water and sanitation services in Colombia, particularly in the rural regions, as discussed in the previous paper, the central government must create mechanisms that encourage the engagement of private investors in the development of projects in this sector. To encourage private sector participation, in 2012, the Colombian government enacted Law 1508 on Public-Private Partnerships (PPPs), the aim of which is to generate and regulate mechanisms for the participation of the private sector in the development of public infrastructure. This law was designed to accelerate the development of infrastructure, particularly for systems based on revenue collection

(for example, tolls). For some sectors related to social infrastructure, this has entailed vague or subjective procedures that have caused delays in the development of projects. As a consequence, regulatory decrees 2043/2012, 1610/2013, 301/2014, 1553/2014, 1082/2015 and 063/2015 were issued with the objective of regulating the details of the implementation and start-up of these types of projects in various sectors, such as drinking water and sanitation.

This paper addresses challenges related to private participation in the development of social infrastructure in the drinking water and sanitation sector. In this context, the need to increase coverage demonstrates the necessity of creating mechanisms to promote the involvement of the private sector in providing infrastructure services. Therefore, it is necessary to generate strategies in line with public policies that make it possible to detect and solve the main challenges and critical aspects that need to be addressed to promote private participation.

Given the findings of the literature review, the inclusion of the private sector in the provision of infrastructure would make it possible to increase economic growth; PPPs could allow for the alignment of private and public interests while accounting for factors such as sustainability, accessibility, and reliability in the supply of drinking water and the treatment of wastewater. The private sector must, therefore, be encouraged to provide drinking water and sanitation services through schemes associated with the development of projects using PPPs and PF as financing mechanisms.

This research is based on the hypothesis that increasing the development of water infrastructure systems in Colombia, as well as the related institutional framework, requires adjustments that will increase the involvement of the private sector. The objective of this paper is to identify the main challenges that policies can address to increase of private participation with the aim of closing the gap in coverage and encouraging more active involvement by capital markets in financing projects through PPPs schemes and PF. Such policies could be applied to other sectors such as energy supply, waste management, and telecommunications. To achieve these aims, the most important documents related to the development of infrastructure projects in Colombia, as well as current conditions and future investment needs in the drinking water sector, were analyzed.

Finally, this research concludes that the Colombian government must generate additional policies to encourage private participation in drinking water and sanitation infrastructure projects, which can impact the capital market and reduce the coverage gap, with the latter being the fundamental objective.

This paper is structured as follows. After the introduction, the main aspects related to investment in infrastructure and economic growth are analyzed. Then, opportunities for developing drinking water and sanitation projects through PPPs schemes are presented, followed by the challenges and proposals for the implementation of projects in the sector. Also, the conclusions and proposed directions for future research are presented.

2.2 Investment in infrastructure and economic growth

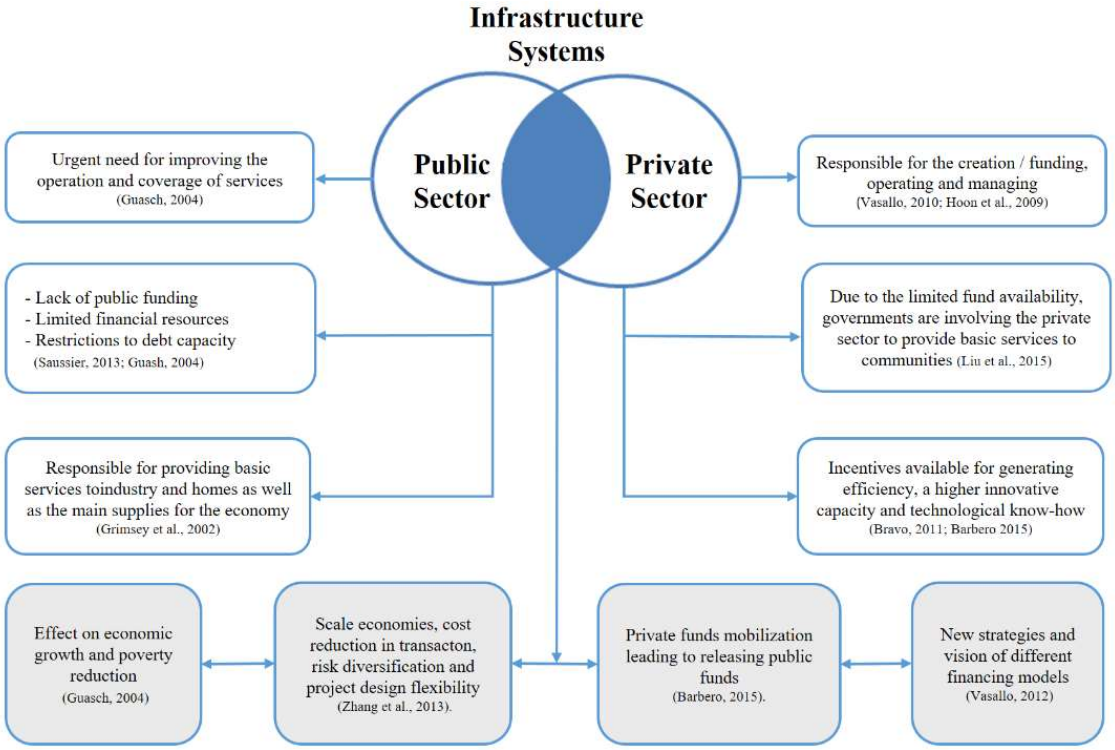
Developing infrastructure systems in various sectors of the economy is important because of both the social and economic benefits that such advances deliver, which are driven by improvements in quality levels and reductions in coverage gaps. Thus, the development of infrastructure systems is undoubtedly one of the main challenges facing Latin America, particularly in small and medium-sized cities, due to their effect on poverty reduction (Barbero et al., 2015; González-Ruiz et al., 2014). Therefore, it is necessary to increase current levels of investment by promoting improvements in infrastructure and assigning greater priority to the implementation of financing mechanisms to address climate change and sustainable development (Barbero et al., 2015).

In the case of Colombia, investment in infrastructure in the past decade averaged 3.2% of GDP (Gross Domestic Product) (Clavijo et al., 2014). The participation of the public and private sectors through partnership mechanisms such as PPPs is necessary to reach an average investment of 5% of GDP, as suggested by the Bank for the Development of Latin America (CAF) (Barbero et al., 2015). Therefore, PPPs have a fundamental role to play in the involvement of private capital. Increased private capital makes it possible to increase production efficiency (Engel, Fischer, and Galetovic, 2010) and boosts the process of infrastructure development by transferring risks to the private sector and directing public funds to social needs in which the private sector would not invest (González-Ruiz et al., 2014).

There is a global trend toward the adoption of PPPs for the provision of infrastructure (Jin and Zhang, 2011; Macário, 2010). This trend has been facilitated by the recognition that the institutional framework and capacity are fundamental for the proper execution of PPPs and PF as a whole (Borgonovoa, Gatti, and Peccati, 2010). Therefore, increased investment must be accompanied by improvements in the institutional framework (Organisation for Economic Co-operation and Development - OECD, 2013). Figure 2-1 depicts the main characteristics of the relationship between infrastructure systems and the public and private sectors (which have primarily been identified in the past five years).

Much of the empirical evidence in the literature suggests a positive relationship between infrastructure investment and economic growth. However, the economic literature argues that this relationship is not automatic or mechanical (Rozas and Sánchez, 2004). Thus, the creation of additional infrastructure does not guarantee economic growth. That is to say, such investment is a necessary but not sufficient condition for growth (Rozas and Sánchez, 2004). Linking the development of sustainable infrastructure at all levels and sectors to economic growth is considered an important opportunity. To obtain economic growth from investment in infrastructure, several factors and requirements are essential (Rozas and Sánchez, 2004). To be effective, policies must include the goal of leveraging the development of investment in infrastructure while simultaneously impacting economic growth through the development of sustainable infrastructure.

Figure 2-1: Relation between infrastructure systems and the public and private sectors



Source: Author's elaboration

2.3 Infrastructure development under the PPPs Law 1508/2012

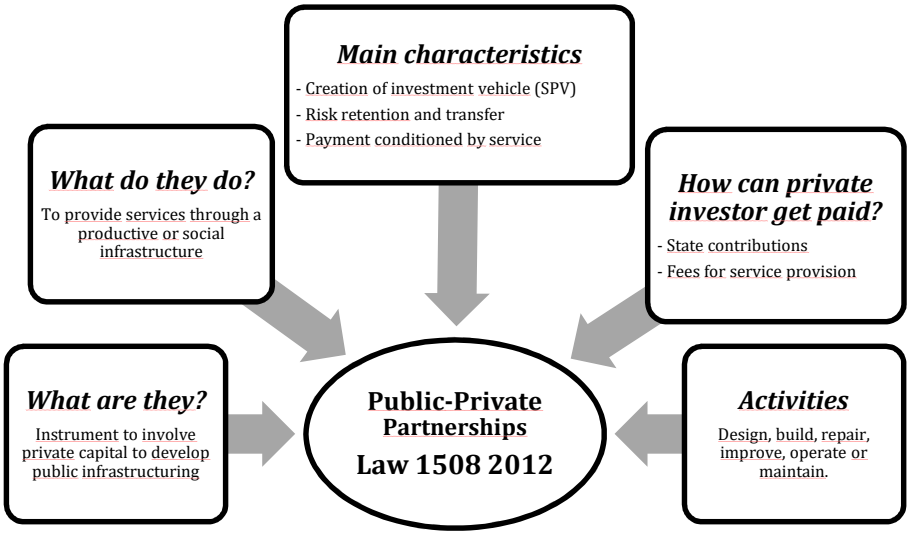
Colombia's 1991 Constitution declares that a function of the government is to guarantee the provision of essential public utilities throughout the country, which may be provided directly or indirectly by organized communities or private entities (Congreso de Colombia, 1991). This led the government to transition from being a supplier to being a service regulator, as stated by Law 142, 1994. It establishes service delivery by private or mixed operators subject to the regulation, control, and supervision of the government.

At present, there are approximately 11,500 drinking water and sanitation services companies, of which 91% are small providers located in community areas and 58% are municipalities that operate as direct providers (Ballestero et al., 2015). These services are provided through special shareholder companies (Public Utility Companies - PUCs), which include public, mixed or private firms, as well as the State Industrial and Commercial Companies (Rojas, 2014).

In Colombia, the participation of the private sector in the provision of public utilities, such as energy, drinking water and telecommunications, has developed slowly since the early 1990s, mainly since the proclamation of the 1991 Constitution. Thus, institutional efforts to encourage the participation of the private sector in the development of public service projects, specifically in drinking water and sanitation, are required.

In 2012, the Government of Colombia issued Law 1508, which defines the PPPs as "Instruments involving private capital, which is embodied through a contract between a government agency and a natural person or legal person under private law, for the provision of public goods and related services involving the retention and risk transfer between the parties and payment mechanisms related to the availability and the level of service of the infrastructure and / or service" (p.1) (Congreso de Colombia, 2012b). This Law's main aspects are presented in the figure below.

Figure 2-2: Main aspects of PPPs Law 1508/2012.



Source: Author's elaboration based on the Congreso de la República de Colombia (2012)

To create mechanisms for private participation in public infrastructure development, this Law established the parameters for developing infrastructure projects in Colombia; it allows the government (at the central and local levels) to stipulate the process for designing, managing and implementing projects, and provides investors with clear roadmaps for defining different investment strategies. An important component of this regulation is the need to seek funding from private investors. This need can be met if private investors structure their projects by implementing PF, which is defined as: "A structured funding of an economically independent entity created by a sponsor, using equity resources and debt, which lenders consider cash flows as a primary source for credit repayment, while the project's assets represent the guarantee: collateral" (p.2) (Gatti, 2013).

The PPPs Law 1508/2012 proposes that, to develop infrastructure projects, the resources used for the project, regardless of their origin (public and/or private), must be managed by a trust, acting as an investment vehicle, which must be created by the private party responsible for developing the project. A special agent will supervise this trust while representing the interests of the public sector to ensure that the resources are used exclusively for a particular project.

Regarding PF, project resources must be managed by a Special Purpose Vehicle (SPV), which allows the sponsors to be shielded against the risks inherent in the project. According to this Law, the SPV will allow the lenders to have a real and tangible guarantee, which could be required by investors during the process of financing the project. This approach envisions that projects can be developed according to the two approaches: public or private.

Table 2-1: PPPs projects initiatives in Colombia

Public	Private
The government has the conceptual idea of the projects. The resources to develop it can be public and / or private and the selection process is carried out through a public competitive bidding.	The private sector proposes developing the project. The resources given by the public sector cannot exceed 30% of the total (except highway projects 20%). If the project is developed only with private capital, the selection process will require lower costs; in any other case, it will be through a public competitive bidding.

Source: Author's elaboration based on Congreso República de Colombia (2012)

Thus, to regulate private participation in the water sector and recognizing aspects that were not included in Law 1508/2012, the Government issued Decree 063, 2015 to standardize the implementation of PPPs in this sector. The purpose of this regulation is to prevent some common problems in contractual arrangements under PPPs, such as:

- Multiple renegotiations,
- Non-compliance with goals,
- Inadequate risk allocation,
- Financial imbalances and
- Delays in making investments (Departamento Nacional de Planeación - DNP -, 2015b).

The main issues included in the decree are as follows (Departamento Nacional de Planeación - DNP -, 2015b).

- Income source: from the project's social object and/or public resources (royalties, General Budget of the Nation, General System of Participation, among others).
- Project promoter: private investors who own public utilities (PUC) or have a contract with a PUC for the operation and management of the new project.
- Service indicators: the conditions and goals in regarding quality described in the PPPs contract must be reflected in the Uniform Conditions Contract signed between the PUC and the users. Non-compliance will result in a deduction from revenues. The levels of service and quality standards are defined by the Commission for the Regulation of Drinking Water and Sanitation (CRA).
- Project evaluation: The Ministry of Housing (for the drinking water and basic sanitation sector) is responsible for evaluating PPPs; these will be financed with resources from the General Budget of the Nation.

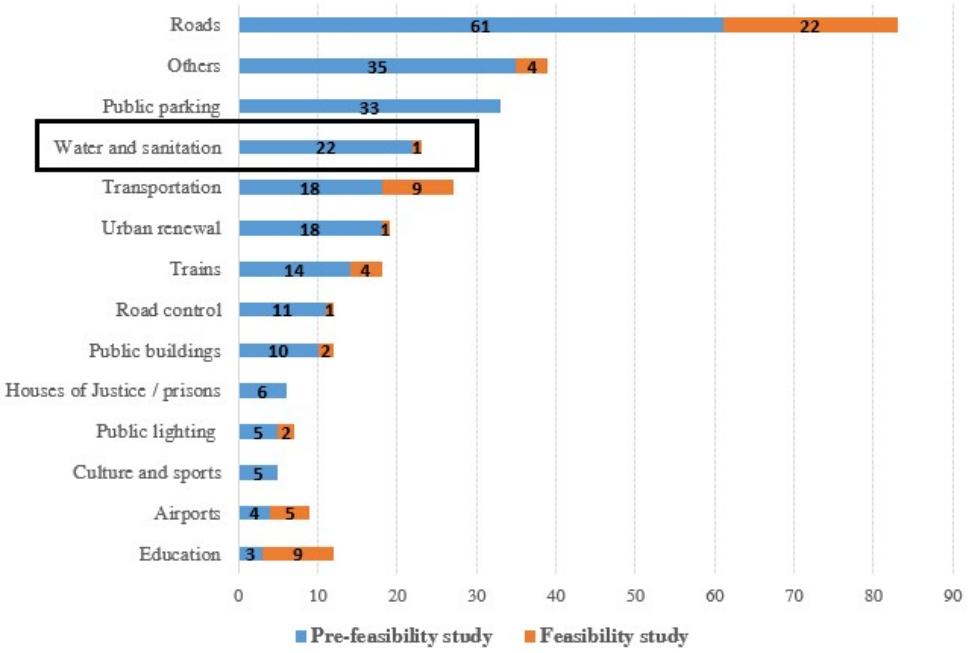
Some of the projects that can be developed include dams, desalination plants, aqueducts and sewage systems, water extraction wells, waste treatment plants (WTPs), and rainwater collection systems (Departamento Nacional de Planeación - DNP -, 2015b). In the case of WTPs, there is a wide range of projects that are expected to be developed through PPPs (Departamento Nacional de Planeación - DNP -, 2015a). The following table describes these projects.

Table 2-2: Offer of WTP projects

Department	Municipality
Boyacá	Duitama
Quindío	Armenia
Caldas	Manizales Villamaría
Cauca	Popayán
Bogotá D.C.	Bogotá D.C.
Norte de Santander	San José de Cúcuta
Risaralda	Dosquebradas and Pereira
Valle del Cauca	Cartago, Florida, Guadalajara de Buga, Jamundí, and Palmira
Huila	Neiva

Figure 2-3 shows (as of December 2016) the projects proposed by the private sector to be developed through PPPs in the different sectors. Nine of these are related to the management and construction of water and sanitation services, one of which requires public resources for its development (a private initiative using public resources). There is a preference for the private sector to submit offers to develop road projects, entailing less attention for social infrastructure projects such as prisons, and water and sanitation.

Figure 2-3: State of the projects developed by PPPs



Source: Author's elaboration based on the Dirección Nacional de Planeación - RUAPP - (2016).

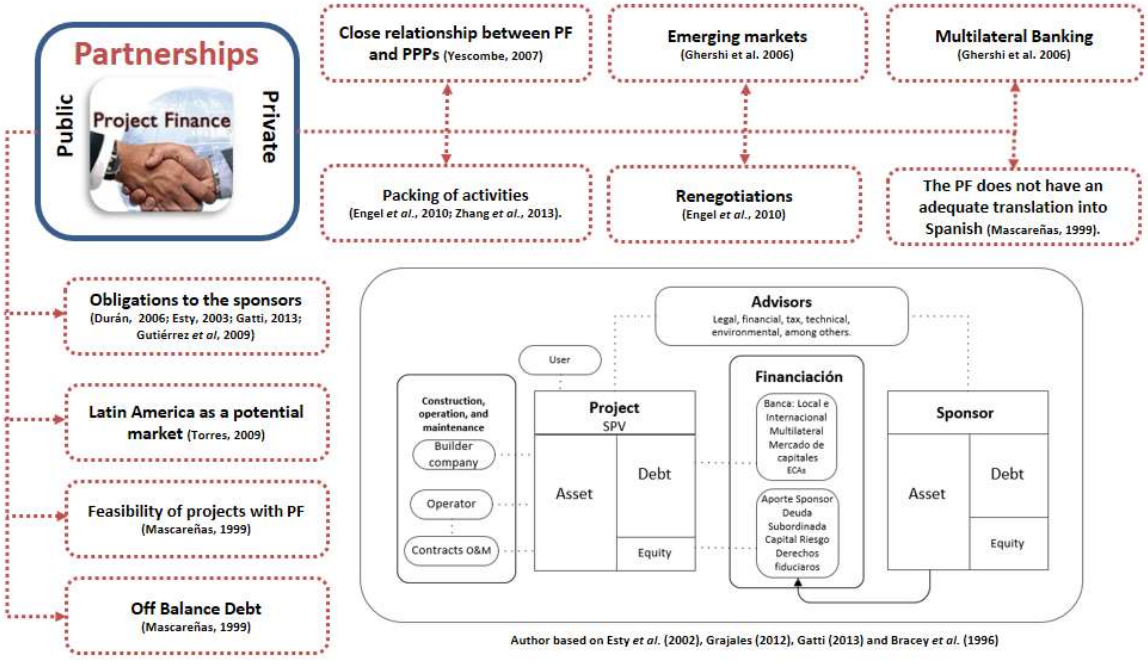
Considering the above, including the private sector in the provision of social infrastructure to improve the functioning and coverage of goods and services is important because of the effect it has on economic growth and poverty reduction (Guasch, 2004; Saussier, 2013). Consequently, due to the scarcity of public funds and constraints on debt capacity, most countries have chosen to transfer the provision of infrastructure to the private sector through PPPs schemes (see Alonso-Conde et al., 2007; Jin y Zhang, 2011; Thomson et al., 2005; Zhang y Durango-Cohen, 2012).

The importance of PPPs in the development of infrastructure in Colombia is based on the following factors:

- The resources available from pension funds and foreign investors willing to invest in infrastructure projects,
- The lack of public resources to develop projects and the lack of adequate infrastructure to facilitate free trade agreements,
- Attracting long-term investors to the provision of public infrastructure,
- Improved infrastructure to enable the private sector to operate at peak performance,
- The interest among companies from developed countries in investing in developing countries, and
- The correlation between economic growth and infrastructure quality.

Therefore, the Colombian government should issue legislation to promote infrastructure investment in other sectors, such as drinking water and sanitation, with the aim of improving coverage and complying with its SDGs (González-Ruiz et al., 2015a). The following figure shows the main theoretical aspects of PPPs.

Figure 2-4: Main theoretical aspects of PPPs



Source: Author's elaboration

2.3.1 Opportunities for developing water infrastructure projects in Colombia through PPPs

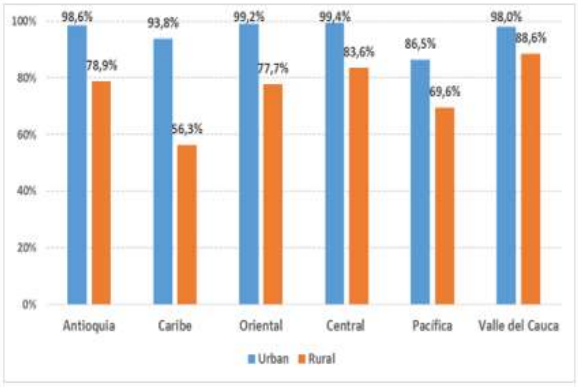
Due to the scarcity of funding, budget constraints and debt capacity constraints, the public sector cannot meet its infrastructure investment needs in a variety of sectors. As a result, the government does not invest directly in these projects, and the initial capital investment is granted to the private sector. The investment is recovered through commercial exploitation (González, 2006). In the Colombian case, this period must not exceed 30 years, unless the National Council of Economic Policies (CONPES) approves a longer duration (Congreso de Colombia, 2012b).

The long-term nature of PPPs allows for the development of projects such as drinking water, wastewater treatment, and irrigation. Over time, these projects have shown to have a qualitative impact on social and environmental issues (Alborta et al., 2011). Thus, the characteristics of these projects, particularly those with an intensive use of capital, encourage the use of long-term contracts.

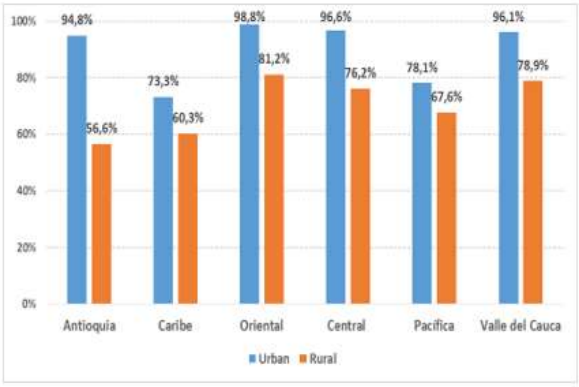
Figure 2-5 shows the coverage gaps for the year 2013 for aqueduct (part A) and sewerage systems (part B) in rural and urban areas in the main regions of Colombia. Figure 2-6 shows the consolidated information for 2014. A comparison of the two reveals few changes that have occurred in recent years and demonstrates the opportunities to involve the private sector through PPPs to develop projects that will help bridge the gap and improve service quality in infrastructure.

Figure 2-5: 2013 Urban and Rural Aqueduct Coverage in Colombia.

Part A. Urban and Rural Aqueduct Coverage.

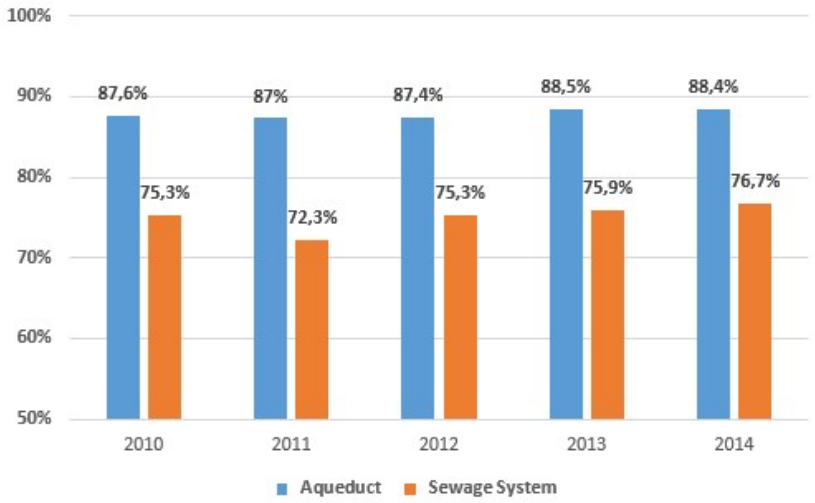


Part B. Urban and Rural Sewerage Coverage



Source: Author's elaboration based on the Departamento Nacional de Planeación de Colombia (2014)

Figure 2-6: Urban and rural Aqueduct and Sewage Coverage 2010-2014



Source: Author's elaboration based on the Departamento Nacional de Planeación de Colombia (2014)

According to the Inter-American Development Bank (2013a), the modifications that have been made to promote the involvement of the private sector in Colombia's drinking water and sanitation services have not achieved the expected results. It has been argued that PPPs can help to improve access and coverage conditions. This will improve the efficiency in managing operating and financial resources (Ballestero et al., 2015).

Furthermore, such projects cannot be designed from a single-sector perspective. The solutions must be integrated with other related sectors, especially housing and industry (Ballestero et al., 2015). Thus, private investors are expected to conceptualize, structure, develop and operate infrastructure systems and manage the commercial solutions in a holistic way that allows set up a closer relation among the different sectors and entities.

In the Colombian case, this partnership mechanism would increase coverage, particularly in rural areas, where drinking water supply and sewage systems are a particular priority. Higher-income urban areas can partially finance investments in rural areas, which require subsidies (for connection and / or consumption; these can take the form of direct, geographically cross-linked, customer category or payment capacity subsidies). In these types of projects, it is therefore necessary to define clear rules and encourage the search for economies of scale (Lentini, 2015).

Therefore, achieving a balance between the social and financial aspects of the service must be based on an efficient and equitable tariff regime, and this task is the responsibility of the regulators (Lentini, 2015). To improve coverage in the rural sector, the Government of Colombia has estimated an investment plan in the amount of COP 7,6 billion to be implemented between 2014 and 2024.

This means that nearly 1.8 million new people will benefit from drinking water supply and 2,5 million from new sewage systems (Departamento Nacional de Planeación, 2014). The table below shows the estimated investment in drinking water supply and sewage systems in rural areas.

Table 2-3: Estimated investment needs in the rural sector.

Item	Total
Infrastructure construction	5,046,111
Studies and design	519,513
Indoor installations	1,728,356
Social Capital	290,756
Property management	50,253
Total	**7,634,989**

Source: Departamento Nacional de Planeación (2014). Figures in COP Million.

However, according to the Departamento Nacional de Planeación - DNP (2016), public resources continue to be insufficient to provide new infrastructure at the pace necessary to meet existing needs. Therefore, there is a need to reconsider the current development models and the financing of projects in the water and sanitation sector in a way that leads a greater private investment, which currently represents 20% of total investment in the sector (Departamento Nacional de Planeación - DNP -, 2016)

Accordingly, the CAF indicates that, to achieve the SDGs related to water and sanitation, Latin American countries must invest at least 0.3% of their GDP (Ballestero et al., 2015). This would allow for an increase in wastewater treatment, coverage, quality, and efficiency in urban and rural areas and will promote the participation of the society (Lentini, 2015). Furthermore, studies conducted across the globe have shown that one USD of investment to improve drinking water and sanitation has a return of between 5 and 28 USD (Mejía et al., 2012). Therefore, it is necessary to innovate and more efficiently use each dollar invested (Ballestero et al., 2015). To achieve this aim, several macro inductors that could define the future of the sector have been identified.

- Comprehensive resource management: involve stakeholders in project development.
- Coverage: specifically target isolated areas and marginal and underserved markets to achieve universal coverage. Alternative access points solution.
- Financing: create new funding schemes to integrate the different stages.
- Sustainable construction: construction costs should represent future benefits as a result of operating efficiency.
- Mergers and acquisitions: reduce the large number of operators and avoid atomization.
- Private participation: increase the participation of private agents in the provision of the service.
- Generation of products: use the by-products of new production processes.
- Water sources: diversify water sources, for example, underground and sea.
- New businesses: reuse water in the agricultural and industrial sectors (washing, irrigation, etc.)

2.3.2 Drinking water and sanitation financing in Colombia

To increase the access to and coverage of drinking water and sanitation resources, active participation by the private sector is required. Financing is a critical problem that has yet to be solved. Financing is currently provided by a combination of public funds and fees (Ballestero et al., 2015). The revenues from this service are insufficient to cover the OpEx (Operating Expenses) or the CapEx (Capital Expenditures) (Fernández et al., 2009). Therefore, most of the companies are not financially sustainable (Ballestero et al., 2015). A study conducted by Lentini (2015) for the CAF and IDB indicates that 16% of operators receive tariff revenues that do not cover the OpEx, while a small number can cover a significant amount or all of the CapEx. Thus, increasing the participation of national and international funders will allow for the diversification of financing sources and result in improved financial conditions, such as the interest rate, loan terms and amounts, and better coverage rates in the water sector.

The Government of Colombia limits the contribution from its Future Funds, as measured by CapEx and OpEx, to not exceed 30% of the total value of the originally agreed contract (except for highway projects, where the corresponding figure is 20%). These funds are conditional on infrastructure availability and compliance with required service levels and quality standards. Furthermore, project delays will be valued, and projects should not fail to meet agreed timetables (Congreso de Colombia, 2012b).

Given its social nature, the government has historically been the main supporter of infrastructure projects to provide drinking water supply. Therefore, due to the limited opportunities identified in the sector, its low revenues, and the lack of funding sources available for the private sector, to create incentives for 2015, the Government of Colombia, operating through Findeter (a second-tier bank), allocated COP 850,000 million to develop drinking water supply and sanitation projects with a compensated rate (which would result in a 70% savings on interest costs). That allowed below-market-rate financing conditions and created greater financial capacity to implement new projects to improve the quality of life (Ministerio de Hacienda, 2014b). Moreover, in 2009, the Government of Colombia, through state entities, issued debt under the “Water Bonds” scheme. These bonds benefited 117 municipalities in the construction of drinking water supply and sanitation projects (Ministerio de Hacienda, 2014b).

That scheme had a significant social impact, but over time, the arranged interest rate (set between 11% and 17%) came to exceed market rates; this led to high financing expenses that resulted in a debt substitution operations to extend new lines of credit with special conditions granted by Findeter (Ministerio de Hacienda, 2014b). This debt replacement operation represented COP 500,000 million; the bonds were expressed in Real Value Units (RVU) and were then converted to Colombian pesos to prevent the balance from growing at the same pace as inflation. This process generated COP 250,000 million savings in interest payments. This financial operation allowed more resources to be invested in other social projects (Ministerio de Hacienda, 2014b).

Table 2-4 shows the main private equity funds and development banks with investments in the drinking water supply sector. These are expected to be actively involved in the development of projects in Colombia.

Table 2-4: Private Equity Funds and development banks.

International Funds Private Capital	Highstar Capital Catalyst – Private Equity Climate Change Capital The Charlie Group BC IMC – Investment Management Corporation CAI Private Equity
Development Banks	Inter-American Development Bank World Bank Asian Development Bank Asian Infrastructure Investment Bank Inter-American Development Bank European Investment Bank Findeter Financiera Desarrollo Nacional China Development Bank
Private Capital Funds Operating in Colombia	SEAF Nexus Capital Partners Brookeld Asset Management Inc Ashmore Management Company Colombia Darby Overseas Investments Ltd Tribeca Asset Management

Source: Author's elaboration

Other sources of public funding mentioned in Conpes[2] Document 3810 to fund drinking water supply projects in Colombia (particularly in rural areas, where there is less coverage and, therefore, a greater need for higher levels of investment) are as follows (Departamento Nacional de Planeación - DNP, 2014):

- Colombia's General Budget
- The General System of Royalties
- The Regional Drinking Water Supply Plans
- The General System of Revenue Sharing

Unfortunately, in designing water infrastructure systems, little importance is assigned to the financial evaluation of the available alternatives as wel as social and environmental assessments when considering engineering solutions. This is linked to the distortions generated by financing schemes, which can lead to the execution of projects that are suboptimal with respect to cost, size, and technology (Ballestero et al., 2015).

[2] Conpes stands for the National Council on Social and Economic Policies

Therefore, a new generation of planning instruments covering economic, social and environmental elements, as well as interrelations with sectors such as housing is necessary. Without these instruments, it will be difficult to develop efficient and sustainable drinking water and sanitation projects (Ballestero et al., 2015).

In recent Colombian projects with more than 5,000 users, the share of investor investment (equity resources) and debt have recently averaged 67% and 33% respectively (Comisión de Regulación de Agua Potable y Saneamiento - CRA, 2014). This indicates that the sector requires new strategies for obtaining financial resources, especially debt instruments. Furthermore, the WACC of these projects averaged 12.28% (Comisión de Regulación de Agua Potable y Saneamiento - CRA, 2014). To clarify the financial mechanisms available, Table 2-5 groups them according to their stage of development.

Table 2-5: Available Financing Mechanisms according to the projects' development stage.

Financial Mechanisms			Stage		
			Preparation	Construction	Operation
Short-term	**Debt**	Commercial Papers			
		Suppliers			
		Factoring			
		Confirming			
Short-term / Long-Term	**Debt**	Syndicated Loans			
		Bank Credit Nal / Intern.			
		Bridge Loans			
		Second-tier banks			
		Credit builder			
	Hybrid	International Cooperation Resources			
		Mezzanine credits			
Long-Term	**Debt**	Private Equity			
		Ordinary and subordinated bond			
		Multilateral Banks			
		ECAS - Export Credit Agencies			
		Leasing			
		Securitization			
		Debt Funds			
		Project Bonds			
		Infrastructure Bonds			
	Hybrid	Bonds convertible into shares			
	Equity	Sweet Equity			
		Cash			
		ADR[1] - GDR[2]			
		Future Funds			

1. American Depositary Receipt. 2. Global Depositary Receipt

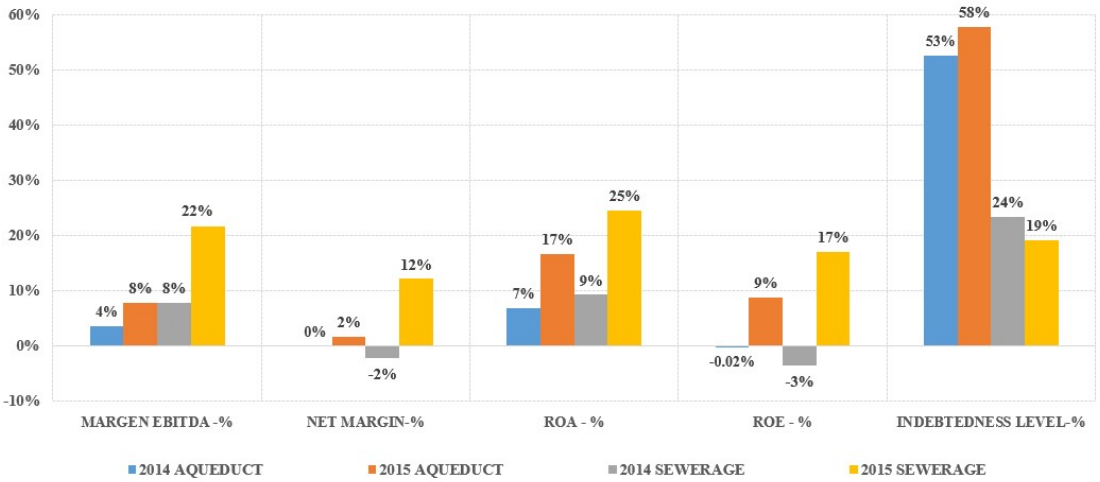
No common funding strategy in phase

Source: Author's elaboration

According to Lentini (2015), to make projects viable in the sector, it is necessary to diversify funding sources beyond tariff revenues to include joint financing, capital markets, credit guarantees, subsidized interest rates, specific funds and the public budget. However, the primary sources of funding are public funds, development banks and revenues from resource generation, or a combination thereof (Lentini, 2015). Thus, with the objective of including more private capital in these projects, investing should be as profitable for investors as PPPs infrastructure projects in other sectors (Salamanca, 2015).

Figure 2-7 shows the main financial outcomes separately for water and sewer companies in Colombia in 2014 and 2015. For EBITDA and Net Margins, despite relatively small margins, there is evidence of growth in excess of 100%. This demonstrates improvements in the operational and tactical strategy as reflected in the ROE and ROA indicators. However, existing debt levels indicate the sector's limited ability to raise debt resources.

Figure 2-7: Main financial indicators for the water and sewage sector



Source: Author's elaboration based on data from the Superintendencia de Servicios Públicos Domiciliarios (2016).

Despite institutional efforts to increase private capital participation to close the infrastructure gap and generate features conducive to investment, several additional elements are needed to generate a favorable climate and foster PPPs, which include the following:

- Regulatory changes that encourage private sector inclusion in the different stages of the projects (González, Arboleda, and Botero, 2015) and responsible financial innovation that will lead to flexible regulatory innovation (Gómez, 2015), thereby encouraging the creation of innovative financing and investment.
- Increase the participation of development banks, which will reduce political risk. It will also encourage the involvement of local banks (Hainz and Kleimeier, 2012).
- New national and international participants, such as construction firms, operators, and investors.

- New funding sources (CEPAL, 2015). It is necessary to increase the volume of transactions and the number of issuers. Therefore, there is a need to develop the financial system.
- Recognize the positive relationship between capital market development and economic growth (Haber, 2014).
- Generate mechanisms (financial guarantees, financial products, and tax and fiscal reforms, among others) with the objective of increasing the participation of institutional investors.
- Create a market based on infrastructure assets (González et al., 2015) directed toward more rapid trading of securities and, in turn, reduce liquidity risk (Del Valle, 2015).
- Develop financing and investment mechanisms with special tax regulations for projects related to social infrastructure projects related to climate change and sustainable development.
- Establish financing and investment mechanisms related to climate change, recognizing that they are not yet sufficiently developed to become operational (Barbero et al., 2015). Colombia could become a pioneer in establishing and implementing strategies aligned with addressing climate change. Infrastructure development must be targeted toward sustainable development strategies.
- Improve the conditions for domestic and foreign savings (Serebirsky, 2015). Evidence in developed countries shows that 90% of the capital stock is financed by domestic savings (Aizenman, Pinto, and Radziwill, 2007). In recent years, Colombia's gross savings average reached 19%, while the average for Latin American countries was 21% (Castellanos, 2015).
- Plan the development of the infrastructure while including territorial integration and sustainable development criteria.
- Create debt funds to leverage infrastructure projects, especially in the construction stages, when risks are higher and specialized investors are required.

The above is intended to encourage regulatory and market adjustments based on changes in the structure of the banking sector and in preparation for a possible financial crisis. For example, the disappearance of monoline insurers and the implementation of Basel III restricts long-term financing by banks (Organisation for Economic Co-operation and Development - OECD, 2013). Basel III restricted lending with the aim of controlling banks' liquidity risk and thus avoiding disturbances in the banking sector due to economic crises. In this context, the absence of a deep capital market with specific infrastructure assets represents a barrier to the financing of new projects at all stages; it will impede the circulation of capital (recycling of money) and affect investment and divestment strategies.

In this way, changes in the structure of the financial sector have led institutional investors, pension funds, insurance companies, debt funds and, recently, sovereign wealth funds to become central actors in the provision of long-term capital (Organisation for Economic Co-operation and Development - OECD, 2013). This context, therefore, requires the identification of innovative solutions and new approaches to the financing and execution of investments, which entails identifying new ways of blending various financing instruments using approaches that will help to close the financial viability gap (González-Ruiz et al., 2014).

Through the creation of more innovative mechanisms (World Bank, 2012a), it will be possible to develop financial instruments that encourage the construction of sustainable infrastructure; this will provide drinking water and sanitation services in a continuous, sustainable and balanced manner. In this regard, proposing solutions to financial and investment issues through academic dissertations could lead to the creation of strategies with the potential to stimulate the market and identify structures that engender trust among investors and lenders (Rozas, Bonifaz, and Gustavo, 2012)

2.3.3 Challenges and proposals for developing water projects through PPPs and PF in Colombia

Reducing the coverage gap and improving services through active participation by the private sector presents several challenges. To address them, this research presents structural and functional proposals; these would allow increased involvement by the private sector and generate conditions that promote the sector. Table 2-6 lists the issues identified and their proposed solutions. The aim of this work is to contribute to the development of policies that will lead to increased private participation in drinking water infrastructure systems in Colombia.

Table 2-6: Identified issues and proposed solutions in the water sector in Colombia.

Issue	Proposed solution
The need for increased private investment through joint investment with the public sector.	Ensure the establishment of joint ventures between the public and private sectors in infrastructure projects in the water supply sector, *mxn* purchasing mechanisms can be implemented; in these, each *m* titles bought by the private sector would make the public sector buy *n*. The procurement mechanism is determined by the characteristics of the project.
The need for specialized operators and investors who understand the sector's dynamics are required.	Organize an international roadshow to attract and involve new operators and investors.
The need for increased coverage in drinking water and sanitation for rural areas.	Create special conditions for investment and funding, such as credits or profitability rates adjusted by the number of new connections or by improvements in the quality of service in rural areas.
The need to establish performance parameters to encourage investors to participate in drinking infrastructure projects.	Since the PPPs Law 1508/2012 allows contracts of up to 30 years, this work proposes that according to performance parameters, this deadline could be extended or reduced. It would require amending the PPPs Law 1508/2012.
The need to generate control mechanisms (through indicators) that will permit quality measurement of the drinking water supply and infrastructure operations.	To set dashboards (balanced scorecards) that allow for the monitoring of projects, guide investment decision-making and governmental financing, and create elements for designing policies and risk allocation.

2.4 Conclusions

Colombia needs to encourage the involvement of private funders in social infrastructure projects, especially in the drinking water and sanitation sector. As a result of the coverage gap and expected economic growth, private investors are encouraged to invest and operate Sustainable Infrastructure Systems (SIS), particularly under PPPs schemes. Thus, investors need to understand the water sector and develop projects with high-quality standards, as well as with the operational efficiency and financial support necessary to comply with the SDGs (particularly Objective 6). Therefore, greater private sector participation is required to develop projects in the sector and to diversify funding sources to promote sustainable development that focuses on environmental, social and economic indicators.

This approach, as a development concept, will allow all interest groups to receive integral benefits from the service. For this purpose, it is necessary to promote public policy changes in the sector that directly foster sustainable development; additional and appropriate regulations are needed to refine the PPPs Law 1508/2012 and PF to support the development of sustainable infrastructure systems in the drinking water sector. This will promote the development of specific financial products (credit or participatory content) in the sector that will promote the development of sustainable infrastructure. In this context, domestic and international private capital funds, as well as multilateral banking, are decisive in the investment and financing of this type of project. For example, multilateral banks have specialized funds to support drinking water supply projects. Moreover, Colombia's credit rating has improved of late, and its possible inclusion in the OECD will positively affect that rating, resulting in lower financing costs.

Thus, the Colombian government must lead the financing of these types of projects. To do so, it should allocate greater resources in the form of royalties / Future Funds. Finally, the sector is expected to holistically link its strategic planning and management to foster the creation of market mechanisms through the implementation of public policies; these mechanisms should promote private participation and the harmonization of public and private financial resources while seeking to satisfy economic, social and environmental indicators.

3. MEZZANINE-TYPE DEBT AS A SUSTAINABLE FINANCING SCHEME TO RAISE PRIVATE FUNDS FOR THE DEVELOPMENT OF SUSTAINABLE INFRASTRUCTURE SYSTEMS IN THE COLOMBIAN WATER SECTOR

Many countries, including Colombia, require new financial mechanisms leading to increasing the drinking water and sanitation services coverage through sustainable infrastructure systems (SIS). However, the establishment of such mechanisms demands innovative approaches and analyses that contribute to the development of financial schemes by providing a new vision for private investors and public entities promoting sustainable development and therefore, the creation of new eco-financial assets. To address this need, this paper proposes an integrated framework that involves sustainable financing, capital markets, and public-private sectors and as a consequence, it provides a new financial framework for developing sustainable infrastructure. Hence, its main contribution is a mezzanine-type debt mechanism, in which conversion debt-equity is related to the Triple Bottom-Line. Additionally, this work presents a mathematical model that allows identifying, according to investment plans and capital structures per period, the impact on final capital structure. The paper also introduces some new policies that the Colombian government should implement to foster private participation and the development of sustainable infrastructure-related financial assets. As a result, this paper should contribute to increasing the role of the capital markets and private involvement in the development of SIS for the drinking water and sanitation services in Colombia.

Keywords: Sustainable Infrastructure; Sustainable Financing; Private Participation; Water; Mezzanine Debt

3.1 Introduction

Increasing the coverage of a country's drinking water and sanitation services through the development of Sustainable Infrastructure Systems (SIS) undoubtedly represents a significant challenge, as demonstrated by the case of Colombia. To address this problem, innovative financial mechanisms that incorporate the strengths of the sustainable infrastructure approach are required to create an infrastructure project portfolio capable of attracting private investors and overcoming the investment gap (Egler and Frazao, 2016). Thus, innovative and integral approaches that include financial evaluation methodologies and incorporate sustainability criteria should be implemented (Zhang, 2005).

Consequently, new financial mechanisms that include sustainability criteria to encourage private participation and the establishment of new regulations would lead to the creation of infrastructure systems based on sustainable financing as the key driver of development. Therefore, in order to align infrastructure investments with the Paris Agreement and United Nations Sustainable Development Goals, these goals should be included into planning and development processes through the use of Triple Bottom-Line (TBL) criteria, with social, economic, and environmental sustainability being core objectives (Bielenberg et al., 2016; Egler and Frazao, 2016; Martens and Carvalho, 2016).

Over the past decade, infrastructure investment has represented, on average, over 3.2% of Colombia's GDP (Clavijo et al., 2014). Nevertheless, the Development Bank for Latin America CAF (Barbero et al., 2015) and the Inter-American Development Bank IADB (Banco Interamericano de Desarrollo, 2013b) have argued that such infrastructure investment should represent 5% of GDP.

Recent studies have also confirmed that Latin America must aim to achieve an infrastructure investment of close to 5% of its GDP (Bhattacharya, Romani, and Stern, 2012; CEPAL, 2010). In this way, public finance will be fundamental to closing this financing gap. However, the public sector's budgetary constraints and limited debt capacity mean that it may invest only as much as 2.5% of GDP, and therefore, its contribution will be limited (Barbero et al., 2015; UNEP, 2015). This fact confirms the potential for private capital as the key driver in helping to close the gap in developing infrastructure systems (Inter-American Development Bank and Mercer, 2016). Therefore, developing countries can obtain both short- and long-term benefits from integrating sustainable financing innovations into their financial systems (UNEP, 2015).

Because of insufficient government investment in recent decades, there is a significant coverage gap in Colombia's water sector. For instance, in 2013, aqueduct coverage in the Caribbean and Pacific regions was 56.3% and 69.6%, respectively, and individual sewage-system coverage was 60.3% and 67.6%, respectively (Departamento Nacional de Planeación, 2014). This problem has had several effects on health, especially the health of infants. Polluted water sources and poor distribution networks have been responsible for 7.3% of infant deaths (Mejía et al., 2012). Studies at the global level have shown that one dollar of investment to improve drinking water and sanitation has a return of between 5 and 28 USD (Mejía et al., 2012). These results call for increased drinking-water and sanitation-service coverage, which requires the development of a sustainable infrastructure.

These problems and gaps, along with a proposed solution for the Colombian water sector (broadly described by González-Ruiz et al. (2015)), suggest that private investors should play a pivotal role in increasing coverage in this sector. However, financial resources are becoming increasingly limited; therefore, the primary challenge involves the financing process and the mechanism for raising additional private capital (Schneider and Wiener, 2013). In the current situation (i.e., the developed world's debt crisis), it is becoming more difficult to obtain financial resources. Hence, the development of new projects requires the location of new sources of financing (Schneider and Wiener, 2013).

This context demands eco-innovative solutions and new approaches to the financing and implementation of investments, which entails recognizing new ways of combining financial instruments with procedures that will close the financial viability gap. A key point in this context is that the successful development of infrastructure systems requires efficient management and improved financial engineering techniques to explore new sources of financing (Zhang, 2005). Therefore, through the creation of innovative mechanisms and the development of financial instruments to encourage sustainable infrastructure, it will be possible to construct a new infrastructure is possible (World Bank, 2012a).

Traditionally, infrastructure systems have generally been financed by sponsors and debt, using equity capital and bank loans, respectively (Esty, 2004; Gatti, 2013; González-Ruiz et al., 2014; Yescombe, 2007), meaning that these financing schemes have had a predictable capital structure (Dong et al., 2011) and have not been subordinated to sustainability criteria. According to this assumption, the capital structure varies deterministically, and thus, that it can be known at any moment (Dong et al., 2011; González-Ruiz et al., 2017). Therefore, although capital structure has long been studied (since 1958, when the Modigliani-Miller theory was established) (Modigliani and Miller, 1958), very little attention has been devoted to subordinated and convertible financial instruments and their impact on capital structure (Dong et al., 2011).

Studies conducted by Leland (1994) and Dann and Mikkelson (1984) are among the most important studies on the relationship between convertible debt and capital structure. The former conducted a detailed analysis of the behavior of convertible bond prices and optimal debt-to-equity ratios along with aspects of asset substitution, debt repurchase, and debt renegotiation. The latter offers evidence on the valuation effect of convertible debt issuance and describes important empirical regularities in stock price responses to corporate financing decisions involving convertible debt.

According to Vasallo (2012), these conditions explain the elaboration of analyses and approaches that support the development of a new vision for public finances, the financial sector and construction companies through new financing models. In this regard, Estache, Serebrisky, and Wren-Lewis (2015) argue that a common problem identified by the economic literature is that the financing of infrastructure projects has remained a secondary concern. These issues (for example, how to design funding structures) are among the PF literature's main concerns.

As a result, studying eco-innovative financing mechanisms will allow for a better understanding of how sustainability criteria could be employed to encourage private participation and, therefore, in the financing process of SIS, particularly in Colombia. The development of these mechanisms should be related to the TBL concept, which includes economic, environmental, and social dimensions. The TBL, developed by Elkington (1998), suggests that organizations are concerned not only about financial behavior but also the positive social and environmental benefits that can be obtained. In this regard, when project managers use the TBL, the economic, social and environmental aspects of projects are better integrated into their decisions (Martens and Carvalho, 2016).

Therefore, a sustainable financing strategy is critical for enhancing the development of infrastructure systems that will help to prevent adverse effects of climate change diseases that result from poor service quality, and coverage gaps while ensuring service continuity. Thus, it is necessary to develop a standard method that incorporates the TBL benefits (The Johnson Foundation, 2012).

In this regard, the Colombian government enacted PPPs Law in 2012 to increase and improve the coverage and quality of infrastructure systems. As a result, private investors (particularly in highway infrastructure systems) have identified several opportunities for developing projects. However, the lack of a deep capital market has caused problems in the financing process, which has resulted in delays or halted and, in some cases, prevented construction from beginning.

The sustainable financial scheme proposed in this paper, which can be categorized as an eco-innovative financial instrument, examines how sustainability criteria could be incorporated into infrastructure systems' financing process, particularly for water infrastructure systems. Accordingly, this paper's primary contribution of this paper is to propose the creation of a mezzanine-type debt mechanism. Under this mechanism, the payment of interest and principal are related to sustainability criteria (such as economic, social, and environmental criteria), with the possibility to convert outstanding debt into equity shares if goals and covenants are met. In this way, the creation of a sustainable financial mechanism and the measurement of its impact on capital structure is a rarely explored topic in the traditional finance literature.

For these reasons, the financing model will have a financial asset associated with special characteristics evidenced by the creation of the financial asset until the repayment of debt or its conversion into equity shares. Therefore, this type of debt could be considered a new form of sustainable hybrid debt. Therefore, this debt could be considered a new type of sustainable hybrid debt. In this way, this proposal intends to offer ways to overcome the barriers identified by Bielenberg et al. (2016) related to private-sector participation in the development of sustainable infrastructure: These barriers include the following:

- Lack of funding models,
- Inadequate risk-adjusted returns,
- Unfavorable and uncertain regulations, and
- Policies and "bankable" pipelines, which are aligned with development and climate goals.

This proposal could help to overcome challenges restricting investor behavior and the development of sustainable investments; in this way, central aspects of the development of infrastructure systems could be reformulated, changed, or created with the goal of conceiving a new trend in and path for sustainable investment. Also, this proposal would provide the private sector, which usually participates as equity investors or lenders, with more investment options, particularly with respect to private equity investors, which are frequently inclined to participate in the SPV via mezzanine financial mechanisms (Dong et al., 2011). In this manner, the separation of financial activities through the SPV will enable the creation of a suitable capital structure with an optimal mix of equity and debt (Leland, 2007).

Another motivation for this proposal is that sustainability-related investments have not been adequately addressed in the literature nor have not been pursued widely in practice for two reasons (Bolton, 2015). First, how one should value or measure the subjective and abstract cash flows associated with such investment remains unclear. Second, the standard theories presented in finance and economics textbooks implicitly include sustainability in investments because these theories apply to all investments (Bolton, 2015).

Because of the increasing development of infrastructure projects in Colombia, the aim of this paper (which accounts for the relationship between PPPs and PF) aims to systematically integrate the various elements that compose the development of sustainable infrastructure projects in the Colombian water sector. These elements have yet to be explicitly addressed or combined. For example, elements such as sustainability and financing have never been linked to the goal of developing infrastructure systems in the water sector.

This paper does not seek to create or redefine investment valuation criteria for the infrastructure sector, nor does it attempt to add new definitions of sustainable infrastructure. On the contrary, this study develops an integrated theoretical framework for SIS financing that could be used in countries facing funding problems. Finally, this study should encourage private participation in the development of SIS in Colombia's water sector and provide decision-makers with valuable information that they can use to improve the practices applied in structuring, financing, and management processes.

3.2 Developing sustainable infrastructure systems

The Sustainable Infrastructure Systems (SIS) concept was identified by the Inter-American Development Bank and Mercer (2016). The following is Egler and Frazao's (2016) definition, which integrates the key features of the concept: "Infrastructure that integrates environmental, social and governance aspects into a project's planning, building and operating phases while ensuring resilience in the face of climate change or shocks – is capable of making the difference: it improves the attractiveness of infrastructure investments by mitigating risks, creating tangible benefits and opportunities as well as reducing emissions and climate risks" (p.4). Thus, SIS must overcome barriers such as commercialization risk and public-private financing to improve low-carbon investments focused on "green" economic growth, particularly in developing countries (Granoff, Hogarth, and Miller, 2016).

According to Bielenberg et al. (2016), sustainable infrastructure includes projects related to transport, telecoms, power, water, and waste. With respect to financing sustainable infrastructure projects, those authors have also identified the lack of adequate private-sector participation for financing these kinds of projects. For this reason, one of the primary challenges (which is also mentioned by Meltzer (2016)), is to increase volume financing and shift funds toward sustainable infrastructure.

Sustainable water systems must be understood as integrated systems that reduce treatment costs by improving resources, being energy efficient, and extracting significant resources (energy and nutrients) found in wastewater instead of discarding them as waste. Every dollar spent on water infrastructure systems must provide several benefits, including decreasing temperatures, improving green space, developing parks, and creating local jobs (The Johnson Foundation, 2012). This approach includes traditional human-made or built infrastructure components and natural infrastructures that integrate traditional components with the protection and restoration of natural systems. Accordingly, the TBL can be enhanced through sound practice (Monsma, Nelson, and Bolger, 2009). The principles of SIS management in the water sector are shown in the following table.

Table 3-1: Principles of sustainable water infrastructure

Principle	Description
Adaptable	Maximize flexibility and future adaptability to climate change and other conditions
Watershed scale	Plan and implement infrastructure at a watershed scale
Natural infrastructure	Protect and restore natural system functions
Decentralize	Integrate decentralized, distributed green infrastructure that replicates natural hydrology with built infrastructure
One water	Integrate drinking water, wastewater, and stormwater and fit the best water to use
Resource Efficiency	Optimize conservation and efficiency investments before developing new supply or expanding treatment
Multiple benefits	Maximize the environmental, social, and economic benefit of every infrastructure dollar
Pricing	Price water, wastewater, and stormwater for ratepayers/customers to meet the total cost of sustainability requirement
Full life cycle	Plan, manage, and account for full life-cycle infrastructure expenditures
Asset management	Apply best industry practices for repair/rehabilitation and replacement and innovative management
Good governance	Governing boards, city councils, and special utility boards should be designed to ensure sustainability and transparency

Source: The Johnson Foundation (2012)

SIS development must be an integral aspect of all countries' economic growth plans. Indeed, because of a large part of the current infrastructure is deteriorating, it will have to be replaced in the upcoming years, entailing new construction projects (González-Ruiz et al., 2014). There are many opportunities to address these aging assets for developing restorations and replacements that provide smarter, more efficient, and lower-carbon methods of delivering improved services (Ainger and Fenner, 2014).

In this regard, financial innovation has emerged both to complement traditional financing structures, which are already insufficient to meet the growing need to maintain and restore infrastructure, and to close the financing gap (Mostafavi, Abraham, and DeLaurentis, 2011; Mostafavi et al., 2012). According to the World Bank (2009), financial innovation involves non-traditional applications, such as PPPs, that provide fundraising support for delivering financial solutions to development problems by tapping new financial resources and encouraging investors to consider aspects that go beyond projects' financial issues.

Thus, even though several studies have been conducted on the sustainability-project management relationship, this issue remains in the exploratory stage; therefore, to understand how sustainability topics can be related to project management to support decision-making in project evaluation, an academic field has emerged to enable more empirical studies (Martens and Carvalho, 2016; Singh et al., 2012; Valdes-Vasquez and Klotz, 2013).

In this same line, some ethical and responsible investment theorists (Heinkel, Kraus, and Zechner, 2001; Renneboog, Ter, and Zhang, 2008) hold that sustainable investments (that involve financial eco-innovations) allow broadening the spectrum of investors beyond traditional investors, who consider only financial criteria to make investment decisions, to socially responsible investors, who also consider non-financial criteria.

As a consequence, to establish a stronger relation between sustainability and finance, this research also intends to propose how to develop the principles of eco-innovative financing with an emphasis on social infrastructure, responding to the scientific and business world's growing in this emerging field (Karakaya, Hidalgo, and Nuur, 2014) and leading to an advanced understanding of the relation between sustainability and finance (Boons and Wagner, 2009; Przychodzen and Przychodzen, 2015).

Merk et al. (2012) classified the financial mechanisms used for developing SIS into different categories by sectors, as shown in Table 3-2. Most of these mechanisms were also mentioned in Paper 1, as shown in Figure 1-1. They also indicate that not only a wide sphere of financial mechanisms could boost the development of SIS but also innovative finance solutions for transforming the industry are required. These solutions should include new financing models with new financial mechanisms to encourage non-traditional investors by increasing incentives and creating specific markets for SIS; that will allow the development of a new type of infrastructure (The Johnson Foundation, 2012). This position is directly related to Marcus et al. (2013), Mostafavi et al. (2014), Polzin et al. (2016), and Barbero et al. (2015), these researchers consider that the development of financing mechanisms is one of the most important instruments for boosting the sustainable development through eco-innovations (see Table 3-2).

Table 3-2: Main financial instruments for developing SIS

	Sector			
	Transportation	Building	Water / Waste	Energy
Taxes		Property taxes		
Fees and charges	Congestion charges Parking fees High Occupancy Toll lanes	Building permits	Tariffs and fees	Electricity user fees
Grants	General grants with environmental indicators, specific grants for environmental goods and services, matching grants.			
PPPs	Concessions and Private Finance Initiatives (PFIs), energy performance contracts.			
Land-based income	Development charges/impact fees, tax higher density building rights			
Loans and bonds	Loans and green bonds.			
Carbon finance	Clean Development Mechanism/Joint Implementation, voluntary carbon offsets.			

Source: Merk et al. (2012)

These are the main sustainable financial mechanisms for developing sustainable infrastructure: Social Impact Bonds (SBI), Clean Development Mechanisms, and Green Bonds. They are explained below.

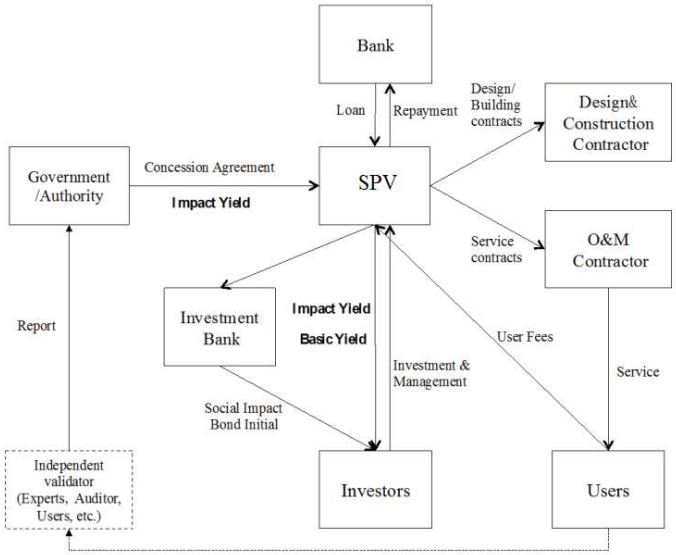
3.2.1 Social Impact Bonds

According to Pandey et al. (2016), Social Impact Bonds (SIBs) are "a recent innovation in social finance that integrate philanthropy, venture capitalism, performance management, and social program finance into an innovative new mix" (p.1). SIBs are also known as pay-for-success financing because they involve a deal with the public sector in which a commitment is made to pay for an enhanced social outcome; for this purpose, financial resources are raised from socially responsible investors (Barclay and Symons, 2013; Lu et al., 2015). In this way, investors in the capital markets have begun to migrate towards a new age of emerging and social investors (social impact investors), who seek both social impacts and financial returns (Bengo and Calderini, 2016; Bugg-Levine and Emerson, 2011). Therefore, SIBs connect the governmental "payments by results" method with private-sector investments and risk sharing (Clifford and Jung, 2017).

Regarding financing models for developing SIS, Lu et al. (2015) propose the Social Impact Project Finance framework, which includes SIBs. This framework is shown in Figure 3-1 and is composed as follows:

1. A public sector problem is identified.
2. The government finds investors who are interested in a social project.
3. Investors provide capital to the SIB intermediary, which is also known as an SPV.
4. The SIB intermediary then provides capital to NGOs or companies to implement the program.
5. An independent evaluation is conducted, and then the government pays principal and interest to investors only if the expected impact is achieved by the program.

Figure 3-1: Social Impact Project Finance framework



Source: Lu et al. (2015)

Lu et al. (2015) indicated that in a toll road project, investors receive not only a basic interest rate but also impact income as a consequence of satisfied feedback from users. Although social, economic, and environmental benefits are reported, indicators for measuring them were not specified. For this reason, they include as future research the embedding of indicators related to three components of sustainable infrastructure (social, environmental and economic) in the framework (Lu et al., 2015). Some authors, such as Krajangsri and Pongpeng (2016), Gunathilaka, Tuuli, and Dainty (2013), and Alias et al., (2014) have identified criteria for measuring social success. The most important criteria include, *inter alia*, social support, community involvement, effective feedback from local government, community satisfaction, construction time, quality, and additional social equipment.

3.2.2 Clean Development Mechanisms

The Clean Development Mechanism (CDM) is one of the three flexible mechanisms established by the Kyoto Protocol, which provides legally binding reduction targets for six greenhouse gasses in industrialized countries. The CDM has been developed as a means to reduce greenhouse gas (GHG) emissions cost efficiently by allowing emission reductions in developing and newly industrialized countries. These countries are credited and financed by the industrialized countries in the Kyoto Protocol. Each ton of CO_2 reduced in a Non-Annex I country becomes a "Certified Emission Reductions" (CER) and is tradable in the carbon market. Therefore, the CDM is a financing tool to transform investment into clean energy technologies (Schroeder, 2009).

Small hydropower projects could be of interest under the CDM because they directly displace GHG emissions while contributing to sustainable rural development (Purohit, 2008). The CDM has certainly transformed renewable energy into the world's focus on sustainable development. The key feature of this mechanism is that industrialized countries set their emission-reduction targets and developing countries can benefit from the implementation of clean energy technologies. Implementing CDM in projects results in carbon emission reductions, commonly known as Certified Emission Reductions (CERs). Hydropower projects have emerged as one of the most popular projects to be developed in CDM project activities because of their environmentally benign nature.

3.2.3 Green Bonds

According to Reichelt (2010), Green Bonds are "a 'plain vanilla' fixed income product that offers investors the opportunity to participate in the financing of 'green' projects that help mitigate climate change and help countries adapt to the effects of climate change" (p. 3). At the time this dissertation was written, 153 Blue Bonds had been issued by 84 issuers (the biggest issuer was Anglian Water) for a total of USD 18bn (Climate Bonds Initiative, 2016a). Blue Bonds can be considered a subset of the Green Bonds market (Climate Bonds Initiative, 2015) and are used to finance water-related assets. Water infrastructure systems will build them over the next 15 years, particularly in the developing countries; they have a strong influence on track for a 2-degree Celsius (or lower) pathway, as outlined in the Paris Agreement (Inter-American Development Bank and Mercer, 2016).

Nevertheless, despite their strategic importance for closing the coverage gap in the water sector, this type of financial mechanism is in its growth stage and the issued volume (2.6%) in comparison to other sectors accounts for only a small proportion of the climate-aligned universe (Climate Bonds Initiative, 2016a). It is important to consider that not all Water Bonds can be considered green by default. To become a green bond, a Water Bond must fulfill the Water Climate Bonds criteria. The Water Climate Bonds Standard (2016b) aims to provide investors with valid, science-based criteria for evaluating water-related bonds. These criteria include:

- Delivering greenhouse gas mitigation,
- Promoting adaptation to climate change, and
- Facilitating increased climate resilience in social, economic and environmental systems, reinforced by water assets (Climate Bonds Initiative, 2016a).

To improve the water-related bonds market, these criteria should meet the needs of both investors and issuers. Thus, Table 3-3 shows the main eligibility criteria for both investors and issuers.

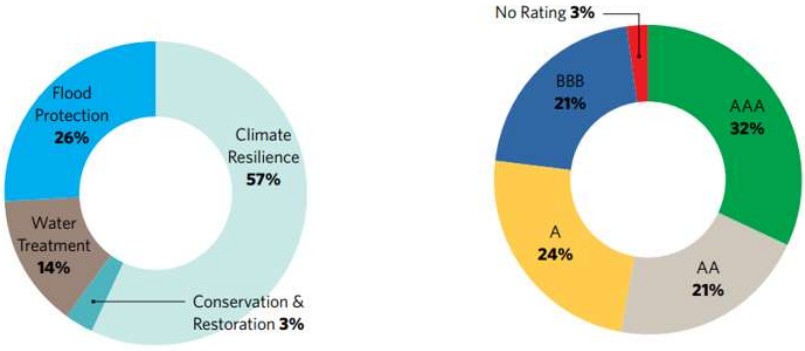
Table 3-3. Main eligibility criteria for water-related bonds

Investors	Issuers
• Relatively straightforward, predictable, and easy to understand (e.g., in terms of the source, and reliability of expected cash flows). • Transparent regarding use of proceeds and intended impacts, allowing independent third-party scrutiny. • Sizable and liquid, and preferably rated. • A comparable investment opportunity relative to non-green-labeled bonds.	• Allow a relatively wide scope of eligible project and assets. • Not restrict innovation or appropriate local solutions and tradeoffs. • Demonstrate efficacy and expertise that promote trust and confidence. • Clarify how environmental risks are reduced or eliminated, and how the issuance will ultimately promote environmental benefits.

Source: Climate Bonds Initiative (2016a).

The following figure shows in which kind of projects the Water Bonds have been used and their credit rating.

Figure 3-2: Water Bonds per kind of project and credit rating.



Source: Climate Bonds Initiative (2016)

3.3 Mezzanine Debt for developing Sustainable Infrastructure Systems

Historically, apart from equity investment, water systems have primarily been financed by external financial resources, including both cash financing and debt financing. Cash financing is limited. Because of the revenue from water rates, service fees or connection fees from new accounts, there is not enough cash financing to fund a capital-intensive effort. Debt financing is the most common method that utilities use for raising upfront capital. Municipal bonds, which are issued by governments in the capital markets, are the most commonly used debt instrument for raising resources (The Johnson Foundation, 2012). As explained in Paper 2, in the Colombian case, even though this mechanism was useful for developing water projects in 2009 under a financial asset called "Water Bonds", its high-interest rates caused a high financial expense, resulting in a debt-substitution operation (Ministerio de Hacienda, 2014a).

As mentioned above, the main financial resources used to develop infrastructure systems through PF schemes are equity and debt. Repayment is made from the Free Cash Flow generated by the project (Esty, 2004; Gatti, 2013; Zhang, 2005). There is, however, a third capital source located between equity and debt: mezzanine debt. This type of financial mechanism primarily involves debt but also some features of equity capital that occupy an intermediate position between senior debt and common equity shares. For this reason, mezzanine debt is also called quasi-equity (Zhang, 2005). Although mezzanine debtor is used in other forms of structured finance, it has not been widely used in PF (Yescombe, 2007). Therefore, considering the recent boom in structured finance (Leland, 2007), there are wider opportunities to develop research on this topic. According to Dong et al. (2011) and Nijs (2014), mezzanine debt can be characterized as subordinated debt and convertible securities, as Figure 3-6 shows and Table 3-4 describes.

Table 3-4: Description of subordinated debt and convertible security

Type of Mezzanine debt	Description
Subordinated debt	Subordinated debt is called junior debt. It is ranked below that senior debt and therefore, it has a lower priority and, in turn, a higher interest rate debt due to its intrinsic risk. Also, it is frequently an unsecured debt. Subordination can be configured contractually or structurally. Contractual subordination involves an explicit indication that principal and interest will be repaid only after all other senior debts have been repaid. Structural subordination occurs when the conditions and maturity of the debt have been structured in such a way
Convertible security	This type of debt includes convertible bonds, convertible subordinated debt, and debt with a warrant. This product can, therefore, change nature during its lifetime, from a fixed-income instrument into common equity (i.e., it is an American-type option, although in some cases the conversion is mandatory). At the moment of conversion, a convertible security will dilute the existing position of the common shareholders. It will, at the moment of conversion, dilute the existing position of the common shareholders. It can have other embedded options included (call or put, soft or hard, protection, etc.). Also, these include the conversion period and the conversion ratio; this last one will be based on outstanding debt.

Source: Author's elaboration based on Nijs (2014) and Dong et al. (2011).

Convertible securities have a contingent claim from lenders, which may cause that capital structure to change once during the project's life. For example, outstanding debt may be transformed into equity shares. Thus, because private investors prefer a secure financial return in the short term and are relatively passive about investing in sustainable constructions, mezzanine-type debt should be considered a well-structured investment option for infrastructure projects since it initially allows private investors' participation as lenders with the possibility of becoming sponsors. Accordingly, mezzanine debt can also include equity participation rights and may be attractive to investors such as pension funds (OECD, 2015).

In a study conducted by McKinsey & Company on financial mechanisms, 54% of current infrastructure investors indicated that they are willing to participate in projects through mezzanine financing (e.g., subordinated debt) and more than 85% are interested in equity shares (Bielenberg et al., 2016). Accordingly, it can be concluded that there is a potential demand for financial assets that include both debt and equity. On this point, "innovations in financial instruments could expand the range of investment options, improve risk-return profiles, help reach a wider investor base, and channel more resources into sustainable infrastructure" (Qureshi, 2016, p. 40).

This could help the discussions presented by Leland (2007) on how structured finance creates value and by The Johnson Foundation (2012) on how private capital can be directed toward sustainable water projects and which new financing techniques can be used to pay for integrated and sustainable infrastructure approaches. In this way, lenders are willing to accept a lower payout (measured by Kd_m interest rate) because of the potential return from sharing the increment of the project's valorization through the conversion of outstanding debt per share (Investopedia, 2016).

In this way, and given the need for both debt and equity for financing infrastructure systems, the mechanisms' design to improve sustainable infrastructure investments should address both financing modes (Bielenberg et al., 2016). Rezende et al. (2016) consider it important to contribute to theory that will advance the conceptual debates on sustainable financial issues.

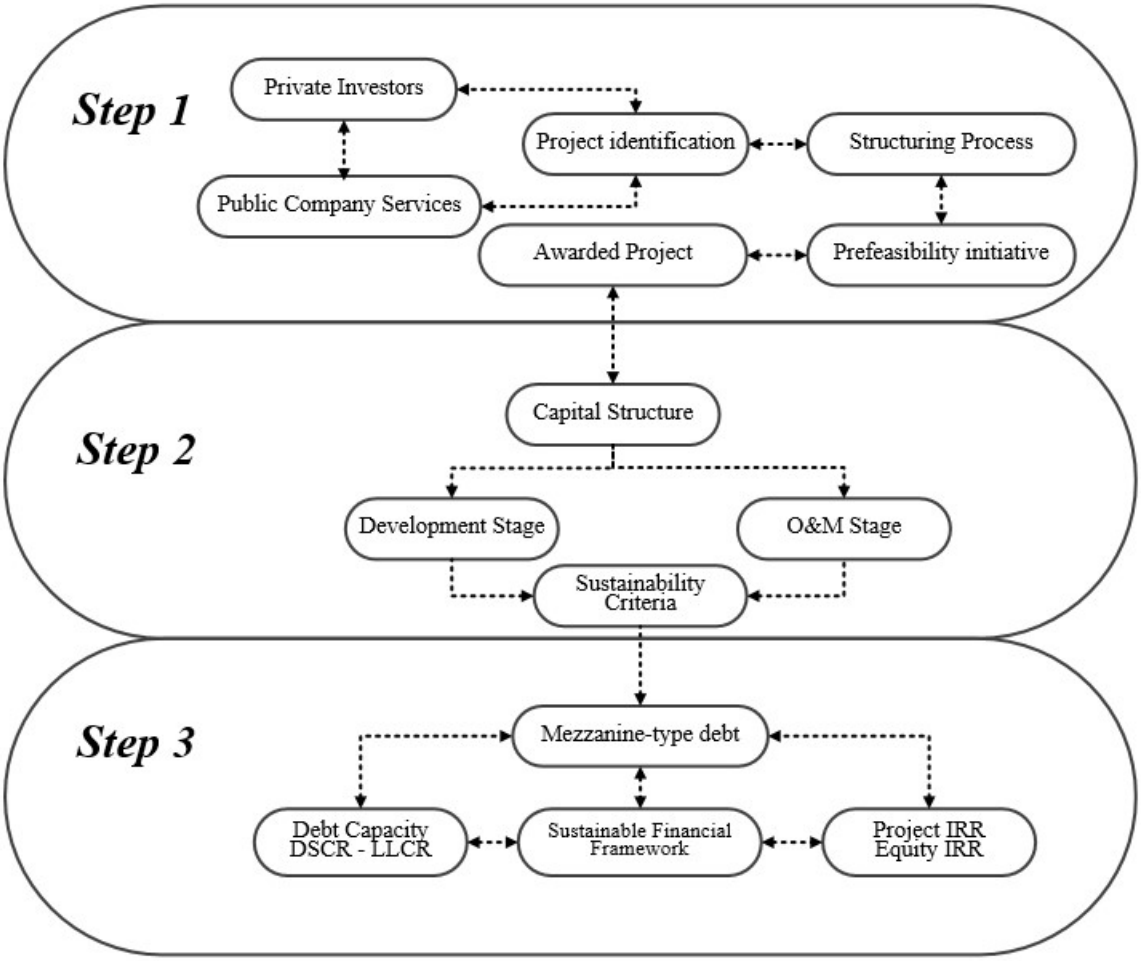
Since this financial framework includes the TBL on its structuring process, it could be considered an eco-innovative financial mechanism because, like the Paris Agreement and the United Nations Sustainable Development Goals, it encourages the development of SIS and the private sector's involvement. According to this research, the literature contains no elements that determine whether there is any kind of subordination of economic, social or environmental sustainability elements in the structuring of financing, particularly when paying debt service or transforming debt into shares. For these reasons, sustainable innovation can be considered a process that integrates environmental, social and financial sustainability factors into the business development system, generating new business models and business organization.

3.4 Methodological proposal

The methodological approach to financing SIS in the Colombian water sector is structured by steps. Figure 3-3 shows a scheme that summarizes, in a general form, the proposed methodology. Subsequently, each step is systematically integrated into a sustainable financial framework. This methodology will provide a better description of the SIS structuring process and how to improve strategic decision-making, particularly in financing issues. This way, the methodology becomes a financial tool that strengthens the financing process, helping boost the development of SIS and close the coverage gap.

The design and establishment of the methodological proposal considered both theoretical and academic findings in the development of the theoretical framework, along with the main difficulties in the water sector. These issues were mentioned in the previous papers. These theoretical and practical findings constituted the basis of this dissertation's methodological proposal.

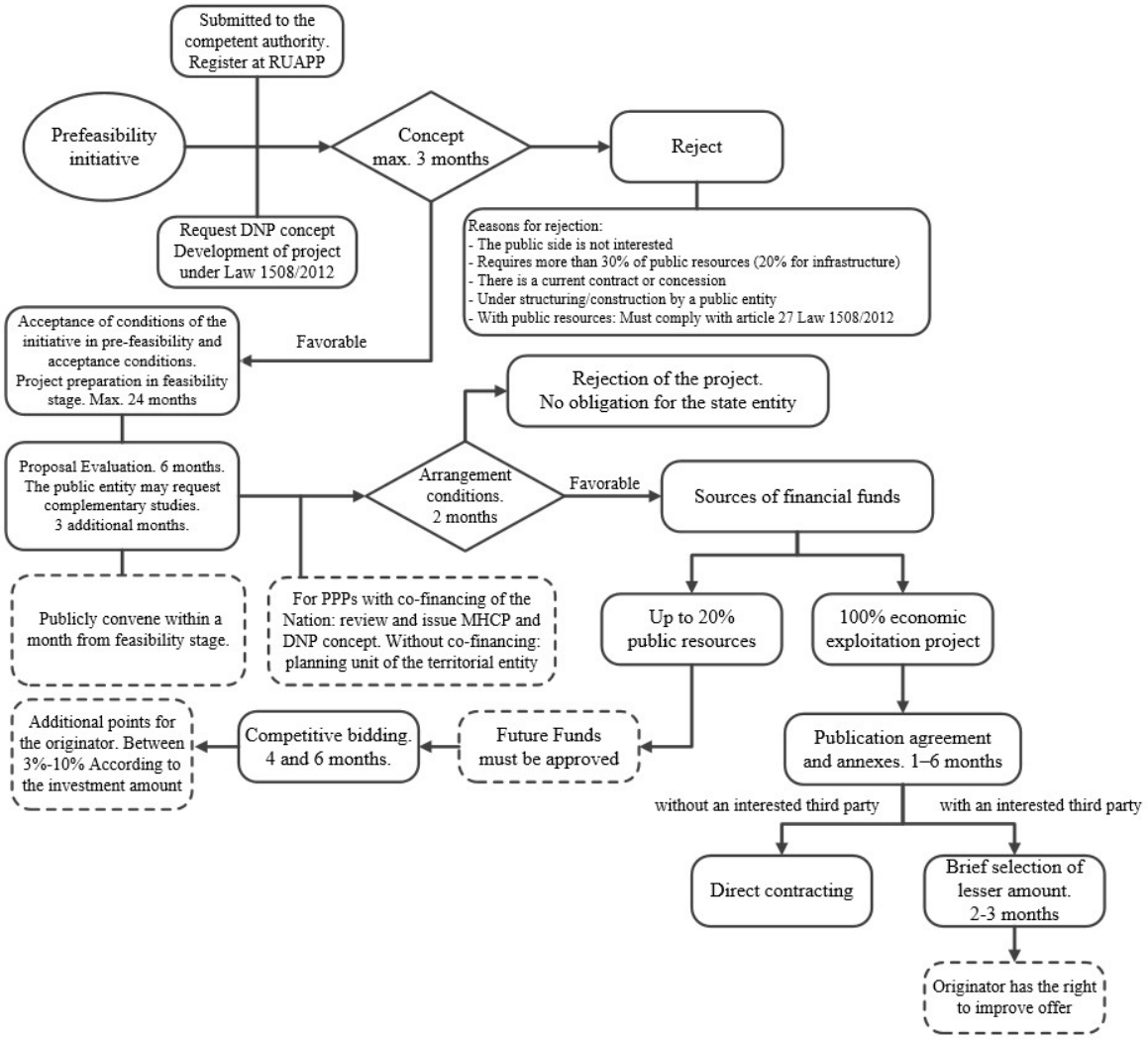
Figure 3-3: Methodological scheme



3.4.1 Step 1 → Structuring Process

Based on the identification of investment opportunities in the water sector, as shown in Paper 2, private investors can present two types of proposals to carry out projects (see. Table 2-1): with public resources and without public resources. The main difference between the two is based on the public funding issue. In the first type of proposal, Private Initiative with Public Resources (PIPR), the amount of public financing cannot be more than 30% of the value of the original contract. Such proposals will be conditioned on infrastructure availability. For example, operating projects must comply with service levels and quality standards. In the second type of proposal, Private Initiative without Public Resources (PIWPR), there is no public funding; therefore, projects must be financed exclusively by operating income. Figure 3-4 is a flowchart showing what private investors must do to propose an infrastructure project. According to the Colombian PPPs Law, this process takes not more than 18 months.

Figure 3-4: Flowchart of a Private Initiative under the Colombian PPPs Law



Source: Author's elaboration based on Departamento Nacional de Planeación (2016)

3.4.2 Step 2 → Structuring of Development and O&M stages

Taking into account that almost all financial models adopt a bottom-up approach to PPPs projects (Kurniawan, Mudjanarko, and Ogunlana, 2015), this proposal has used a strategy that prioritizes input identification. Thus, to present an approach to a sustainable financial scheme that incorporates sustainability criteria into a financial model, this proposal considers two stages in the implementation of infrastructure projects. The first has two stages, namely, Preparation and Construction; they have been unified for practical effects at the Development Stage. The second is the Operations and Maintenance (O&M) stage. The two stages are explained as follows.

- **Development stage**

With the aim of keeping track of the capital structure's evolution during the development stage, which includes both the Preparation and the Construction stages, this work presents a mathematical model that enables identification of the impact on the final capital structure based on an investment plan and capital structure per period. As shown in Table 2, this model uses three financial sources: equity, senior debt, and mezzanine debt.

Table 3-5: Capital structure evolution described as a mathematical model

<table>
<tr><td colspan="2" rowspan="2">Financial Sources</td><td colspan="4">Development Stage</td><td rowspan="2">Final
Capital Structure</td></tr>
<tr><td colspan="2">Preparation → x periods</td><td colspan="2">Construction → k periods</td></tr>
<tr><td colspan="2">Equity</td><td colspan="4">$\sum_{i=0}^{x+k}\left(I_i.(1+\%SF_i)+S_{i-1}.Kd_{s_i}+M_{i-1}.Kd_{m_i}\right).\%E_i$ (1)</td><td>$\frac{E_{x+k}}{E_{x+k}+D_{x+k}}$ (4)</td></tr>
<tr><td rowspan="2">Debt</td><td>Senior</td><td colspan="4">$\sum_{i=0}^{x+k}\left(I_i.(1+\%SF_i)+S_{i-1}.Kd_{s_i}+M_{i-1}.Kd_{m_i}\right).\%S_i$ (2)</td><td rowspan="2">$\frac{D_{x+k}}{E_{x+k}+D_{x+k}}$ (5)</td></tr>
<tr><td>Mezzanine</td><td colspan="4">$\sum_{i=0}^{x+k}\left(I_i.(1+\%SF_i)+S_{i-1}.Kd_{s_i}+M_{i-1}.Kd_{m_i}\right).(1-\%E_i-\%S_i)$ (3)</td></tr>
<tr><td colspan="2">$\%E_i+\%D_i=1$ (6)</td><td>$Capex_i=E_i+D_i$ (7)</td><td>$Kd_{mi}>Kd_{si}$ (8)</td><td>D_{x+k} = (2)+(3)</td><td>E_{x+k} = (1)</td><td>Total Capex
(1)+(2)+(3)</td></tr>
</table>

I_i = Investment at period *i.* $\%E_i$ = % Equity at period *i* . $\%D_i$ = % Debt at period *i* . S_i = Accumulated Senior debt at period *i.* $\%S_i$ = % Senior debt at period *i.* Kd_{si} = Interest rate of Senior debt at period *i* . M_i = Accumulated Mezzanine debt at period *i.* Kd_{mi} = Interest rate of Mezzanine debt at period *i.* $Capex_i$ = Capital expenditures at period *i.* SF_i = Sustainability Factor at period *i.*

This mathematical approach proposed is adjusted to any financing process in which includes equity, senior debt and/or mezzanine debt. The main assumptions are presented as follows.

1. The investment plan could be divided into 2 stages. The first stage (Preparation) has a duration of x periods and the second stage (Construction) has a duration of k periods. Thus, the development stage, which combines the above stages, will have a duration of x+k periods. This way, each investment will be given by I_i, where *i* indicates each period and thus $\sum_{i=0}^{x+k} I_i = \text{investment plan}$ (9). This equation enables an investment curve according to the construction plan; therefore, it does not uniformly use the distributed cost. In addition, O&M will have a duration of n periods and will not have an investment plan. In this manner, the project's total duration will be given by x+k+n periods, which includes the Preparation, Construction, and O&M stages.

2. Each period could have a different capital structure. Thus, equity investment, given by $\%E_i$, could be different at each period *i*; therefore, total debt provided by the Senior and Mezzanine debt will be the complement (1-$\%E_i$). As a result, equation (6) is mandatory. This model can be used in any scenario. For example, lenders can limit the sponsors' investment strategy through guarantees, covenants or letter of credit; thus, projects' debt could be disbursed after 100% equity investment or Pari Passu. The final capital structure will be given by the participation of total equity and debt between Total Capex, which is shown in the "Final Capital Structure" column in equations (4) and (5) respectively. Another method is to calculate the weighted average between total equity and Total Capex per period (Equation 10). In a similar way, the weighted average could be used as shown in equation 11.

$$\%\ \text{Equity} = \frac{\sum_{i=0}^{x+k} \%E_i . Capex_i}{\sum_{i=0}^{x+k} Capex_i} \quad (10) \qquad \%\ \text{Debt} = \frac{\sum_{i=0}^{x+k} \%S_i . Capex_i + \sum_{i=0}^{x+k} (1 - \%E_i - \%S_i) . Capex_i}{\sum_{i=0}^{x+k} Capex_i} \quad (11)$$

3. Interest rates in senior debt (Kd_{si}) and mezzanine debt (Kd_{mi}) could be different at each period *i*. Therefore, according to the project's risk and development-stage duration, it would be possible to have an interest-rate arrangement per each period *i*. In any event, because of intrinsic risk the relation between these interest rates follows equation (8). The average cost of debt funding, which includes both senior and mezzanine debt, could be calculated as shown in equation (12).

$$\text{Weighted average cost of debt financing} = \frac{\sum_{i=0}^{x+k} kd_{si} . S_i + \sum_{i=0}^{x+k} kd_{mi} . M_i}{\sum_{i=0}^{x+k} Debt_i} \quad (12)$$

4. Interest generated at each period *i* by accumulated debt, which includes senior and mezzanine debt, must be paid according to the capital structure of each period *i*.

5. The investment plan, which includes both the construction contract and inflation, will be signed by sponsors through an SPV with a construction company. The total interest paid during the development stage can be calculated as the difference between the Total Capex and the investment plan, which are given by $\sum_{i=0}^{x+k} Capex_i$ (13) and $\sum_{i=0}^{x+k} I_i$ (9), respectively. Therefore, if the project is financed only by sponsors, this difference must be equal to zero and if there is debt at the development stage, the Total Capex must include the investment plan plus the interest.

6. Sustainability Factor, given by SF, is defined as the increase in the investment at each period *i*. According to Egler and Frazao (2016), this could be approximately 5%.

As explained above in Paper 1, fiscal benefits play a pivotal role in encouraging eco-innovations in the financial area. Thus, based on the mathematical approach presented and according to Article 158-2 of the Colombian Tax Law, the following consideration is taken into account in the proposal. Private investors, which invest in controlling and improving the environment, validated by competent authorities, will have the right to deduct the value of such investments from their annual income in the appropriate tax year; this deduction cannot be more than 20% of taxable income. Thus, since corporate income-tax payment must be paid one year later, the benefits can be taken into account one year after the investment has been made.

However, given that projects have only investment expenses in the Development Stage, the projects would not have either income or expenses and therefore would not have taxable income. This proposal suggests that tax benefits obtained at this stage could be used as a fiscal credit at the O&M stage. Similarly, this assumption will be evaluated in the case study. In this way, Capex invested by private investors during the Development Stage for developing water and sanitation projects, particularly for improving the quality of wastewater discharges to rivers, could be transformed into cash benefits during the O&M stage. Therefore, the total benefits provided by this regulation can be calculated as follows.

$$Fiscal\ credit_i = (Taxable\ income_i)(20\%)$$

$$\sum_{i=x+k+1}^{n} (Taxable\ income_i)(20\%) \leq \sum_{i=1}^{x+k} Capex_i \quad (15)$$

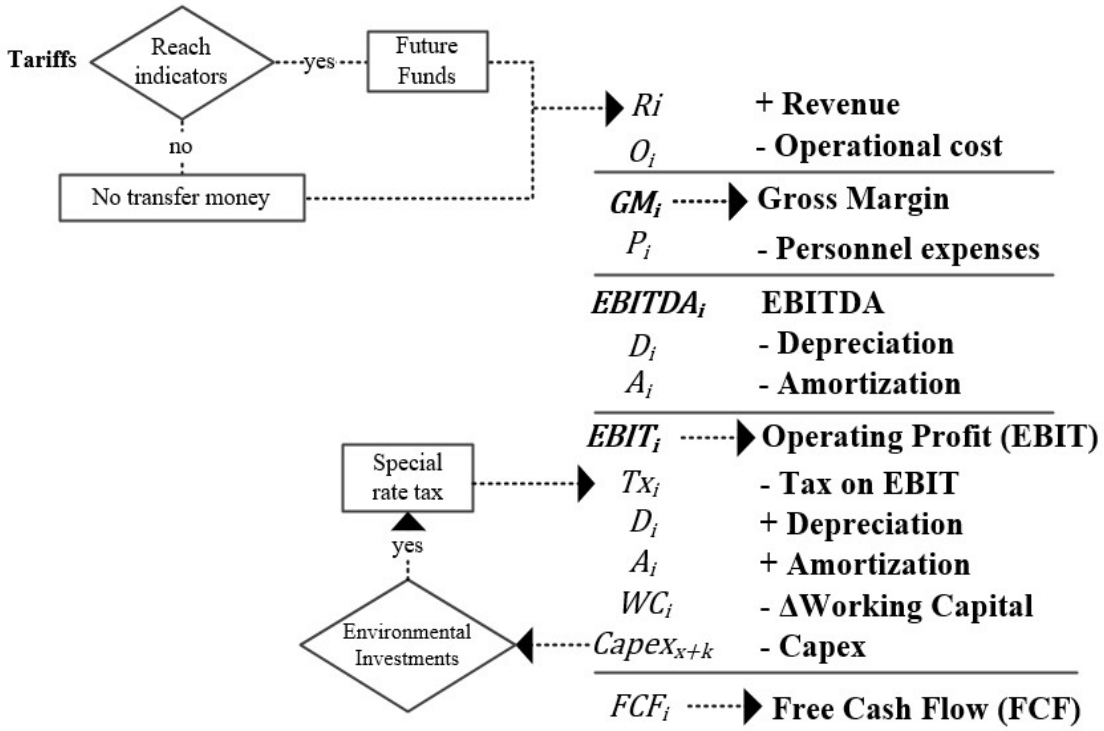
Recently, the average involvement of equity investment and debt in Colombian water-sector projects with more than 5,000 users was 67% and 33%, respectively (Comisión de Regulación de Agua Potable y Saneamiento - CRA, 2014). This indicates that the water sector requires new strategies for increasing its financial resources, especially debt instruments. Additionally, the average WACC in these projects was 12.76% (Comisión de Regulación de Agua Potable y Saneamiento - CRA, 2014); this indicates that benefits could be obtained through the achievement of less expensive financial resources than debt, improving corporate value.

- **Operating and Maintenance Stage**

Having modeled the evolution of the capital structure during the development stage, the model must incorporate in the O&M stage the sustainable criteria into cash flows, particularly in free cash flow, debt cash flow, and equity cash flow. This project will be carried out using financial engineering techniques as one of the main supports for PF schemes. In addition, it will be structured as a PIPR project and will be based on the BOT (Build, Operate, and Transfer) method for PPPs projects. Accordingly, sponsors must create an SPV for developing infrastructure projects and when the concession duration is over, they must transfer the assets (infrastructure projects) to the government. Therefore, the terminal value is not considered in the financial valuation process. In the Colombian case, according to PPPs Law 1508/2012, the maximum duration is 30 years, including extensions (Congreso de Colombia, 2012b).

To begin the mathematical modeling of the O&M stage, this stage is divided into two parts: operational and financing. Figure 3-5, based on the cash flow waterfall, shows the first part with the main drivers for encouraging the involvement of private investors in the water sector, aiming at increasing regional coverage through sustainable infrastructure projects.

Figure 3-5: Operational section



Source: Author's elaboration

The main assumptions are presented below:

1. According to PPPs Law 1508/2012 (Congreso de Colombia, 2012b), PIPR projects can obtain financial resources from the Colombian government. These resources are called "Future Funds" and are conditioned by their availability, service levels, quality standards, and service continuity. These funds may not exceed 30% of the contract's originally agreed value and will be delivered only at the O&M stage. This scheme assumes that fee-structure subsidies given to users are not part of the "Future Funds".
2. Private investors using legal entities will be enabled to take annual deductions from their taxable income of investments in environmental control and improvement. This value cannot exceed 20% of taxable income.
3. Income tax can be established per section.

From a programming perspective, Table 3-8 shows how the capital structure can be calculated at the O&M stage, which can occur when the Water Criteria are achieved; therefore, conversion debt-equity is executed.

Table 3-6: Capital Structure programming

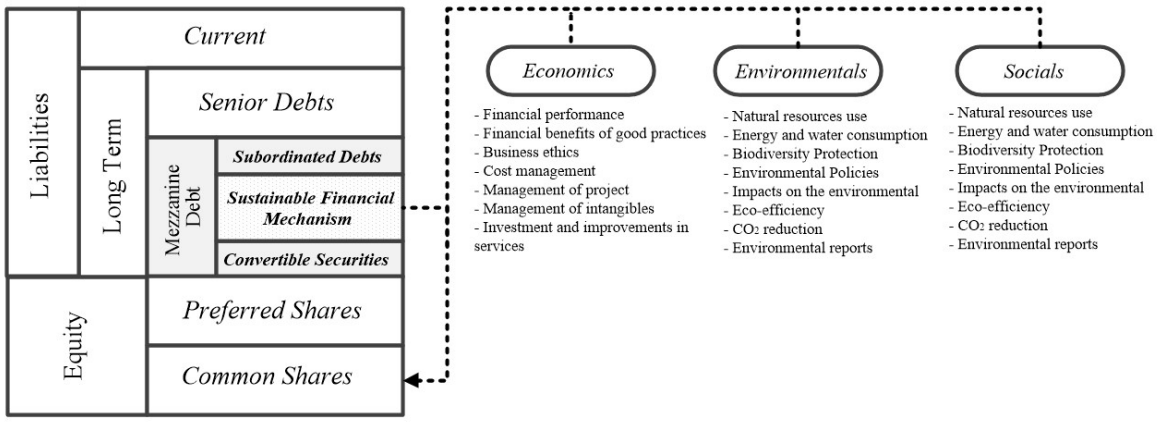
```
Conversion Debt-Equity = False

  For i = 1 To n-1

        If Water Criteria_i = Certify and Conversion Debt-Equity = False Then

              % Debt_i   = (Debt_i - Mezzanine_i) / Asset_i
              % Equity_i = (Equity_i + Mezzanine_i) / Asset_i

                      Conversion Debt-Equity = True
        Else

              % Debt_i   = (Debt_i - Amortization_i) / Asset_i
              % Equity_i = Equity_i / Asset_i

         End if

  Next i
```

- **Mezzanine-type debt as a sustainable financial scheme**

As stated above, because of the coverage gap, there are several opportunities to develop SIS in Colombia's water sector. However, financial resources from public entities are limited, so it is important to create new mechanisms that foster the private sector's involvement in developing a stronger infrastructure with respect to finance, society, and the environment. Consequently, a standard model based on best practices would create a standardized basis to establish innovative investment solutions that channel private investors toward SIS (Egler and Frazao, 2016).

Therefore, the development of new, innovative financial instruments that articulate such variables will enable expansion of the investment spectrum for the social infrastructure sector (where the coverage gaps are broad and there are no incentives to promote the involvement of the private sector). Figure 3-6 shows the mezzanine debt among the various financing sources; thus, based on this paper's goal, it shows how the proposed sustainable financial scheme works.

Figure 3-6: Sustainable Financial Mechanism proposed



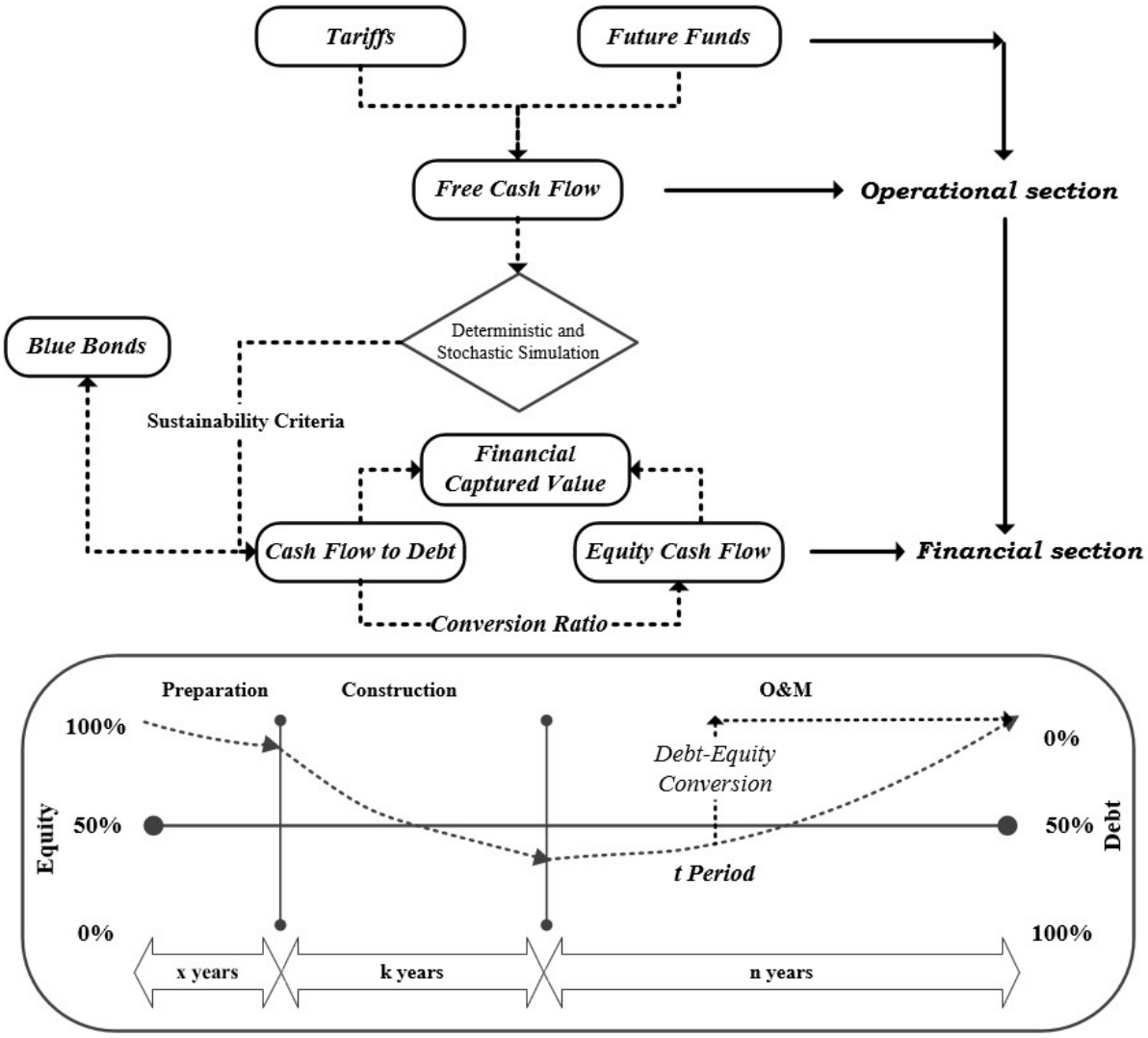
Source: Authors' elaboration

As mentioned above, the return expected by lenders could take the form of interest, given by the Kd_m interest rate, and in the case of changing debt per equity share, dividends or profits obtained by lenders selling their equity shares before the concession is over. In this last scenario, the creation of a primary and secondary financial market for assets indexed to infrastructure projects is mandatory, as shown in Figure 3-11 shows. This enables private investors to have a diversified project portfolio and therefore manage trades of the equity shares of different projects, generating liquidity in the capital market. Accordingly, through the creation of more eco-innovative mechanisms and the development of financial instruments to encourage sustainable infrastructure, it will be possible to build a new infrastructure (World Bank, 2012a). In addition, financing should be more innovative and should adapt to the needs of the SIS (Bielenberg et al., 2016).

This work suggests that if private investors finance projects using this mechanism (which is indexed with sustainable criteria), the capital structure could change if goals and covenants related to sustainability criteria are accomplished and if an American-type option or warrant is exercised. In short, payment of interest and capital will be subordinated to sustainability criteria and (if it exists) the senior debt payment. In the same way, the conversion of outstanding debt per equity shares will be subordinated by lenders to sustainability criteria when the goals and covenants related those the sustainable criteria are accomplished; this condition must have been included in the deal. Since the sustainable financial mechanism proposed presents elements of both subordinated debt and convertible security, it will be located between them, as shown in Figure 3-6.

Consequently, the capital structure will initially have a deterministic form (at the development stage). Since projects are full of uncertainties, for this proposal, the projects' capital structure will be stochastic during the operating and maintenance stage (O&M). This work does not intend to identify or propose a method for finding an optimal capital structure approach in SIS; on the contrary, through this financial eco-innovative proposal, it intends to show how the mezzanine debt and sustainability criteria integrated into in a theoretical framework could work together to raise private capital. In this way, Figure 3-7 shows not only how operational and financial sections are integrated but also their impact on the capital structure when outstanding debt is transformed into equity shares.

Figure 3-7: Operational and financial section integration



Source: Author's elaboration

The Capex, the operating income, and the cost structure are the variables that impact Net Present Value (NPV) and for the model above, are based on static values (deterministic results); in contrast, the Future Funds, the Environmental Benefits, and the Sustainable Financing proposed are random variables. Initially, this research applies deterministic simulation and then Monte Carlo Simulation to the model; thus, the variability of the criteria is applied. The tools used are Microsoft Excel and @risk by Palisade Corporation.

One problem identified by Fernández-Sánchez and Rodríguez-López (2010), cited by Martens and Carvalho (2016), is based on the need to establish a method for identifying and selecting a set of indicators in the project's life cycle that includes an appropriate balance among all the involved actors. For this purpose, The Water Criteria of the Climate Bonds Standard (Climate Bonds Initiative, 2016b) are used as a means of determining whether a project can be funded through the proposed financial mechanism. These criteria, which are related to the TBL concept, have three bases: Allocation, Governance, and Diagnostic. They are explained in the following table.

Table 3-7:The Water Criteria of the Climate Bonds Standard

Criterion	Description
Allocation	Addresses how water is shared by users within a given basin or aquifer. With regard to the proposed bond project, this element of the scorecard concentrates on the potential impact(s) of bond proceeds on water allocation. This is important in the context of climate adaptation as future uncertainty regarding water supply may impact allocation amounts over time and it is important for any bond projects to take water allocation mechanisms into account.
Governance	Addresses how / whether the use of proceeds takes into account the ways in which water will be formally shared, negotiated, and governed. Strong water governance is important in ensuring compliance with allocation mechanisms and helps protect water resources from conflict, overuse, waste, and degradation.
Diagnostic	Addresses how / whether the use of proceeds takes into account changes to the hydrologic system over time. Is the project infrastructure and / or ecosystem resilient to current and projected climate change impacts on water resources within the basin? For this element, the use of a credible hydrologic model is essential to understanding current and future conditions within the watershed or aquifer in question.

Source: Climate Bonds Initiative (2016b)

Although evidence has shown a positive relationship between infrastructure investment and economic growth, sustainable investments are not always profitable. Therefore, it should ensure that the private sector is aware that the use of sustainable finance as a strategy for financing infrastructure systems may not always guarantee a financial return. Furthermore, although the development of sustainable infrastructure can increase upfront capital costs by approximately 5%, it can also generate lower operating costs over the project's life-cycle, decreasing both risks and negative externalities (Egler and Frazao, 2016). According to Granoff et al. (2016), the main literature that compares this type of infrastructure with the traditional infrastructure considers the cost-differential between the two as a competitive disadvantage.

However, an OCDE study suggests that increasing the development of infrastructure systems that would limit the increase of temperature to no more than two degrees Celsius could be achieved through investment costs similar to a business-as-usual scenario (OECD, 2008). In this way, the World Bank shows the potential synergies between "build as it should" and "build more" provided total long-term costs are assessed (World Bank, 2012b)

Also, it cannot be guaranteed that the use of a PF scheme ensures that a project will raise the financial resources for its development. Thus, such schemes may not have either operation profitability (measured by Return on Assets (ROA)) or equity profitability (measured by Return on Equity (ROE)). Anyhow, wise investors seek a higher ROE than ROA. The following table indicates the main contributions on this topic.

Table 3-8: ROA, ROE, Mezzanine debt about eco-innovative investments.

Author	Description
Gatti (2013)	Demonstrates that using mezzanine debt as a financing source it is possible to improve ROE.
Clarkson et al. (2011)	Emphasize that the consequences of better environmental performance should lead to a better forthcoming financial performance reflected in the ROA and the Operational Cash Flow, as well as in a higher value of the firm measured by Enterprise Value.
Clarkson et al. (2011)	Good environmental performance reduces regulatory risks. Therefore, this affects directly corporate valuation through a lower discount rate
Przychodzen and Przychodzen (2015)	In an in-depth research, these authors indicate that eco-innovative companies generally have higher ROA and ROE.
Gupta et al. (2016)	Investors may opt for cheaper Capital Expenditures (Capex) in exchange of higher long-term Operating Expenditures (OpEx). As a result, the initial higher costs required to implement sustainability practices may negatively impact the short-term Return on Investment (ROI) thereby discouraging decision makers from adopting such methods.
González Ruiz et al. (2016)	Green benefits derived from sustainable financing are incorporated in the calculation of the WACC.

It is important to impact investors' behavior and thus shift the investment industry mindset in relation to sustainable infrastructure. That means that higher financial returns could be the consequence of better operation performances, lower financial costs and an adequate financing strategy, which should include sustainable financial resources. In this way, SIS could reduce operational costs through a focus on efficiency (Bertera, 2015).

In this regard, Fatemi and Fooladi (2013) argue that it is necessary to change traditional shareholders' maximization of sustainable value creation as only the viable way forward. Likewise, Bolton (2015) provided a remarkable description of financial and sustainable investments indicating no difference between the two given that both types of investments create social, financial, and environmental value, which is confirmed by Martens and Carvalho (2016).

Taking into account what was mentioned above, there has been a call for an adjustment in the traditional valuation framework based on the TBL criteria (Fatemi and Fooladi, 2013); a call for attracting green resources requires the development of financial instruments that expose investors to sustainable infrastructure assets (Meltzer, 2016). Along these lines, it is no longer true that investment decisions are based only on financial returns; instead, they are also based on a combination of economic, social and environmental issues (Foxon et al., 2015). In this way, states should encourage private investments through tax incentive mechanisms that improve the coverage gap through the development of sustainable constructions. This could enable both financial returns and sustainability effects.

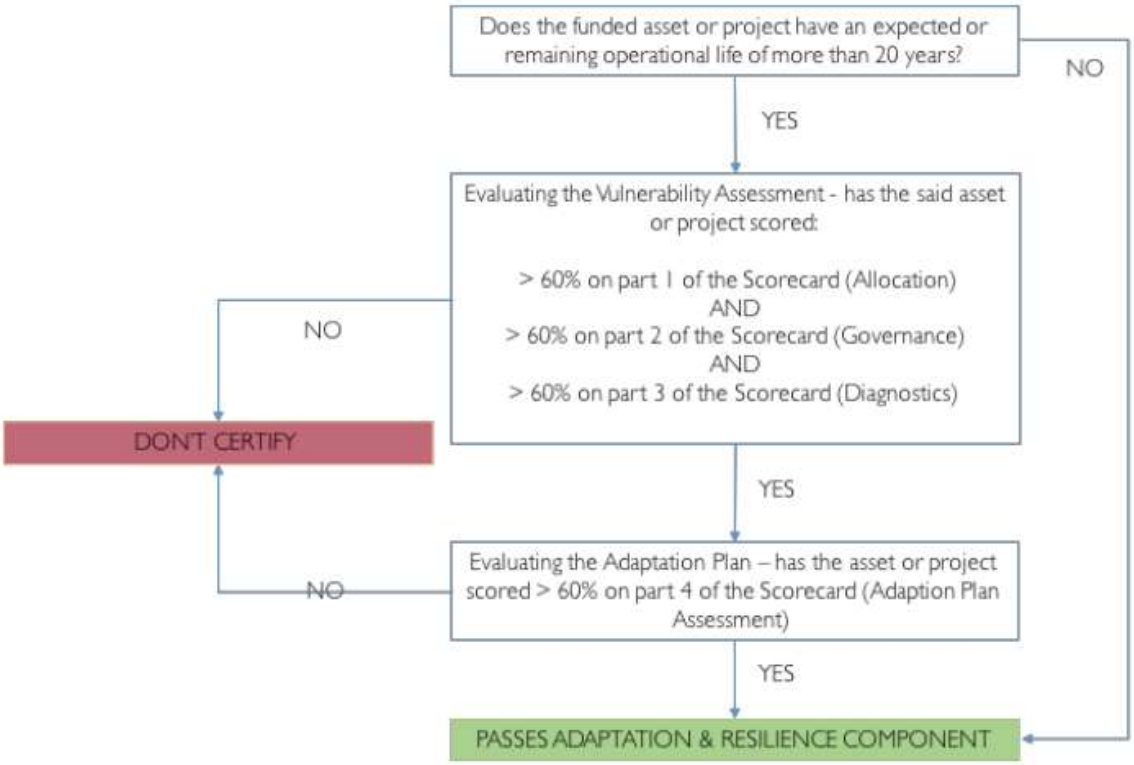
That said, governments must measure the agreed conditions regarding the availability and quality of infrastructure, which is determined according to the characteristics of the projects, the use requirements; these indicators allow to monitor and control the previously agreed conditions (Yescombe, 2007).These ensure the provision of the service effectively. In Colombia, the indicators are defined by the competent state entity, leading to compliance measures based on availability, quality standards, and service levels. (Complying with the agreement creates the right to remuneration by the state.)

Likewise, there will be a mechanism of gradual deductions in the event of failure to comply with the agreement; this mechanisms will be included in the contract (Congreso de Colombia, 2012a). These payments are called Future Funds and represent the items that are reserved by the state for the development of infrastructure projects and that will be delivered during the operating phase. These resources can be a maximum of 30% in dollars (Congreso de Colombia, 2012a), allowing the SPV to diversify its financing sources and to obtain loans in dollars, providing a natural hedge against the exchange rate.

- **Water Climate Bonds Criteria**

Figure 3-8 shows the decision tree for the Adaptation & Resilience component of the Water Criteria. This shows that to satisfy the standard, the minimum score in each indicator must be at least 60%. According to Climate Bonds Initiative (2016b), issuers have the responsibility to self-assess and self-score the project's Scorecard or asset funded by the bond proceeds in the first instance. Next, verifiers are required to validate those statements using the information and evidence presented to them by the issuers.

Figure 3-8: Decision tree for the Adaptation & Resilience component of the Water Criteria



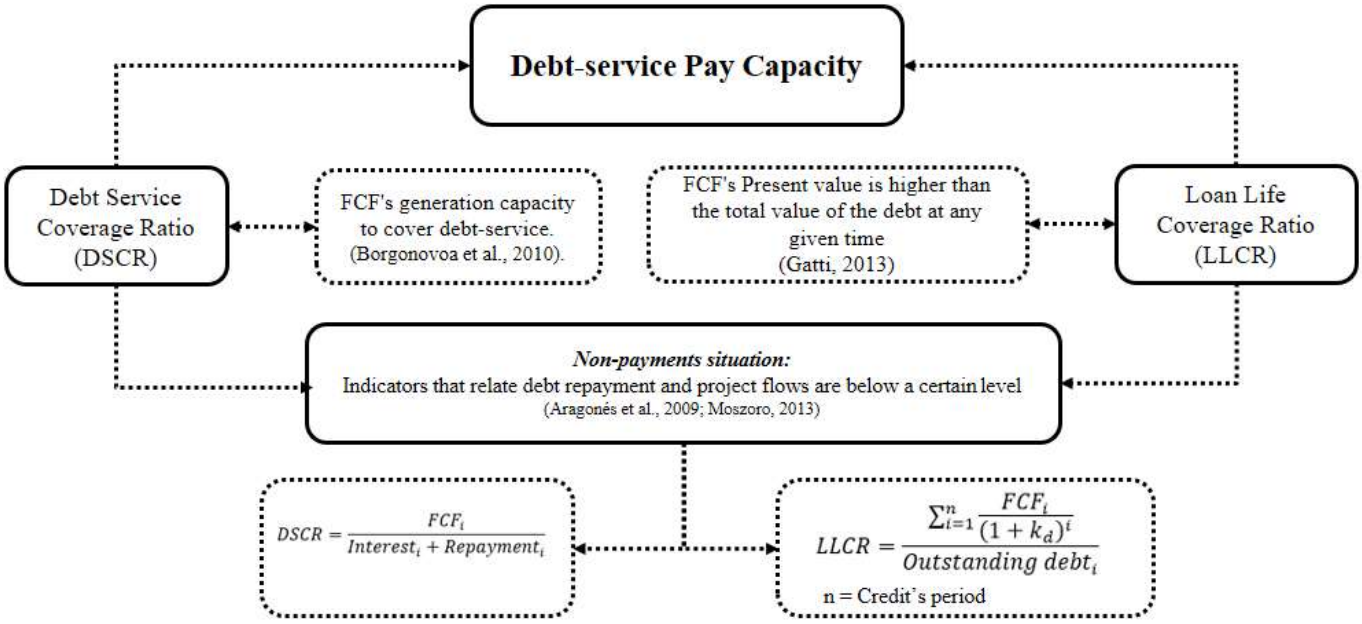
Source: Climate Bonds Initiative (2016b)

- **Indicators of debt-service capacity**

The importance of the control and monitoring mechanisms to be implemented by sponsors, lenders, and governments have led to the use of indicators that measure a project's capacity to pay for debt service and compliance with the infrastructure's quality and service levels. In practice, the primary mechanisms used by financial institutions are the Debt Service Coverage Ratio (DSCR) and the Loan Life Coverage Ratio (LLCR) (Borgonovoa et al., 2010), which measure the coverage of Free Cash Flow (FCF) on debt service (interest plus repayment) during the credit period.

These indicators help to evaluate the default situation; in this regard, Aragonés, Blanco, and Iniesta (2009) state that the PF default event occurs when certain indicators that relate debt service and project flows drop below a certain level. In project monitoring, auditing SPV is used to validate compliance with basic indicators or conditions of projects so that financial institutions could require the issuance of certificates (López and García, 2005). Figure 3-9 integrates the two concepts, and Table 3-8 shows the DSCR and LLCR averages for different sectors.

Figure 3-9: DCSR and LLCR as indicators of debt-service capacity



Source: Author's elaboration based on Aragonés et al. (2009), Borgonova et al. (2010), Gatti (2013), and Moszoro (2013)

Table 3-9: DSCR and LLRC average for sector

Sector	DSCR	LLRC
Power		
Merchant plants	2.00x – 2.25x	2.25x – 2.75x
With a tolling agreement	1.50x – 1.70x	1.50x - 1.80x
Regulated business	1.40x – 1.45x	1.40x – 1.45x
Transportation	1.35x – 1.50x	1.40x – 1.60x
Telecommunication	1.35x – 1.50x	1.35x – 1.50x
Water	1.20x – 1.30x	1.30x – 1.40x

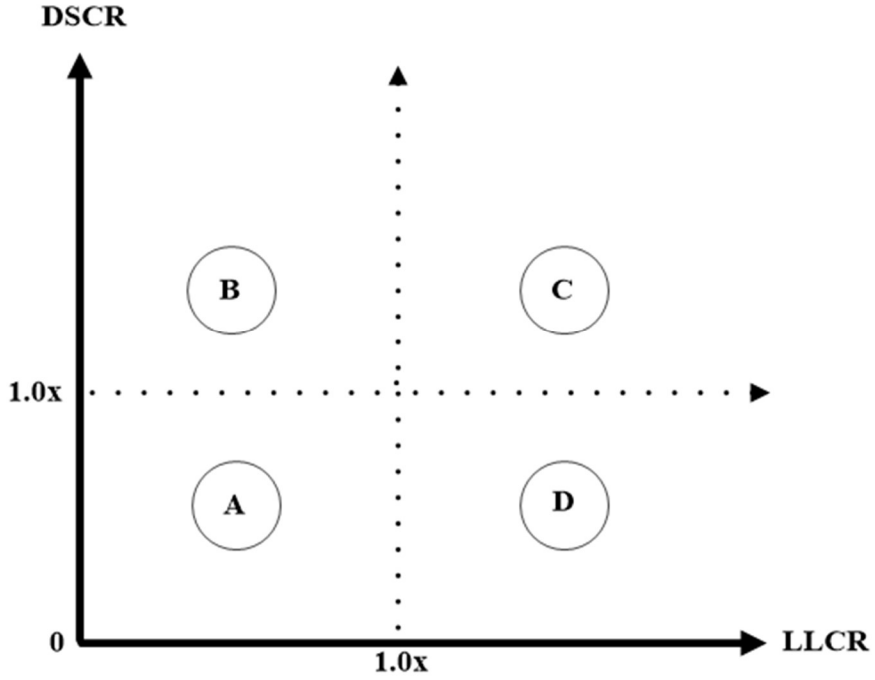
Source: Gatti (2013)

- **Proposal for validating debt-pay capacity**

One of a financial model's primary objectives is to test the project's financial viability (Kurniawan et al., 2015). For that reason, considering that both indicators must be higher than one, both in a graphical way and as an extension to the DSCR and LLCR indicators, this proposal also contributes to the construction of a new method for monitoring debt-service capacity, as shown in Figure 3-10. Zone A indicates that the project does not have the debt-service capacity to pay; therefore, operating or capital structure must be reconsidered. Zone B shows that the project can service its debt during a specific calculated period; however, it will not generate enough future FCF to pay the debt service.

In Zone C, current and future debt-service payments can be made by FCF. Zone C is the ideal zone for any project. Finally, in Zone D, the project cannot service its debt during a specific calculated period; however, the project will generate enough future FCF to service its debt, unlike in Zone B.

Figure 3-10: Proposal for validating Debt-Service capacity



Source: Author's elaboration

Other indicators identified in the literature and used to analyze the financial viability of infrastructure projects include Adjusted Net Present Value, Modified Internal Rate of Return, Self-financing Capacity, Equity Ratio in Risk (Iyer and Sagheer, 2012), Decoupled Net Present Value (Espinoza and Morris, 2013), and the Project Life Cover Ratio (Grimsey and Lewis, 2002).

3.4.3 Step 3 → Sustainable financial framework

Promoting the implementation of innovative models, particularly in the social infrastructure sector (where coverage gaps are wide) will articulate the environmental variables related to sustainable development. As a result, supporting the Colombian capital market and investing in the mitigation of climate change have become the most important challenges in Latin America, particularly in Colombia.

Although the transition to a greener economy has highlighted the importance of financial innovations, these innovations have not been fully addressed (Polzin, von Flotow, and Klerkx, 2016). Therefore, a funding framework that includes PPPs and PF schemes is crucial in the transition towards the development of eco-innovations (Leete, Xu, and Wheeler, 2013; Moore, Westley, and Nicholls, 2012; Polzin et al., 2016). Next, PPPs mechanisms, which are considered innovative by nature, play a fundamental role in financing development since they leverage private sources to support the provision of public utilities (Schmidt-Traub and Sachs, 2015). It also must be considered that PF offers real possibilities to promote sustainable development (Zhou, Keivani, and Kurul, 2013). In this way, it will be required to incorporate sustainability criteria into PPPs is required (Koppenjan, 2015)

Because there is a historic window of opportunity to develop a sustainable financial system (UNEP, 2015), a complete funding framework for SIS should be based on a clear understanding of the complementary roles of public and private funding and how the two of them can work together to achieve complex long-term social objectives (Schmidt-Traub and Sachs, 2015). In this way, many public financial institutions work with private financing to close the viability gap for investors in green projects (World Economic Forum, 2015).

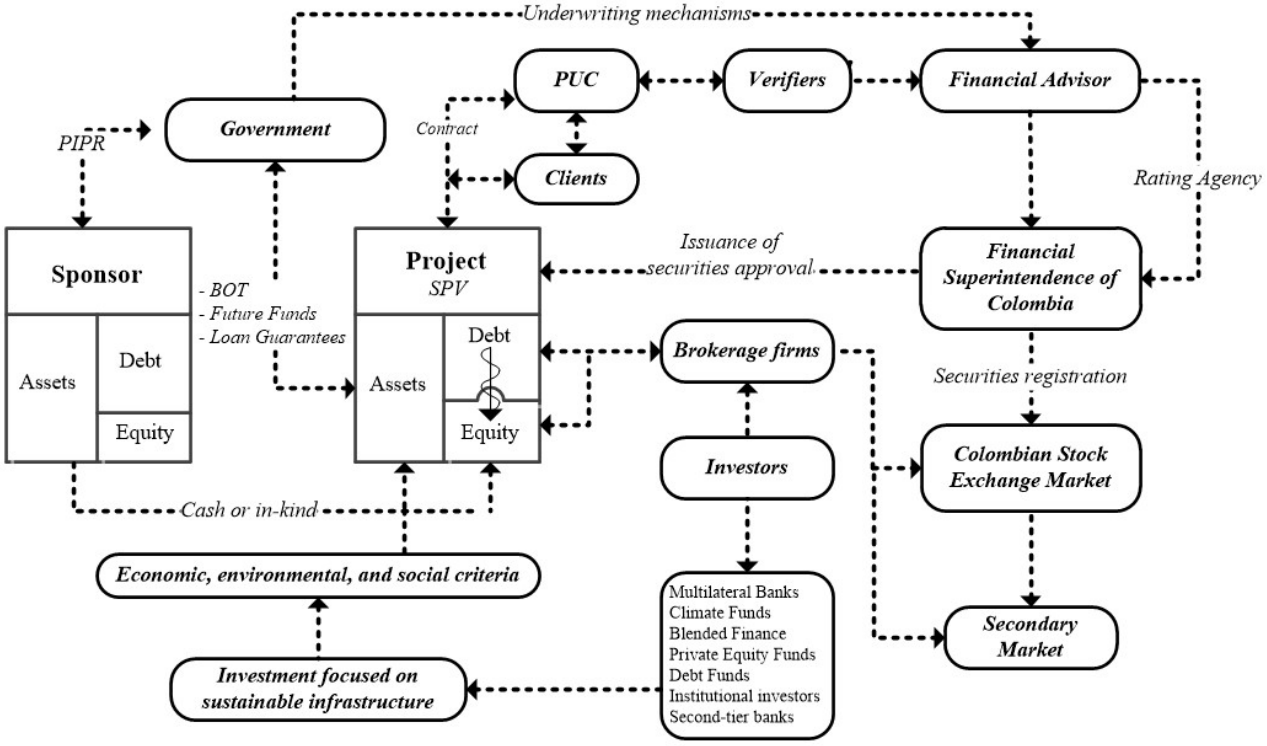
- **Financing Sustainable Infrastructure projects through capital markets**

As a proposal for financing SIS, Figure 3-11 allows the identification, under a systemic approach, of the main participants in a sustainable financial framework. This proposal is based on PPPs and PF schemes and incorporates the Colombian capital market as a means of raising sustainable financial recourses provided by special investors. Therefore, the primary objective of a sustainable financial framework should create value by implementing financial assets in ways that shape real wealth to support the long-term demand of a sustainable economy (UNEP, 2015). Consequently, a revision of the financial regulations is required to remove constraints on sustainable infrastructure investments, especially by institutional investors such as pension funds and insurers, along with the creation of a rollover mechanism for sustainable infrastructure assets through debt and equity markets (UNEP, 2015). In this way, the creation of a sustainable financial framework is a great opportunity to defeat restrictions that avoid a complete recognition of environmental and social criteria in financial decision-making.

Additionally, the generation of new market rules leading to long-term investment will help reduce GHG emissions by improving quality of life. This initiative mobilizes financial and technological resources, requiring PPPs schemes that link players in the private sector and prompting them both to develop public infrastructure and to provide financial strategies aligned with sustainable interests.

In the Colombian case, Decree 1385/2015 allowed both pension funds and insurance companies to finance PPPs projects (Ministerio de Hacienda y Credito Público de Colombia, 2015). Additionally, with the growth of infrastructure investments, specialized investors such as private equity funds are increasingly using mezzanine capital as a mechanism of investment in this area (Dong et al., 2011). However, sustainability criteria are not being completely considered in the financial decision-making process. In this regard, according to the UNEP (2015), it is important to align, as the essential first step, the design of investment plans for this kind of investor with sustainability criteria.

Figure 3-11: Proposal of a sustainable financial framework for financing SIS.



Source: Authors' elaboration

In this framework, the Sponsor must create an SPV, which is the investment vehicle. If the Sponsor is not a Public Utilitiy Company (PUC), the SPV must establish a contract with one. The SPV has a BOT (Built-Operate-Transfer) contract with the Colombian government, which in turn could provide it with loan guarantees. The SPV is financed by both the Sponsor (cash or in-kind) and the sustainable infrastructure market through sustainable mezzanine-type debt. There, investors with a high credit rating, such as institutional investors, could centralize funding requests into groups for financing SIS. A sustainable mezzanine-type debt could be thus structured as proposed in this work; this aims to incorporate social, environmental, and economic criteria into financing decisions. Thus, the project will help attract financial resources from private investors such as pension funds, multilateral banks, and investment funds that are dedicated to encouraging the development of sustainable projects.

Given that private investors are making investments to provide public utilities (a responsibility of the state), the Colombian government could provide financial guarantees that would make it cheaper than usual to raise financial resources. Although this argument could represent a good approach at the theoretical level, it would not work at the practical level.

The need for a new framework corresponds to a lack of research on new theories about innovations in financing strategic infrastructures and efforts to create new financing systems, as indicated in Mostafavi et al. (2014). Moreover, the scientific literature on investment and financing that addresses climate change, and therefore sustainable development, remains limited and knowledge gaps are substantial (Gouldson et al., 2015). In this context, sustainability will play a strategic role in the development of infrastructure. Sustainability is supported by the benefits of improving quality and coverage levels and encourages eco-friendly investment. However, it will be a considerable challenge to develop a sustainable market project in Latin America, particularly in Colombia (Barbero et al., 2015; González-Ruiz et al., 2014).

This type of development requires increasing current levels of investment, boosting infrastructure improvements, and prioritizing the implementation of financing mechanisms related to climate change and thus sustainable development (Barbero et al., 2015). Therefore, a financing mechanism is fundamental to the success of an investment connecting the creation of infrastructure and economic development with sustainable development. Indeed, much of the required economic development and infrastructure financing can be found in the developing countries (Inter-American Development Bank and Mercer, 2016). Thus, for economic growth derived from SIS investment in Colombia, the government, the private sector, the capital market, and the research community must actively work together to establish and promote a new behavioral model of development based on sustainability.

Therefore, the creation of a new business model for developing SIS provides an opportunity to establish a market for climate derivatives. Colombia does not have either an organized market or over-the-counter (OTC) derivatives related to the environment (Hernández, 2013). Climate change represents a development challenge; therefore, integrating sustainability criteria into the process of generating infrastructure projects should begin with the planning and integration of these elements (Serebrisky, 2014).

- **Identified issues for developing a sustainable infrastructure market in Colombia**

According to Bielenberg et al. (2016), the SIS gap in financing largely results from inadequate policies, institutional failures, and a lack of investor experience with greener technologies and sustainable projects. With the main goal of promoting a market based on sustainable infrastructure for the water sector, it is critical to find solutions to these problems. Thus, to propose the creation of primary and secondary markets in SIS, the following table shows the main issues, how they could be solved, and their impact on the infrastructure market.

Table 3-10: Issues based on the creation of a sustainable infrastructure market

Issue	Proposed solution	Infrastructure market impact
Regulation for investing in sustainable infrastructure.	To create grants and tax-deduction regulations based on the level of investment, the impact on climate measured by reducing CO_2 emissions, the quality of water, and the coverage achieved.	Because of these financial benefits, investors could consider sustainability elements in the design and financing stages, encouraging a sustainable development infrastructure.
Encouraging institutional and specialized investors to build a sustainable projects portfolio.	Regulatory changes to promote the inclusion of institutional investors at different stages of sustainable projects. These new regulations should allow such investors to exceed the current legal maximum amount of infrastructure investments, currently limited to 5% of their portfolios.	Institutional investors such as pension funds and insurance companies will increase their investment in infrastructure projects because they will not have constraints on investing in sustainable projects.
There are not specific securities for sustainable infrastructure projects.	To create a special market for sustainable infrastructure projects that enables the development of specific financial assets for the sector; they should also permit institutional and specialized investors, widening the base of issuers and investors. Permitting such investors will lead not only to primary and secondary securities markets linked to infrastructure projects but also to transactions in derivatives and various financial products.	A financial system to align infrastructure investment plans with INDCs and other environmental/ social outcomes. Additional innovative investment vehicles or the implementation of new, attractive regulatory frameworks.
Securities are not purchased by the market.	To ensure funds for developing SIS, the Government could ensure the remaining unsold securities in the market through fixed or offer underwriting mechanisms.	This will encourage specialized investors to work with governments to develop "bankable" projects, thus convening investors that can channel more funds into sustainable infrastructure projects.
The need to build resilient-structured climate-proofed projects.	To encourage the implementation of sustainable and environmentally friendly technologies through tax compensation mechanisms; to fund projects that promote ecosystems.	Investors will be encouraged to incorporate environmental and social issues into the investment and monitoring process, resulting in increased risk-adjusted returns based on environmental/social outcomes.
The need to generate financial guarantees, thus instilling confidence to investors and lenders.	To structure (between the Government and multilateral banks) partial credit and risk guarantees specifically to infrastructure projects of water sector.	Facilitates investment confidence and lower interest rates on projects.
The need to allow greater community involvement in project development.	To promote communities' active participation in the different stages of the project (granting access to the boards of directors or councils)	Parafiscal charges would decrease in the event of community involvement, increasing returns to sponsors.

Source: Author's elaboration

3.5 Conclusions

The increasing development of infrastructure in Colombia will require not only the inclusion of new actors and the mobilization of more financial resources but also the linking of environmental and social criteria to the structuring of projects, especially in the funding process. Consequently, concerns about the construction of sustainable infrastructure that is resilient to climate change must transform how public-private sector policies are determined. Such policies must lead to redirecting investment and financing to market mechanisms that involve the generation of eco-innovative financial products with elements that promote sustainable development.

To develop an infrastructure that minimizes greenhouse gas emissions without compromising the financial viability, specific financial mechanisms must be developed. This goal is supported by the National Development Plan 2014-2018, which encourages research and development that contributes to and promotes sustainable development through new mechanisms and instruments (Congreso de Colombia, 2015b). Thus, Colombia will be responding to the global challenge to reduce GHG emissions through a new way of developing infrastructure that should improve coverage in regions lacking water and sanitation services. If the world wants to achieve the Sustainable Development Goals, adequate infrastructure development is part of the answer; therefore, a standard and clear model is crucial. Such a model would benefit project developers, lenders, and public-sector institutions (Egler and Frazao, 2016).

This research shows that factors such as financing and investment should be directly related to financial, environmental, and social criteria, allowing decision makers to analyze such factors holistically and obtain information about each process, particularly financing. In addition, market-led mechanisms such as benefits, taxes, grace periods, debt forgiveness, duty-free machinery, and new regulations could drive an infrastructure market based on sustainable criteria and thus the creation of a primary and secondary market of stocks and debts issued by sponsors or investment vehicles (SPV). Such actions would allow the expansion of investment options through the Integrated Latin American Market (MILA). The implementation of financial markets based on sustainable investments could eventually influence other sectors such as transportation, energy, and telecommunications.

As discussed above, future research on sustainable finance should involve the Colombian government's flexibility assessment of the creation of sustainable projects as a strategic tool for encouraging private investment through PPPs schemes in which private investors and the public sector develop projects that consider sustainability, accessibility, and reliability in the provision of water and sanitation services. These analyses should account for the sensitivity and dynamics of the available financial resources. For this proposal, the real options theory would capture aspects related to a project's capacity that relates to sustainable financial resources.

Thus, to boost the development of sustainable infrastructure at the practical level, a holistic framework should be developed that integrates sustainability criteria not just in economic projects but also in overall investment strategies that permit a project portfolio to include social infrastructure.

As a theoretical contribution, this paper developed a sustainable financial framework, which includes a mathematical model that allows an understanding how capital structure changes during the project's life-cycle considering a mezzanine-type debt that is subordinated to sustainability criteria. This paper contributes to the project-management literature by exploring the main financial topics that practitioners and academics involved in project evaluation must consider when developing SIS. Although the framework was designed for the Colombian context, it could also be used in other countries that are considering the application of specific tax benefits, which is the central limitation of this research.

Finally, this proposal contributes to the state-of-art in SIS financing decisions. In addition, given the need to satisfy the requirements of both the Paris Agreement and the United Nations Sustainable Development Goals, the relationship between sustainability and project management is an emerging field for contributions of innovative proposals that would allow the achievement of those programs' goals. In this regard, there is a great deal of room for a better understanding of the relation between financial market development and sustainable development and as a consequence, this proposal may also be a further step in the advancing toward the development of a sustainable financial framework that can be applied in a real-world context.

4. CASE STUDY

In order to apply the methodological proposal, the Wastewater Treatment Plant "Aguas Claras" project was conducted as a case study. This project is located in the municipality of Bello – Antioquia and is managed by Aguas Nacionales. This is a subsidiary's company of Empresas Públicas de Medellín (EPM). EPM is one of the largest utility companies in Colombia. Aiming at taking a real approach to applying the methodological proposal, the financial model will use the data provided by Aguas Nacionales as its main input values. For collecting primary and secondary data, a semi-structured interview was conducted (see annex). It was aimed at getting information on the status of the water sector, particularly the Wastewater Treatment Plant "Aguas Claras".

In developing the case study, the methodology developed in the previous paper emphasizes the financial part. The main findings and results will be presented simultaneously, permitting a determination of the main variables. In this way, the research is considered exploratory with a post-positivist approach since the object under investigation (research problem) has been little studied, especially in situations in which there is limited information (Hernández, Fernández, and Baptista, 2010). Its objective is to formulate generalizations in the form of laws, although its scope is limited and provisional in time (but has potential for application) (Corbetta, 2007). In this way, the spatial delimitation will be the Aguas Claras project, and the temporality of the study will have a horizon of 30 years based on Law 1508/2012.

4.1 Overview Project

One of Latin America's most modern water-treatment plants is located in the municipality of Bello, 10 kilometers away from Medellín. It is Colombia's largest secondary-type treatment plant. It is operated on a 45-hectare lot in Bello, treating wastewater from both Bello and Medellín and removing more than 80 percent of the pollution. To stabilize the sludge, Aguas Claras will have six biodigesters with a capacity for 8,700 cubic meters.

This megaproject will conduct the wastewater of the municipalities of Medellín and Bello to the site; wastewater will receive secondary treatment through activated sludge before being discharged to the Medellín River. The plant will have a treatment capacity of 5 m^3/sec and will process more than 70% of the wastewater, for a total coverage of 95%. This percentage will be added to that of the San Fernando Wastewater Treatment Plant, which is currently in operation. Aguas Claras will be three times larger in infrastructure and treatment capacity than the San Fernando plant.

These facilities are expected to receive 120 tons of organic matter from the wastewater produced daily by industries, commerce, and housing. This material will be exposed to biological, chemical and physical processes and then returned to the Medellín River. The goal is to cause the river to exceed the internationally accepted dissolved oxygen levels, indicating decontamination. Thus, by reducing the organic load, the river will increase its dissolved oxygen content to a minimum of 5 mg/l. This result will comply with the requirements of the environmental authority, Area Metropolitana del Valle de Aburrá. The wastewater will be transported through an interceptor that will be eight kilometers long and 2.4 meters wide. In the future, this project is expected to serve urban developments and recreational spaces such as the cities' Christmas lighting and parks (Aguas Nacionales EPM S.A. E.S.P, 2015). Figure 4-1 shows a computer-simulated picture of the project.

Figure 4-1: Wastewater Treatment Plant "Aguas Claras".

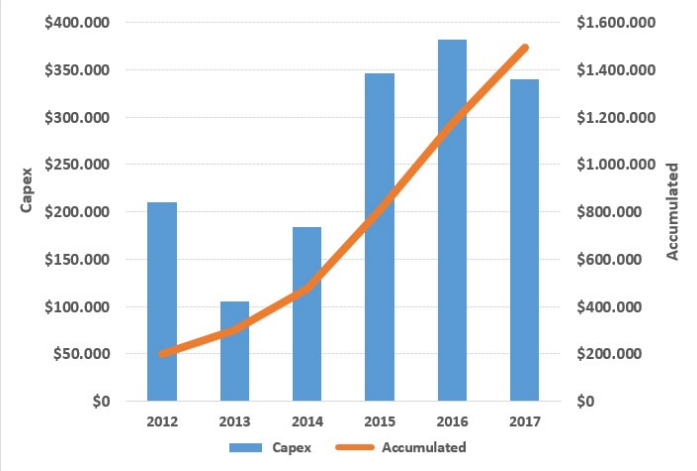
Source: EPM (2016).

In the long term and with the same purpose, the "Saneamiento del Rio Medellín y sus quebradas afluentes" program (the Medellin River and its Tributaries Treatment Program) has planned to build two additional plants. Those plants will be located in the northern municipalities of Girardota and Barbosa (Empresas Públicas de Medellín, 2016a). This methodology is expected to finance these projects. As stated above, and as shown in Table 2.2, there is a wide offer of projects, which will require funding for their development. As stated above, and as shown in Table 2.2, there is a wide offer of projects, which will require funding for their development.

4.2 Investment Plan

The investment plan requires COP $1.47 billion and will be executed during six years at the development stage, which runs from 2012 to 2017. For this project, a USD $450 million credit was granted by the Inter-american Development Bank to EPM (in turn, EPM provided its subsidiary Aguas Nacionales with the money). To financially evaluate the project and the proposal's implementation, the capitalized funds will be equity investment, as confirmed by EPM (2016). Figure 4.2 shows the planned investment curve. This amount represents the value of the contract signed with the building company and accounts for inflation without the construction interests.

Figure 4-2: Planned investment curve of the Wastewater Treatment Plant "Aguas Claras".



Source: Author's elaboration based on data from Aguas Nacionales S.A. E.S.P. Figures in COP Million.

4.3 Development Stage

In order to validate the mathematical modeling of the capital structure's evolution (as shown in the previous paper), the following information is considered:

Table 4-1: Input values for modeling the capital structure.

Item	Development Stage					
	2012	2013	2014	2015	2016	2017
Investment -> $1.493.000	200.000	100.000	175.335	330.000	364.000	323.665
Sustainability Factor	5%	5%	5%	5%	5%	5%
Accumulated Investment (9)	200.000	300.000	475.335	805.335	1.169.335	1.493.000
Capital Structure						
% Debt Mezzanine	0%	50%	70%	70%	70%	70%
% Equity	100%	50%	30%	30%	30%	30%
Interest Rate --> kd (AE)	8,7%	7,1%	7,5%	8,4%	10,9%	9,0%
IBR (AE)	5,01%	3,39%	3,84%	4,69%	7,10%	5,30%
Spread MV	3,50%	3,50%	3,50%	3,50%	3,50%	3,50%

Source: Author's elaboration. Figures in COP Million.

Assumptions:

- Planned Investment curve: data based on Aguas Nacionales S.A. E.S.P
- Sustainability Factor: according to Egler and Frazao (2016), this could be approximately 5%.
- Capital structure per period: although the project is 100% funded by own resources, to apply the methodological proposal based on primary information, it was considered that in the event of acquiring a debt, the capital structure per period would behave as presented in the table. The debt funds would be Blue Bonds in COP issued by the SPV.
- The interest rate: Given that the Colombian capital market (and the Latin American) have little experience in financing sustainable development, the last green bonds emission's interest rate (issued by Bancolombia S.A. in December, 2016) was considered a referent; it was equal to the IBR + 2.2% at a seven-year period (the IBR is the Banking Reference Indicator in Colombia). This is the first time that a Latin American bank has issued this type of security (Bancolombia, 2016). Accordingly, and given the project's duration and its characteristics, a 3.5% spread was considered (information provided at the semi-structured interview).
- IBR values were obtained from the Bank of the Republic of Colombia and Bancolombia and projected by the author.

Table 4-2 shows the last table's values mathematically modeled according to the previous paper's development. The equations were developed in Table 3-5 and shown in parenthesis.

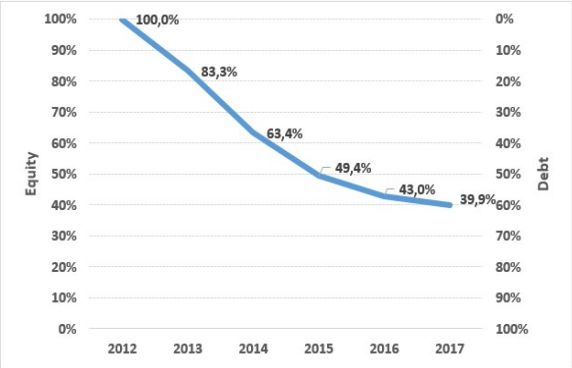
Table 4-2: Capital structure by period

Item	Development Stage					
	2012	2013	2014	2015	2016	2017
Capex						
Debt Mezzanine (3)	0	52.500	131.635	253.370	300.882	284.561
Equity (1)	210.000	52.500	56.415	108.587	128.950	121.955
Total Capex (7)	210.000	105.000	188.049	361.957	429.832	406.516
Accumulated						
Debt Mezzanine (3)	0	52.500	184.135	437.504	738.387	1.022.948
Equity (1)	210.000	262.500	318.915	427.502	556.451	678.406
Total Capex (13)	210.000	315.000	503.049	865.006	1.294.838	1.701.354
% Debt Mezzanine (11)	0,0%	16,7%	36,6%	50,6%	57,0%	60,1%
% Equity (10)	100,0%	83,3%	63,4%	49,4%	43,0%	39,9%
Total (6)	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%
Interest Rate --> kd (AE) (12)		7,1%	7,4%	8,0%	9,2%	9,1%

Source: Author's elaboration. Figures in COP Million.

The left part of Figure 4-3 shows the capital structure's behavior at the development stage and the right part shows the general balance during the development stage.

Figure 4-3: Capital structure behavior and balance sheet.



	2012	2013	2014	2015	2016	2017
Cash						
Net fixed assets	210.000	315.000	503.049	865.006	1.294.838	1.701.354
Land	157.338	157.338	157.338	157.338	157.338	157.338
Construction in progress	52.662	157.662	345.711	707.668	1.137.500	1.544.016
Building						
Accumulated depreciation						
Asset	210.000	315.000	503.049	865.006	1.294.838	1.701.354
Accrued taxes						
Current Debt	0	0	0	0	0	0
Long-term debt	0	52.500	184.135	437.504	738.387	1.022.948
Blue Bonds	0	52.500	184.135	437.504	738.387	1.022.948
Debt	0	52.500	184.135	437.504	738.387	1.022.948
Common Stock	210.000	262.500	318.915	427.502	556.451	678.406
Additional paid in capital						
Reserves						
Net Income						
Equity	210.000	262.500	318.915	427.502	556.451	678.406

4.4 Operation and Maintenance Stage

To present this stage, the following tables present the first ten years' Income Statement and Balance Sheet projection[3] considering the implementation of both the future tax benefit in control and environmental improvements (explained in the previous paper), and the Future Funds[4].

Table 4-3: Projected Income Statements

Item / Year	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
(+) Total Income	273.476	296.036	307.534	317.410	327.964	338.596	349.470	360.247	371.063	382.215
+ Investment remuneration	222.125	284.694	296.192	306.068	316.622	327.254	338.128	348.905	359.721	370.872
+ Operational	39.747	53.612	57.687	60.039	62.797	65.440	68.107	70.443	72.627	74.878
+ Retributive Rate	262	413	309	321	331	342	352	363	374	386
Future Funds	11.342	11.342	11.342	11.342	11.342	11.342	11.342	11.342	11.342	11.342
(-) Cost of good sold	38.132	56.996	60.155	62.744	65.357	68.092	71.107	73.337	75.611	77.955
- O&M Plant	26.975	41.203	43.993	45.943	47.954	49.976	52.084	53.810	55.478	57.198
- Interceptor maintenance	43	44	46	47	48	49	51	52	54	56
- Retributive Rate	0	524	301	317	326	336	347	358	369	381
- Taxes and others	5.227	5.718	6.014	6.331	6.609	6.990	7.551	7.699	7.938	8.184
- Administrative Staff	2.796	2.883	2.972	3.065	3.160	3.257	3.358	3.463	3.570	3.681
- General expenses	3.091	6.624	6.830	7.041	7.259	7.484	7.716	7.955	8.202	8.456
(=) EBITDA	235.344	239.040	247.380	254.666	262.608	270.504	278.363	286.910	295.453	304.260
EBITDA Margin	86%	81%	80%	80%	80%	80%	80%	80%	80%	80%
- Depreciation	26.713	26.713	26.713	26.713	26.713	26.713	26.713	26.713	26.713	26.713
(=) EBIT	208.631	212.327	220.666	227.953	235.895	243.791	251.650	260.197	268.739	277.547
Operation Margin	76%	72%	72%	72%	72%	72%	72%	72%	72%	73%
- Interest expense	92.889	89.792	86.696	83.600	80.503	77.407	74.311	71.215	68.118	65.022
(=) Net Income Before Taxes	115.742	122.534	133.970	144.354	155.391	166.384	177.339	188.982	200.621	212.525
- Income taxes	5.787	6.127	6.699	7.218	7.770	8.319	8.867	9.449	10.031	10.626
(=) Net Income	109.955	116.408	127.272	137.136	147.622	158.065	168.472	179.533	190.590	201.898
Net Margin	40%	39%	41%	43%	45%	47%	48%	50%	51%	53%

Source: Author's elaboration. Figures in COP Million.

[3] Full information in the annexes. Future Bonds are not considered.

[4] Investment plan is divided into 30 years.

Table 4-4: Projected Balance Sheet.

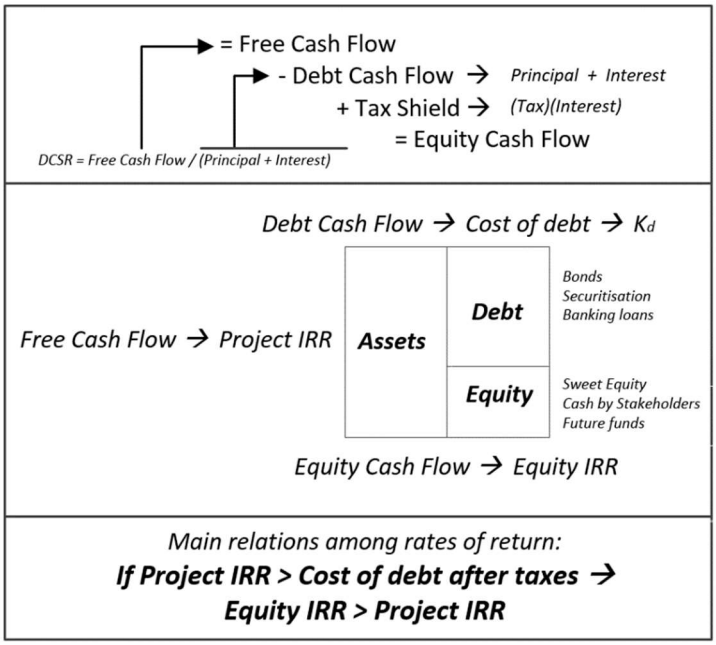
Item / Year	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Cash	6.664	15.205	24.090	33.272	42.771	52.589	62.732	73.200	83.991	95.117
Net fixed assets	1.674.641	1.647.928	1.621.214	1.594.501	1.567.788	1.541.075	1.514.361	1.487.648	1.460.935	1.434.222
Land	157.338	157.338	157.338	157.338	157.338	157.338	157.338	157.338	157.338	157.338
Construction in progress										
Building	1.544.016	1.544.016	1.544.016	1.544.016	1.544.016	1.544.016	1.544.016	1.544.016	1.544.016	1.544.016
Accumulated depreciation	-26.713	-53.426	-80.140	-106.853	-133.566	-160.279	-186.993	-213.706	-240.419	-267.132
Asset	**1.681.305**	**1.663.132**	**1.645.305**	**1.627.773**	**1.610.559**	**1.593.663**	**1.577.094**	**1.560.848**	**1.544.926**	**1.529.339**
Accrued taxes	5.787	6.127	6.699	7.218	7.770	8.319	8.867	9.449	10.031	10.626
Current Debt	5.787	6.127	6.699	7.218	7.770	8.319	8.867	9.449	10.031	10.626
Long-term debt	988.850	954.751	920.653	886.555	852.457	818.358	784.260	750.162	716.063	681.965
Blue Bonds	988.850	954.751	920.653	886.555	852.457	818.358	784.260	750.162	716.063	681.965
Debt	**994.637**	**960.878**	**927.352**	**893.772**	**860.226**	**826.677**	**793.127**	**759.611**	**726.095**	**692.591**
Common Stock	678.406	678.406	678.406	678.406	678.406	678.406	678.406	678.406	678.406	678.406
Additional paid in capital	0	0	0	0	0	0	0	0	0	0
Reserves		8.262	23.848	39.547	55.595	71.927	88.580	105.561	122.831	140.425
Net Income	8.262	15.586	15.699	16.048	16.332	16.653	16.981	17.270	17.595	17.916
Equity	**686.668**	**702.254**	**717.953**	**734.001**	**750.333**	**766.986**	**783.967**	**801.237**	**818.832**	**836.748**
Check	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔

Source: Author's elaboration. Figures in COP Million.

As mentioned above, it is important to include project-funding strategies that provide profit to both public and private parties. Therefore, special characteristics must be considered in this conceptual framework. This framework includes a special focus on the relation among the different cash flows (such as Free Cash Flow (FCF), Debt Cash Flow (DCF), and Equity Cash Flow (ECF)), and has been mentioned several times by Damodaran (2012), Mascareñas (2011), and Vélez (2013) because of its importance in the financial world, especially in the areas of project investment and firm valuation. In addition, this framework is in line with the World Bank's (2015) view of how concessionaires should be paid. Equation 16 and Figure 4-4 show the relation among the different cash flows and return rates.

Free Cash Flow + Tax Shield = Debt Cash Flow + Equity Cash Flow = Capital Cash Flow (16)

Figure 4-4: Relation among the different cash flows.



Source: Author's elaboration based on Damoradan (2012), Mascareñas (2011), and Vélez (2013).

According to the previous considerations, Table 4-5 shows the projected FCF, DCF and ECF. The elements mentioned in the previous table can also be observed considering both the inclusion and exclusion of the tax benefit in control and environmental improvement (explained in the previous paper), which evidences the relevance of the tax benefit as a factor leading to encouraging the profitability of sustainable infrastructure. In addition, the DSCR and LLRC indicators (according to Table 3-8) are shown. As Figure 4-3 shows, the project's proposed capital structure is 60.1% debt and 39.9% equity.

The credit will be repaid using a constant capital amortization mechanism, as shown in Table 4-5. For calculating k_e and according to the methodology established by the CRA (Comisión de Regulación de Agua Potable y Saneamiento - CRA, 2014), the CAPM was used. In this way, the unleveraged beta was obtained from Damodaran (2016) (section Data - Leveraged and Unleveraged Betas by Industry - Emerging Markets - Water Utility). The beta was leveraged considering the project's capital structure in each year. Appendix G shows a detailed calculation.

Table 4-5: Projected Cash Flows

Item / Year	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
(+) EBIT	208.631	212.327	220.666	227.953	235.895	243.791	251.650	260.197	268.739	277.547
(-) Operating Taxes		10.432	10.616	11.033	11.398	11.795	12.190	12.583	13.010	13.437
(=) NOPLAT	208.631	201.895	210.050	216.920	224.497	231.996	239.461	247.614	255.729	264.110
(+) Depreciation	26.713	26.713	26.713	26.713	26.713	26.713	26.713	26.713	26.713	26.713
(=) Gross Cash Flow	235.344	228.608	236.763	243.633	251.210	258.709	266.174	274.327	282.443	290.823
(-) Net Working Capital	25.174	7.091	1.303	1.119	1.196	1.205	1.232	1.221	1.226	1.264
(-) Capex --> $1.567.650										
Free Cash Flow --> 13,10%	210.170	221.517	235.460	242.514	250.014	257.504	264.941	273.106	281.217	289.559
(-) Interest	92.889	89.792	86.696	83.600	80.503	77.407	74.311	71.215	68.118	65.022
(-) Principal	34.098	34.098	34.098	34.098	34.098	34.098	34.098	34.098	34.098	34.098
(+) Tax Shield		4.644	4.490	4.335	4.180	4.025	3.870	3.716	3.561	3.406
(=) Outstanding Debt	988.850	954.751	920.653	886.555	852.457	818.358	784.260	750.162	716.063	681.965
Debt Cash Flow --> 9,08%	126.987	123.891	120.794	117.698	114.602	111.505	108.409	105.313	102.217	99.120
DCSR	1,7X	1,8X	1,9X	2,1X	2,2X	2,3X	2,4X	2,6X	2,8X	2,9X
LLCR	3,1X	3,2X	3,4X	3,6X	3,8X	3,9X	4,2X	4,4X	4,6X	4,9X
Equity Cash Flow --> 15,56%	83.183	102.271	119.156	129.151	139.592	150.024	160.403	171.509	182.561	193.845
Check	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔

	Equity IRR	Project IRR	Cost of Debt
Including	15,56%	13,10%	9,08%
Excluding	14,19%	11,71%	9,08%

Source: Author’s elaboration. Figures in COP Million.

The following figures show the capital structure evolution and the WACC during the project's life-cycle.

Figure 4-5: Capital Structure's evolution

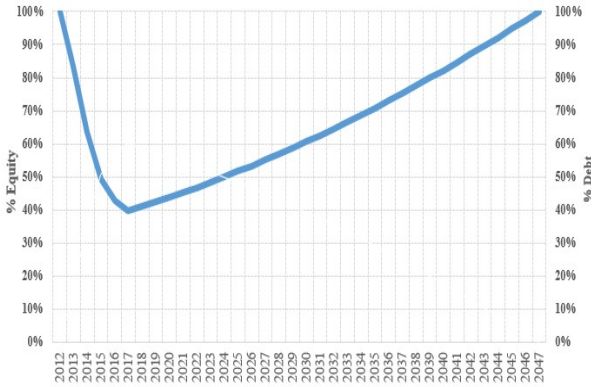
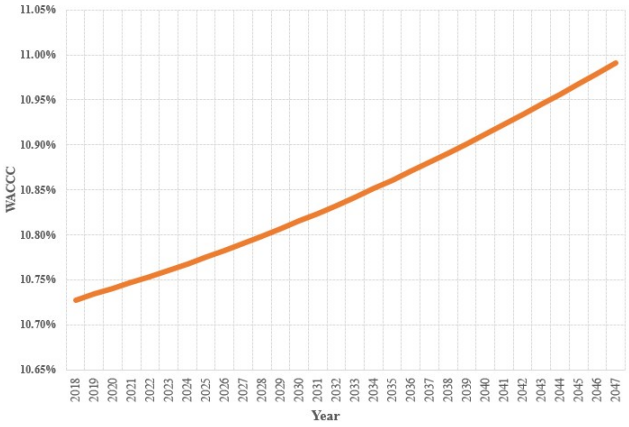


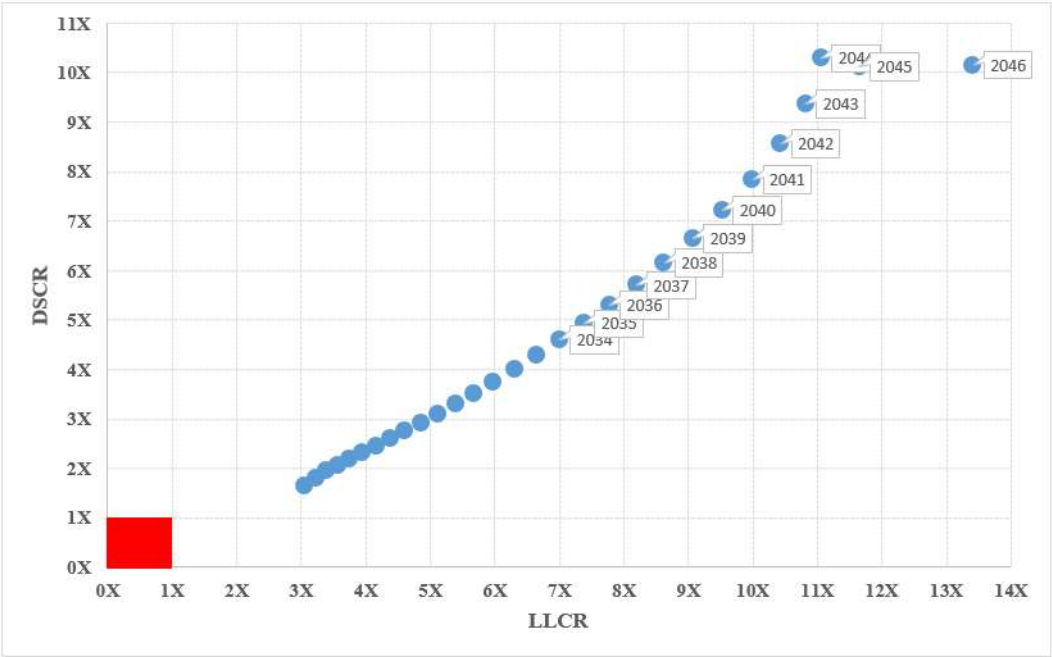
Figure 4-6: WACC's evolution



Source: Author's elaboration

Figure 4-7 shows the application of the proposal for validating debt-service capacity, as indicated in the previous paper. Zone A (in red) is highlighted. In this way, the project has the ability to service its debt.

Figure 4-7: Application of the proposal for validating debt-service capacity



Source: Author's elaboration

4.5 Sustainability Criteria

To incorporate the sustainability criteria and, as mentioned above, this proposal will use The Water Criteria of the Climate Bonds Standard to determine the sustainability of the project. These criteria are shown below. The assigned score[5] in each indicator for the project is shown in the Actual Score column. It is important to note that in indicator 1.2, the score can vary between 0 and 7 (only integer numbers, indicating that it fulfills only some items of the indicator) and in indicators 2.2, 2.3, and 2.4, the score can be 0, 0.5 or 1. For the others, it can be scored either 1 (meets) or 0 (does not meet). In addition, according to The Water Criteria of the Climate Bonds Standard, for each question, an 'n/a' response scores 1 point (Climate Bonds Initiative, 2016c). The results are shown in Table 4-6.

Table 4-6: Water Criteria of the Climate Bonds Standard for Wastewater Treatment Plant project "Aguas Claras."

Allocation		Requirement E = Provide evidence D = Disclose	Max Score	Actual Score
1.1	Are there accountability mechanisms in place for the management of water allocation that are effective at a sub-basin and/or basin scale?	D	1	1
1.2	Are the following factors taken into account in the definition of the available resource pool? - Non-consumptive uses (e.g., navigation, hydroelectricity) - Environmental flow requirements - Dry season minimum flow requirements - Return flows - Inter-annual and inter-seasonal variability - Connectivity with other water bodies - Climate change impacts	E	7	4
1.3	Are arrangements in place to accommodate the potentially adverse impacts of climate change on the resource pool? (E.g. using best available science to plan for future changes in availability, undertaking periodic monitoring and updating of available pool.)	E	1	1
1.4	Is there a distinction between the allocation regimes used in "normal" times and in times of "extreme/severe" water shortage?	E	1	1
1.5	Are there plans to define "exceptional" circumstances, such as an extended drought, that influence the allocation regime? (E.g., triggers water use restrictions, reduction in allocations according to pre-defined priority uses, suspension of the regime plan, etc.)	E	1	1
1.6	For international / transboundary basins, is there a legal mechanism in place to define and enforce water basin allocation agreements?	D	1	N/A
1.7	Are water delivery agreements defined on the basis of actual in situ seasonal/annual availability instead of volumetric or otherwise inflexible mechanisms?	E	1	1
1.8	Has a formal environmental flows (e-flows)/sustainable diversion limits or other environmental allocation been defined for the relevant subbasin or basin? (If there is a pre-existing plan, then has the environmental flows program been updated to account for the new project?)	E	1	1
1.9	Have designated environmental flows / allocation programs been assured / implemented?	D or E	1	1
1.10	Has a mechanism been defined to update the environmental flows plan periodically (e.g., every 5 to 10 years) in order to account for changes in allocation, water timing, and water availability?	E	1	1
1.11	Is the amount of water available for consumptive use in the resource pool linked to a public planning document? (E.g., a river basin management plan or another planning document – please indicate)	E	1	N/A
1.12	If present, is the water management plan a statutory instrument that must be followed rather than a guiding document?	D	1	1
Total Allocation Score		Total	18	15
		Scoring		83,3%

[5] Information obtained at the semi-structured interview.

Governance		Requirement E = Provide evidence D = Disclose	Max Score	Actual Score
2.1	Have water entitlements been defined according to one of the following? - Purpose that water may be used for - Maximum area that may be irrigated - Maximum volume that may be taken in a nominated period - Proportion of any water allocated to a defined resource pool	D	1	1
2.2	Is the surface water system currently considered to be neither overallocated nor over-used? - Over-allocated would be if e.g. current use is within sustainable limits but there would be a problem if all legally approved entitlements to abstract water were used. - Over-used would be if existing abstractions exceed the estimated proportion of the resource that can be taken on a sustainable basis. - Neither over-allocated nor over-used	E	1	1
2.3	If the investment uses groundwater, is the groundwater water system currently considered to be neither over-allocated nor overused? - Over-allocated would be if e.g. current use is within sustainable limits but there would be a problem if all legally approved entitlements to abstract water were used. - Over-used would be if existing abstractions exceed the estimated proportion of the resource that can be taken on a	E	1	1
2.4	Is there a limit to the proportion (e.g. percentage) of water that can be extracted? - There is a limit in the volume of water that can be abstracted - There is a limit to the proportion (e.g. percentage) of water that can be abstracted - There are restrictions on who can abstract the water (but no limit on how much water can be abstracted) - There is no explicit limit on water abstraction	E	1	1
2.5	Are governance arrangements in place for dealing with exceptional circumstances (such as drought, floods, or severe pollution events), especially around coordinated infrastructure operations?	D	1	0
2.6	Is there a process for re-evaluating recent decadal trends in seasonal precipitation and flow OR recharge regime, in order to evaluate "normal" baseline conditions?	D	1	N/A
2.7	Is there a formal process for dealing with new entrants?	D	1	0
2.8	For existing entitlements, is there a formal process for increasing, varying, or adjusted use(s)?	D	1	1
2.9	Is there policy coherence across sectors (agriculture, energy, environment, urban) that affect water resources allocation, such as a regional, national, or basin-wide Integrated Water Resources Management (IWRM) plan?	E	1	1
2.10	Are obligations for return flows and discharges specified and enforced?	D	1	1
2.11	Is there a mechanism to address impacts from users who are not required to hold a water entitlement but can still take water from the resource pool?	D	1	0
2.12	Is there a pre-defined set of priority uses within the resource pool? (E.g., according to or in addition to an allocation regime	D	1	0
2.13	If there are new entrants and/if entitlement holders want to increase the volume of water they use in the resource pool and the catchment is open, are these entitlements conditional on either assessment of third party impacts, an Environmental Impact Assessment (EIA) or an existing user(s) forgoing use?	D	1	N/A
2.14	Are withdrawals monitored, with clear and legally robust sanctions?	E	1	1
2.15	Are there conflict resolution mechanisms in place?	E or D	1	0
Total Governance Score		Total	15	10
		Scoring		66,7%

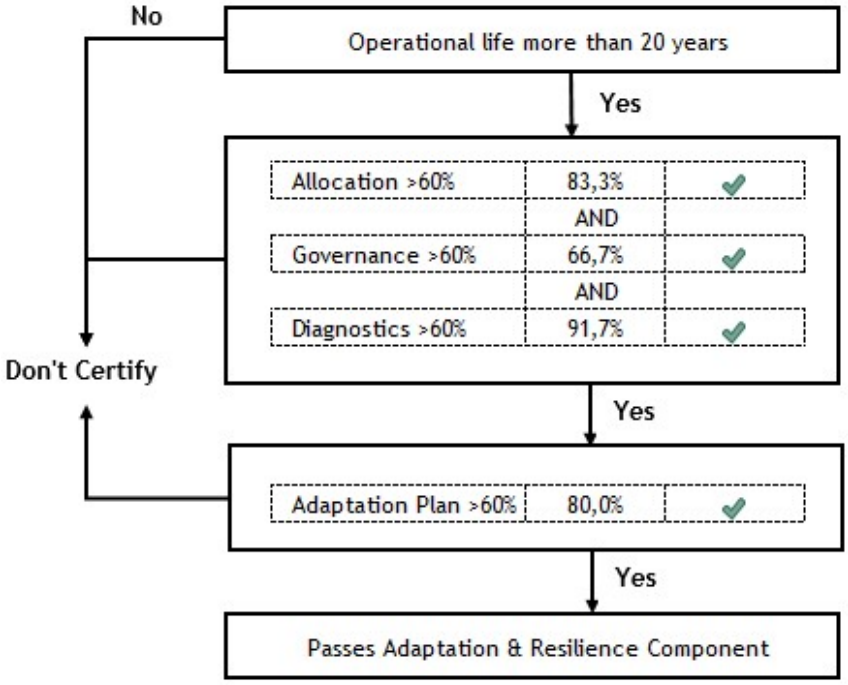
Diagnostics		Requirement E = Provide evidence D = Disclose	Max Score	Actual Score
3.1	Does a water resources model of the proposed investment and ecosystem (or proposed modifications to existing investment and ecosystem) exist? Specify model types, such as WEAP, SWAT, RIBASIM, USACE applications). Scale should be at least sub-basin.	E	1	1
3.2	Can the system model the response of the managed water system to varied hydrologic inputs and varied climate conditions?	E	1	N/A
3.3	Are environmental performance limits (ecosystem, species, ecological community) and/or ecosystem services specified?	E	1	1
3.4	Can these performance limits be defined and quantified using the water resources model?	E	1	1
3.5	Have these limits been defined based on expert knowledge and/or scientific analysis?	E	1	1
3.6	Are these performance limits linked to infrastructure operating parameters?	E	1	1
3.7	Are these limits linked to an environmental flows regime?	E	1	1
3.8	For new projects, is there an ecological baseline evaluation describing the pre-impact state?	E	1	1
3.9	For rehabilitation / reoperation projects, is there an ecological baseline evaluation available before the projects was developed?	E	1	N/A
3.10	Has there been an analysis that details impacts related to infrastructure construction and operation that has been provided?	E	1	1
3.11	Are lost species and/or lost or modified ecosystem functions specified for restoration in the environmental evaluation?	E	1	0
3.12	Have regional protected areas / nature reserves been included in the analysis for impacts from the investment asset and future climate impacts?	E	1	1
3.13	Does the model include analysis of regression relationships between climate parameters and flow conditions using time series of historical climate and streamflow data?	E	1	N/A
3.14	Does the model include climate information from a multi-modal ensemble of climate projections (e.g., from the Climate Wizard or the World Bank's Climate Portal) to assess the likelihood of climate risks for the specified investment horizon(s)?	E	1	0
3.15	Are changes in the frequency and severity of rare weather events such as droughts and floods included?	E	1	1
3.16	Are sub-annual changes in precipitation seasonality included?	E	1	1
3.17	Is GCM climate data complemented with an analysis of glacial melt water and sea level rise risks, where appropriate (e.g., high or coastal elevation sites)?	E	1	N/A
3.18	Is paleo-climatic data (e.g., between 10,000 and >1000 years before present) included?	E	1	N/A
3.19	Is the number of model runs and duration of model runs disclosed?	E	1	N/A
3.20	Has a sensitivity analysis been performed to understand how the asset performance and environmental impacts may evolve	E	1	1
3.21	Is directly measured climate data available for more than 30 years and incorporated into the water resources model?	E	1	N/A
3.22	Has evidence demonstrated that climate change has already had an impact on operations and environmental targets? Are these impacts specified and, to the extent possible, quantified? These impacts should be responded to directly in the Adaptation Plan	E	1	1
3.23	Does the evidence suggest that climate change will have an impact on operations and environmental targets over the	E	1	1
3.24	Is there a discussion of the uncertainties associated with projected climate impacts on both operations and environmental impacts?	E	1	1
Total Diagnostics Score			24	22
		Scoring		91,7%

Adaptation Plan		Requirement E = Provide evidence D = Disclose	Max Score	Actual Score
AP1	Is there a plan to restore or secure lost/modified ecosystem functions / species?	E	1	1
AP2	Is the adaptation plan for environmental targets / infrastructure robust across specified observed / recent climate cor	E	1	1
AP3	Is the adaptation plan for environmental targets / infrastructure robust across specified projected climate	E	1	1
AP4	Is there a monitoring plan designed to track ongoing progress and impacts to inform future decisions?	E	1	1
AP5	Is there a plan to reconsider on a periodic basis the VA for operational parameters, governance and allocation shifts, and environmental performance targets?	E	1	0
Total ADAPTATION PLAN Score		Total	5	4
		Scoring		80%

Source: Author's elaboration based on semi-structured interview and Climate Bonds Initiative (2016b).

Based on the implementation of these criteria, it is possible to conclude that the project can be financed through Blue Bonds. The gathered results are shown in the next figure.

Figure 4-8. Results of the Water Criteria of the Climate Bonds Standard



Source: Author's elaboration

4.5.1 Financial Captured Value

According to Yang et al. (2017), the captured value concept is defined as "the set of benefits that could be captured but have not yet been captured" (p.12). It is important to consider that value capture does not precondition value creation per se (Kivleniece and Quelin, 2012). In this way, Lepak, Smith, and Taylor (2007) indicate that "value creation depends on the relative amount of value that is subjectively realized by a target user (or buyer) who is the focus of value creation—whether individual, organization, or society—and that this subjective value realization must at least translate

into the user's willingness to exchange a monetary amount for the value received" (pg. 182). Based on this, P3s have the potential to create value when hybrid mechanisms deliver new and appropriable benefits (Kivleniece and Quelin, 2012). According to Caldwell, Roehrich, and George (2017), value creation through public-private collaboration is at the core of management research and practice. For these researchers, value will be created by integrating the parties instead of having them act independently. Likewise, P3s literature indicates that collaboration results in opportunities that can create new sources of value (Dyer, 1997; Dyer and Singh, 1998; Priem, 2007).

Although the infrastructure-financing phenomenon has involved a wide range of practitioners and researchers, there has been no systematic review of how lenders capture value through the financing process. Although some studies have identified that the value creation (and therefore the captured value) is closely related to business model innovation (Evans, Fernando, and Yang, 2017; Foxon et al., 2015; Kivleniece and Quelin, 2012; Watson et al., 2016; Yang et al., 2017), this has not yet been examined or quantified from a lender's perspective.

For these reasons, a deeper effort is required to understand the exact value creation mechanisms, especially in P3s (Kivleniece and Quelin, 2012). Likewise, although captured value is theoretically caused by projects' unpredictable upsides, empirical evidence shows that investors and lenders have identified opportunities to obtain uncaptured value through the sustainability concept (Evans et al., 2017; Yang et al., 2017).

With respect to the identification of suitable business models for interest groups (particularly investors and lenders), it is crucial that investments lead to capturing value through these business opportunities (Foxon et al., 2015). Thus, according to Yang et al. (2017), research in this field remains immature; therefore, it must standardize the sustainable business models concepts because in practice, these concepts have been inadequately addressed in the literature. In this way, there is a demand for business models that link value creation with social and ecological compatibility and find a satisfactory balance (Martens and Carvalho, 2016). As a result, financial innovations will enable multiple cities (experiencing problems obtaining financial resources) to find financing options that help design smarter infrastructure systems that incorporate SDGs.

In this way, to help bridge the identified knowledge gap, this study examines how lenders capture financial value through mezzanine-type debt by financing SIS. For this purpose, the Financial Captured Value (FCV) concept is developed and quantified. Table 4-7 shows both the theoretical conditions with which any debt-repayment system must comply and when financial value is captured through the proposed financing framework. The first two columns show the conditions of mandatory compliance, and the third column explains the elements that determine when lenders capture financial value.

Table 4-7: Debt repayment system conditions and Financial Captured Value.

Condition	Description	Financial Captured Value
1	Outstanding $Debt_n = 0$ (17)	Outstanding $Debt_n < 0$ (18)
	Outstanding debt at the end of the credit's payment period must be equal zero. It means that there is no pending balance.	Considering that Cash Flow to Debt (CFD) is created from the project's point of view, the outstanding debt must be negative, which means that the project has paid the debt above the borrowed value.
2	$\sum_{i=1}^{n} P_i = \text{Credit Value}$ (19)	$\sum_{i=1}^{n} P_i > \text{Credit Value}$ (20)
	The Principal's sum during the credit's period must equal the credit's value	The Principal's sum value during the credit's period is higher than the credit's value.
3	$\sum_{i=0}^{n} \frac{CFD_i}{\prod_{j=0}^{i}(1+kd_i)} = 0$ (21)	$\sum_{i=0}^{n} \frac{CFD_i}{\prod_{j=0}^{i}(1+kd_i)} > 0$ (22)
	The CFD's present value equals the credit's value; that is to say, Net Present Value (NPV) equals zero. It is also valid if the credit's interest rate is variable.	CFD's NPV is higher than zero; the project has paid more than the lent value.
4	IRR(CFD) = Cost of debt (k_d) (23)	IRR(CFD) > Cost of debt (k_d) (24)
	CFD's Internal Rate of Return (IRR) should equal the credit's value. It is only valid if the credit has a fixed rate. In credits with variable rates, the result should be interpreted as the average cost of the funding by lenders.	CFD's IRR is higher than financing costs.

Source: Author's elaboration

For a better understanding of the Financial Captured Value (FCV) concept, it is important to consider that when lenders finance infrastructure systems, these will expect to recover the principal plus interest during the O&M stage. Therefore, the equations showed in the second column of Table 4 must be fulfilled. The FCV would be created when outstanding debt is turned into equity shares. Thus, based on Yang et al. (2017), this study defines the FCV as the corporate value captured by lenders through a debt-equity conversion process using a sustainable financing mechanism, thus measuring the amount of money captured by becoming a sponsor. To validate this proposition, the equations showed in the third column must be satisfied. To quantify the FCV, the Cash Flow to Debt (CFD), which is calculated based on debt disbursements and payments, must be redefined.

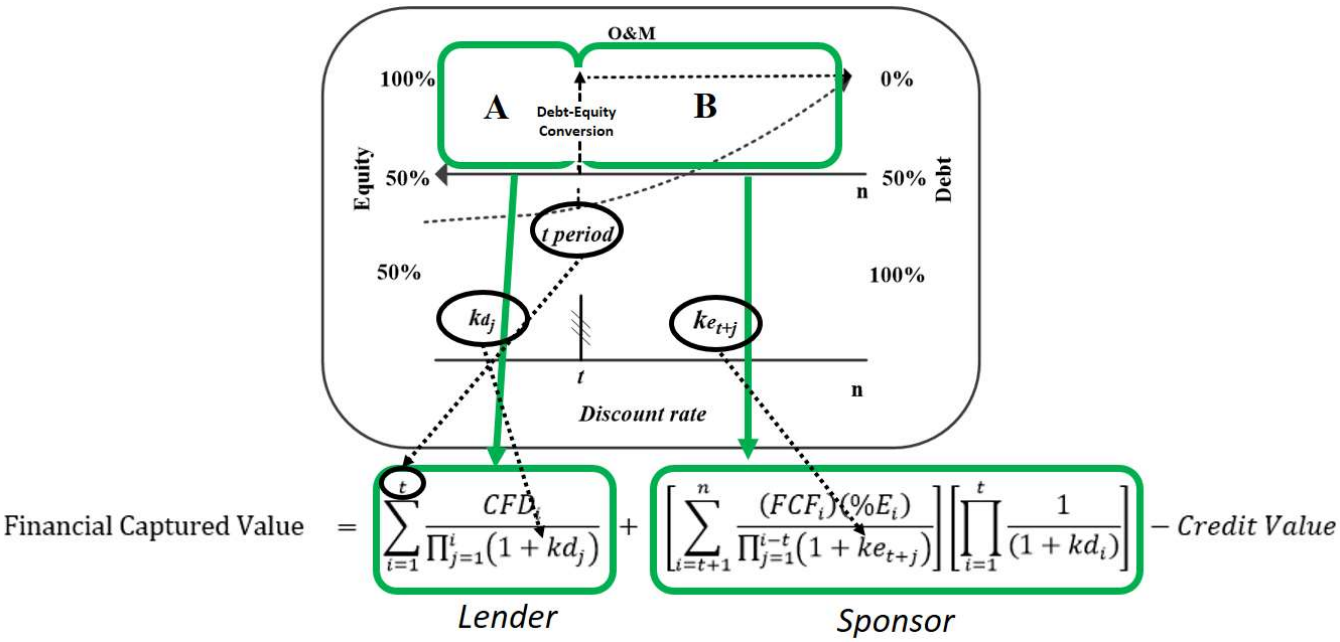
It is important to consider that after the moment of debt-equity conversion, that is, from period t to n (see Figure 4-8), lenders will convert outstanding debt into equity shares and therefore will become sponsors with equity. As mentioned above, this process will be executed when the Water Criteria are fulfilled at the O&M stage. In this way, when these criteria are met for this specific period, the TBL concept is also achieved. Next, the CFD will be the Free Cash Flow (FCF) weighted by the share allocated to the lenders in the debt-equity conversion process; therefore, it should be discounted using the lenders' capital cost given that this cost now comprises part of the equity.

For practical purposes, these cash flows will be discounted at the same interest rate as those of the current sponsors (k_e), which are calculated based on the Capital Asset Pricing Model (CAPM). In this way, the discount rate for calculating the FCV must be divided into two parts. In the first part, the cash flows belong to CFD. In the second part (after the debt-equity conversion), the cash flows belong to Equity Cash Flow. Thus, kd_i and ke_i must be used as the respective discount rates, as shown in each part of Figure 4-9.

$$\text{Financial Captured Value} = \sum_{i=1}^{t} \frac{CFD_i}{\prod_{j=1}^{i}(1+kd_j)} + \left[\sum_{i=t+1}^{n} \frac{(FCF_i)(\%E_i)}{\prod_{j=1}^{i-t}(1+ke_{t+j})}\right]\left[\prod_{j=1}^{t} \frac{1}{(1+kd_j)}\right] - Credit\ Value \quad (25)$$

n-1 ≥ t ≥ 1. $\%E_i$ is the Mezzanine Lenders' participation in equity share through the debt-equity conversion.

Figure 4-9: Capital structure and discount rate zones for DCF.



Source: Author's elaboration

Equation 25 indicates how the FCV must be calculated. If the result is greater than zero, it is possible to confirm that lenders have captured value through this financial mechanism, representing how much financial value lenders have captured. Equal to zero means either that lenders have not captured value or that debt-equity conversion was not performed. Otherwise, it means that lenders have not captured value and conversely, they have lost value.

As an additional contribution, to calculate the captured value, this dissertation developed the financial function + va_plan(Cash_Flows; Interest_Rates) in MS Excel; this allows the calculation of the present value of future cash flows using variable interest rates per period[6].

[6] The programming code is in the annexes.

To calculate the project's share percentage of the mezzanine lender in the debt-equity conversion, the conversion ratio should be considered. For example, 1:2 means that for each Mezzanine Lenders' share, the sponsor will have 2. For practical purposes, it will be assumed that the sponsor will have 100,000 shares (according to the nature of the Colombian SPVs, the correct term is fiduciary rights) with a nominal value of COP 6,784, for a total investment of COP 678.406 m, as shown in Figure 4-3. Equation 26 shows the number of new equity shares that the Mezzanine Lenders will have in the conversion process:

$$\text{Mezannine Lenders shares}_{t+1} = \frac{\text{Outstanding Debt}_t}{\text{Share Value} \,.\, \text{Conversion Ratio}} \quad (26)$$

In this way, the total shared since period t will be as follows: current shares plus new shares. Table 4-8 shows participation shares.

Table 4-8: Participation share.

Participant	Equity Participation		
	From 1 to t	From t+1 to n	
Sponsors	100%	$\frac{\text{Current Share}}{\text{Current Shares} + \text{New Shares}}$	(27)
Mezzanine Lenders	0%	$\frac{\text{New Shares}}{\text{Current Shares} + \text{New Shares}}$	(28)
Total	100%	100%	

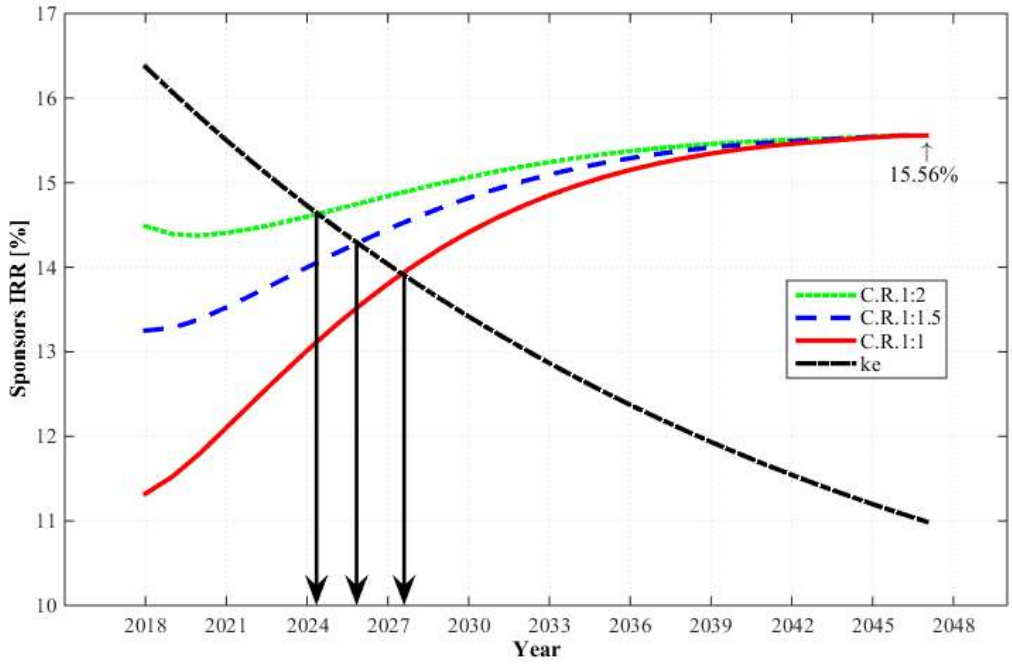
Source: Author's elaboration

4.5.2 Deterministic Model

First, a deterministic analysis is performed to determine the Sponsor's Internal Rate of Return (IRR) behavior (based on Equity Cash Flow) and the FCV according to debt-equity conversion year and the conversion ratio (CR). This analysis also assumes that the Future Funds are delivered each year during the O&M stage and for each year, debt-equity conversion is executed (in other words, each year is evaluated independently).

Figure 4-10 shows the Sponsor's IRR behavior using three conversion ratios (1:1, 1:1,5 and 1:2). There is evidence of convergence towards the Sponsor's IRR (15,56%). This indicates that if the debt-equity conversion that occurs place close to P3s is over, the Sponsor's IRR will not show significant changes. From the Sponsor's perspective, its IRR must be compared to each debt-equity conversion year with the k_e projected. Thus, for 2024, 2026, and 2028, the Sponsor's IRR will be higher than the k_e according to the conversion ratios 1:2, 1:1,5, and 1:1, respectively. The k_e rate changes over time, primarily through changes in the capital structure and therefore in the levered beta calculation. Accordingly, if debt-equity conversion is made before these years, this financial mechanism may not be attractive to the Sponsor, whereas during the final years, the Sponsor's IRR will not have significant changes.

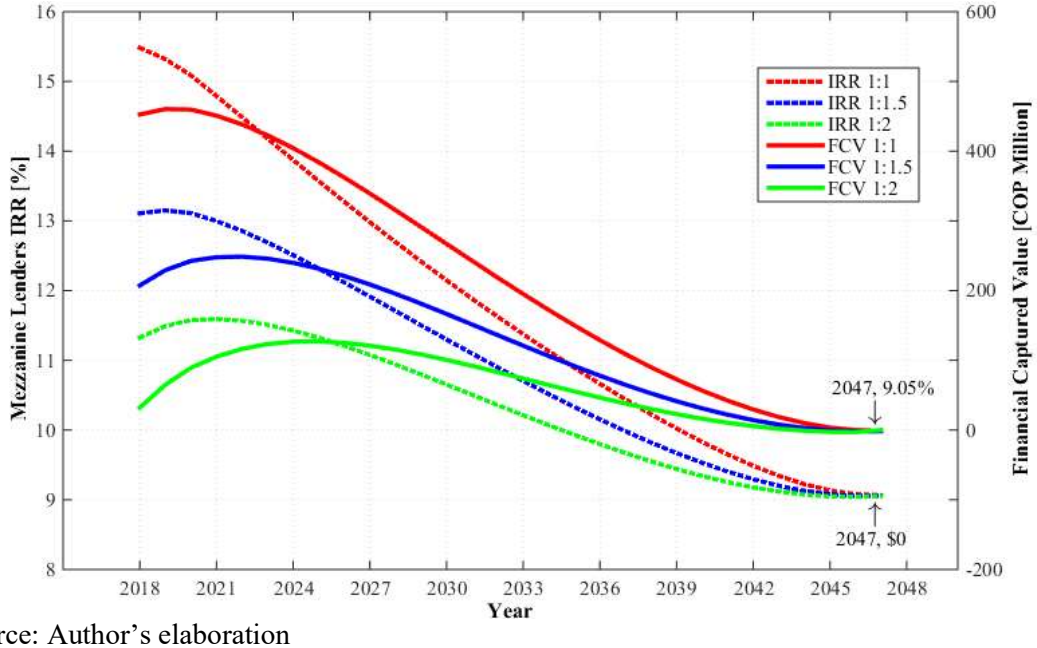
Figure 4-10: Conversion ratio and its impact on the Sponsors IRR



Source: Author's elaboration

Figure 4-11 shows the behavior of both the Mezzanine Lenders' IRR and the FCV. The former converges toward the cost of debt (k_d) because if outstanding debt never becomes equity shares, the Mezzanine Lenders will not capture value; therefore, their IRR will be equal to the projected k_d (9.05%). In this way, the FCV tends to zero. Also, it is clear that the FCV will be higher when the conversion ratio is close to one.

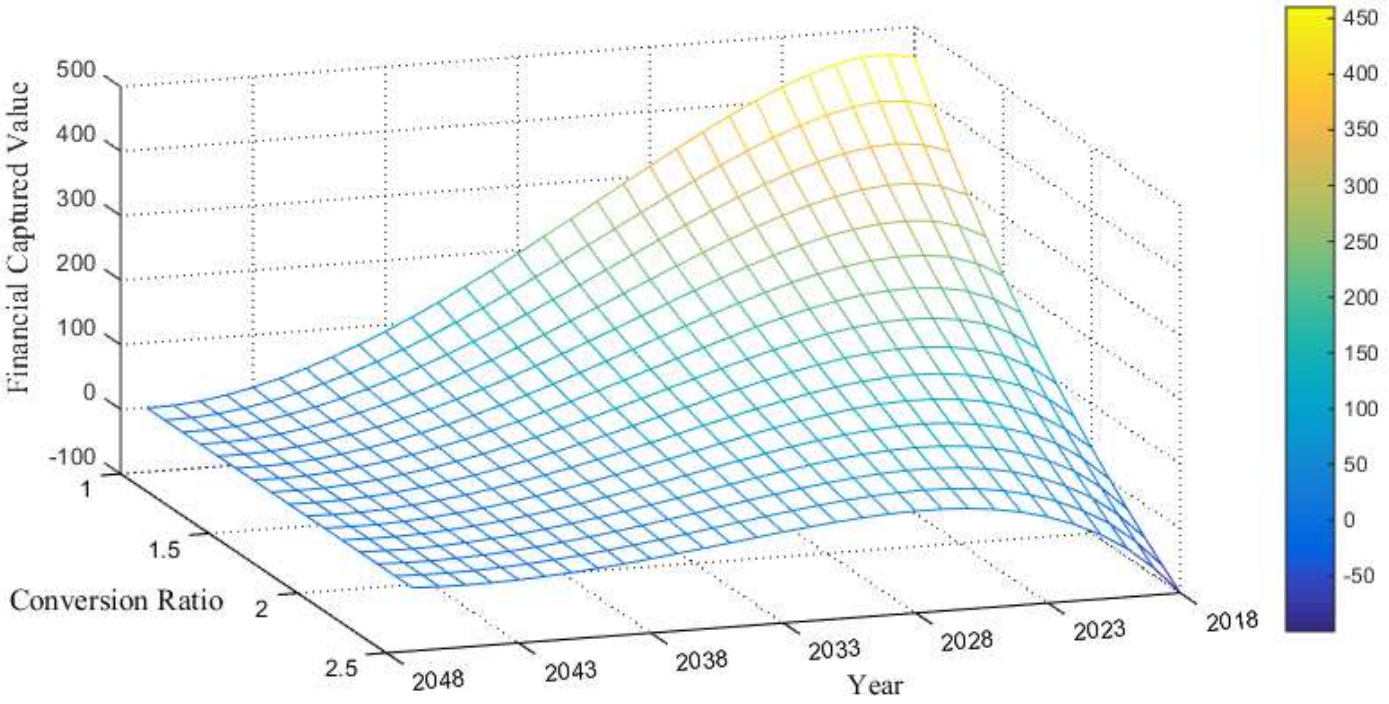
Figure 4-11: Mezzanine Lenders IRR and Financial Captured Value



Source: Author's elaboration

Figure 4-12 plots the impact of the conversion ratios and the debt-equity conversion year on the FCV. This indicates that with the conversion ratios close to one (and considering that the Water Criteria are reached in the first years and the debt-equity conversion process is executed), it is possible to capture a higher Financial Value than that obtained during the project's final years. In addition, an interesting finding is that FCV could also be negative. One potential reason for this is that in contrast to higher-than-zero FCV scenarios, with a conversion ratio higher than one, the Mezzanine Lenders' participation in equity share is increasingly smaller; thus, their Free Cash Flow is smaller. In this way, it is possible to confirm that there is an inverse relation between the conversion ratios and the debt-equity conversion year with the Financial Captured Value. Another reason is that the Mezzanine Lenders' IRR could be lower than the cost of the debt.

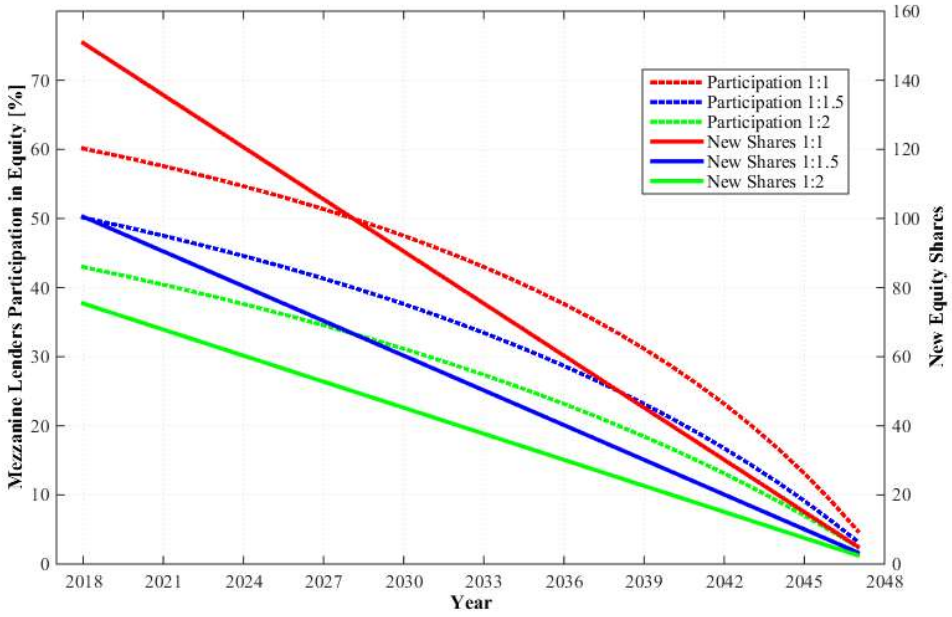
Figure 4-12:. Conversion ratio and conversion's year and their impact on the FCV



Source: Author's elaboration

According to the previous analysis, Figure 4-13 shows the number of new shares for each year and the Mezzanine Lenders' participation. This shows that as the conversion ratio increases, the Mezzanine Lenders' participation in equity shares decreases. This analysis also takes into account that the outstanding debt decreases every year. Consequently, from the Mezzanine Lenders' perspective, the intention is to negotiate a conversion ratio close to one, which enables greater participation at the moment of the debt-equity conversion.

Figure 4-13: Participation and new shares in the debt-equity conversion



Source: Author's elaboration

4.5.3 Stochastic Model

As indicated above, the Blue Bonds are a subset of green bonds created to boost water-related projects. At the time that this dissertation was written, these debt instruments could not be converted from debt to equity, allowing lenders to obtain uncaptured value from the projects through the sustainability concept. In this way, this set of indicators will be applied in the operation stage to determine convertibility into equity, in turn determining the payment of future funds by the Colombian government.

In this way, and as indicated in the previous paper, a Monte Carlo simulation is used to consider the variability of the Water Criteria of the Climate Bonds Standard criteria in time and thus to determine the payment of the future funds and the conversion of debt into equity based on the fulfillment of sustainability elements. Therefore, these criteria will be used not only in the construction stage (to determine whether the project can be financed through Blue Bonds) but also in the O&M stage.

According to the information obtained from the semi-structured interview, the probability distributions assigned for the simulation are shown in the following table:

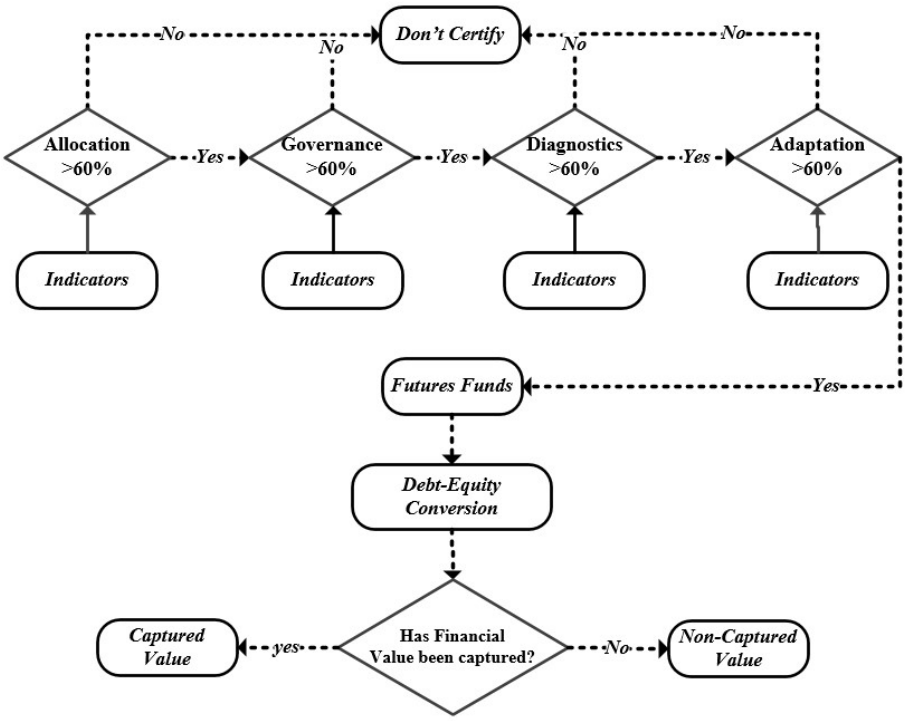
Table 4-9: Probability distributions

Indicator	Probability Distribution
1.2	Tringular (0, 3, 5)
2.2, 2.3, and 2.4	Uniform (0, 0.5, 1)
All others	Uniform (0, 1)

Source: Semi-structured interview

It is important to note that according to the Water Criteria of the Climate Bonds Standard, the indicators with a "n/a" score will be scored as 1 (Climate Bonds Initiative, 2016c); consequently for the analyzed case, the 2.6, 2.13, 3.2, 3.9, 3.13, 3.17, 3.18, 3.19, and 3.21 indicators will have deterministic values. The following figure shows the proposal's implementation.

Figure 4-14: Proposal's implementation



Source: Author's elaboration

For the stochastic analysis, 1322 independent input variables were considered; that is, the correlation among them has not been assumed. Each of these variables corresponds to each indicator in each projection year. Once the probability distribution functions are entered with their respective parameters, the Monte Carlo simulation is executed using @Risk. The Latin Hypercube sampling method is used.

This method has been considered by Palisade (2016) to be a technique that allows the collected samples to corresponding more directly to the input distributions and therefore allows the distributions to converge more quickly to the theoretical statistics of the input distribution. As noted above, the probability distributions were collected in the semi-structured interview. However, to determine the use of a suitable probability distribution for each input variable, historical information is required both for statistical analyses and for tests of goodness and fit. This requirement is a limitation of this research. According to Vélez (2003), the methodology for determining the number of iterations to perform is described as follows: It consists of the simulation of the results' analysis when these results are stabilized; at that point, the process can be stopped and no further iterations are necessary.

In this way, once the simulation has been executed, convergence is found for the Financial Captured Value in 5,000 iterations. Table 4-10 presents four scenarios showing the Financial Captured Value with different conversion ratios. In this way, it can be concluded that lenders can capture value through a financial eco-innovations mechanism structured as a mezzanine-type debt, considering the conversion ratio as a variable sensitive to the results. Given the above, the objective of this work is verified. Figure 4-13 shows the probability distributions of the Financial Captured Value for each scenario using different conversion ratios.

Table 4-10: Relationship between the conversion ratios and the Financial Captured Value.

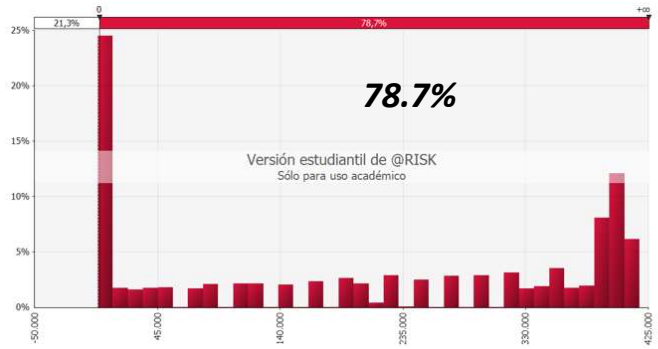
Item	Conversion Ratio			
	1:1	1:1.5	1:2	1:2.5
Prob(FCV>0)	78.7%	76.5%	69.8%	50.9%
Averaged FCV	209,390	113,400	47,639	-317
Min	-1,182	-1,854	-13,349	-139,301
Max	418,258	221,153	110,670	48,732
Standard Deviation	162,664	85,710	43,049	46,206

Figures in COP million.

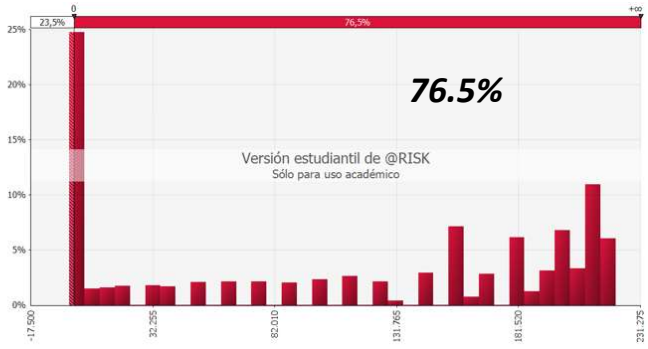
The following figures show the probability distributions of the Financial Captured Value for each scenario using different conversion ratios.

Figure 4-15: Distribution probability of FCV using different conversion ratios

a) Conversion ratio 1:1

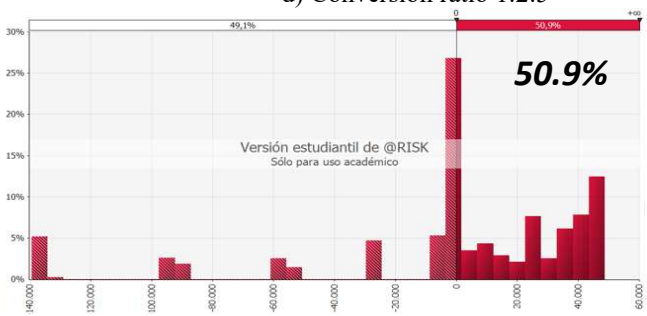


b) Conversion ratio 1:1.5



c) Conversion ratio 1:2

d) Conversion ratio 1:2.5



Source: Financial model created by author using Microsoft Excel and @risk 7.5

4.6 Conclusions

The paper presented the implementation of the methodology developed in the previous paper on mezzanine-type debt as a sustainable financing scheme for the Wastewater Treatment Plant "Aguas Claras" project using the Water Criteria of the Climate Bonds Standard as a mechanism to validate the project's sustainability. Throughout the case study, this dissertation presented the stages that validate the pertinence of the financial instrument designed, taking into account the theoretical basis and appropriate practice of the proposed mechanism; it also presented the evidence on the research field as a response to this study's general objective. Initially, the deterministic simulation evidenced the Mezzanine Lender's captured value by means of the conversion of debt into equity, as later verified by the stochastic simulation. In both simulations, the conversion ratio played a very important role in determining the captured value. In this way, the application of the methodology will lead to new investment options for those who offer sustainable development investments in their portfolio.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

- According to PPPs and PF state-of-the-art, there is a wide research field related to sustainable development that leads to improved project-management practices (particularly, project funding). Therefore, and to comply with SDGs, it is fundamental (through conducting research) to attempt to articulate the design of new investment vehicles, funding strategies, project management and the construction of sustainable projects.

- This dissertation provides relevant information that supports SIS funding decision-making. Taking into account that it is necessary to comply with the Paris Agreements and the United Nations Sustainable Development Goals, the link between project management and sustainability constitutes a developing field that undoubtedly (through modern schemes) contributes to fulfilling those commitments. However, there remains a need for further consideration of the relation between the development of financial markets and sustainable development. For that reason, this dissertation represents support for moving toward the implementation of a sustainable financial framework in real contexts.

- Strategic management and planning in Colombia, particularly in the water sector, should move toward the creation of market mechanisms, which means designing and executing new public policies. The government is expected to encourage the private sector's involvement in this type of project, synchronizing public and private funding resources with the country's social, economic and environmental indicators.

This research proposes a novel financial framework that involves P3s and mezzanine-type debt related to the TBL criteria to encourage the private sector's participation in developing SIS. Thus, it makes several contributions to the literature. First, the paper presents a mezzanine-type debt mechanism in which there is the possibility of exchanging outstanding debt for equity shares if goals and covenants related to TBL are accomplished. To the best of the authors' knowledge, there are no elements in the current literature that determine whether any type of subordination (economic, social or environmental sustainability) components exist in the structuring of financing, particularly in servicing debt or in performing debt-equity conversions. In this way, these elements have neither been addressed explicitly nor combined.

Therefore, this financial framework could be considered a new sustainable hybrid debt mechanism. Second, the Financial Captured Value by lenders theory is developed and integrated. This theory was addressed using both the deterministic and the Monte Carlo simulation. Thus, from a financial perspective, the capture of financial value through a sustainable hybrid debt mechanism is directly related to the conversion ratio.

One remarkable finding of this study arises out of the fact that the FCV can be negative given the inverse relationship between the conversion ratios and the debt-equity conversion year with the FCV. In this way, the determination of this ratio in the negotiation deal between sponsors and lenders plays a pivotal role, potentially leading to agency conflicts. The results of this study suggest that both the Sponsors IRR and the FCV are quite sensitive to the debt-equity conversion ratio.

This research positively contributes to the body of knowledge and practice by being the first to integrate mezzanine-type debt into sustainability criteria. Also, it measures lenders' financial results from a captured value perspective using a novel framework. In this way, this study contributes to the state-of-the-art in financing decision-making related to SIS, particularly in the drinking water and sanitation sector.

This study's findings enable us to advance theoretical knowledge in SIS funding. These findings also have practical implications for the success of the infrastructure industry. Specifically, the findings challenge investors' behavior related to the development of sustainable investments and how their profitability should be measured. In this way, to achieve the SDGs, an adequate infrastructure development is part of the answer; therefore, clear standards and new models are crucial. This would benefit project developers, lenders, and public-sector institutions (Egler and Frazao, 2016).

Accordingly, this proposal aims at providing new insights about this concern with the goal of contributing to achieving the SDGs. Finally, to bridge the gap between theory and practice, both researchers and practicing professionals may use this study's findings to broaden central aspects of developing infrastructure systems regarding the financing process given that these could be reformulated, changed or created with the goal of conceiving a new trend or path for sustainable investments. Additionally, this study's findings can be incorporated into further research efforts to develop further new methodologies leading to a better understanding of the relation between SIS, finance, and P3s.

5.2 Limitations of the Research

Despite this study's strengths, its most significant limitation is based on the lack of primary and secondary information on the Blue Bonds. Given the limited experience of this type of bond issuance in Latin America, it was impossible to obtain relevant information that would permit us to correlate variables or perform more robust statistical analyses. Therefore, it is possible that additional elements not identified in this study are important to establish new ways to generate value for both lenders and sponsors. This issue must be addressed in future research. Second, because of the low development of drinking water and sanitation projects in Latin America, particularly in Colombia, it was impossible to validate the framework using other projects to obtain contrasting results.

5.3 Recommendations for Future Research

To go beyond this study, further research on topics related to sustainable financial mechanisms will facilitate improved financial practices in the development of sustainable infrastructure. In this way, there is a high potential in both the academic and practical arenas for continuing to build this body of knowledge. Aiming to advance in this area and based on the issues identified in this study, potential research topics are recommended for further studies that would extend this work. These topics are expected to promote qualitative and quantitative research that would reduce the gap between theory and practice and would be focused on the current status of SIS. These topics are listed below.

5.3.1 Project Management

- Corporate governance: relations of corporate governance with the different PPPs schemes.
- PPPs schemes: methodologies to select the optimal scheme according to the type of project.
- Service indicators: to characterize the main mechanisms used to measure the benefits of the services provided in infrastructure projects.

5.3.2 Finance

- Conversion ratio: using Fuzzy Logic to determine how this ratio could be calculated by incorporating lenders and sponsors' risks and profitability expectations. In addition, this analysis could include a range for determining this ratio according to the debt-equity conversion period.
- Real Options: to evaluate the financial option of creating value for lenders using the FCV theory, which will enable an analysis of the indebtedness capacity of projects through sustainable hybrid financial mechanisms focused on the convertible debt-equity framework.
- Risk rating: to develop a methodology to establish the credit risk in SIS projects.
- Agency conflicts: to analyze the sponsor-lender relationship and its impact on financial results.
- Financial Captured Value: in the debt-equity conversion process, the FCV also depends on the discount rate used from the conversion period (t) until the end of the O&M stage (n). For academic purposes, this study used the same discount rate as that of the current sponsors (k_e). To go further in this theory, future research could calculate the FCV based on the risk perceived by Mezzanine Lenders according to their profitability expectations and the project's remaining duration.
- Outstanding debt: because of changes in interest rates, outstanding debt could be valued at market prices, which could have an impact on Mezzanine Lenders' participation in equity shares and therefore in the FCV.
- Financial markets: to develop a theoretical framework for creating primary and secondary financial markets of securities indexed to SIS, which would provide guidance for the creation of securities based on sustainability factors. From a market perspective, it would generate liquidity for both lenders and sponsors.

APPENDICES

Appendix A - Financial Function: +va_plan(Cash Flows; Interest_rates).

```
Public Function va_plan(Cash_Flows As Range, Interest_Rates As Range)
Dim vf As Range
Dim z As Range

  j = 1
    For Each vf In Cash_Flows
    i = 1
    va = vf
      For Each z In Interest_Rates
        If i <= j Then
        va = va / (1 + z)
        End If
      i = i + 1
      Next z
    tva = tva + va
    j = j + 1
    Next vf
  va_plan = tva

End Function
```

Appendix B – Semi-structured interview

Formato Entrevista semi-estructurada

Desarrollo De Proyectos De Infraestructura En El Sector De Agua En Colombia

Presentación

Como parte de la tesis de Doctorado desarrollada en la Facultad de Minas de la Universidad Nacional de Colombia, me encuentro desarrollando una investigación relacionada con el desarrollo de proyectos de infraestructura en el sector de agua en Colombia. La información obtenida en esta entrevista es de carácter confidencial y solo será utilizada para los propósitos de la investigación

Inicio

Empresa: _____

Persona entrevistada: _____

Función: _____

Experiencia (Años)_____

ETAPA 1: Estructuración

Preguntas principales:

1. ¿Cómo identifican las oportunidades para desarrollar proyectos de infraestructura de agua?
2. ¿Considera que los procedimientos ante las autoridades competentes para solicitar los permisos y/o licencias están bien establecidos y definidos?
3. ¿Por qué si han transcurrido 4 años desde la expedición de la Ley de APPs 1508/2012 a la fecha no hay ningún proyecto en operación?
4. ¿El desarrollo de proyectos en el sector están alineados con los planes de desarrollo municipales, departamentales y nacionales?
5. ¿Los subsidios o tarifas compensadas del sector incentivan ó desincentivan la vinculación de capital privado?
6. ¿Son suficientes los incentivos tributarios para motivar la vinculación de capital privado?
7. ¿El tiempo que el gobierno tiene para evaluar una APPs es adecuado? ¿Se podrían estar perdiendo oportunidades de inversión?

ETAPA 2: Financiación

Preguntas principales:

1. ¿Cómo es el proceso de financiación de un proyecto de agua?
2. ¿Son suficientes los recursos públicos para financiar proyectos en el sector?
3. Considerando la emisión de bonos verdes realizada por Bancolombia y el potencial de financiación por medio de Blue Bonds para proyectos del sector de agua, ¿cuál considera que sería una tasa de financiación razonable de acuerdo al nivel de riesgo y plazo de los proyectos?
4. ¿Existen mecanismos de financiación para el sector subordinados a factores ambientales, sociales y/o económicos?
5. ¿Cuáles son las políticas de endeudamiento de corto y largo plazo?
6. ¿Cuáles son las fuentes de financiación que utiliza el sector?
7. ¿Por qué el endeudamiento es tan bajo en el sector en comparación con la infraestructura vial?
8. ¿Considera el aspecto impositivo como factor clave en la rentabilidad de los proyectos?
9. ¿Cómo mide el costo de capital de los proyectos? ¿Utilizan el modelo CAPM?
10. ¿Por qué considera que no se han emitido títulos valores en el mercado de capitales de proyectos de infraestructura, en especial del sector de agua?
11. De acuerdo con la Ley 1508/2012 para proyectos de iniciativa privada con recursos públicos, el Estado solo financiará el 20% del valor del contrato, ¿considera que este porcentaje es adecuado para el sector?

ETAPA 3: Water Criteria of the Climate Bonds Standard

Preguntas principales:

1. ¿Considera que los criterios diseñados por el Climate Bond Initiative se ajustan a la realidad del sector en Colombia?
2. Califique cada indicador de acuerdo al Water Critera of the Climate Bonds Standard
3. De acuerdo a la experiencia en el sector, por favor indique la distribución de probabilidad que mejor se podría ajustar para cada indicador.

Muchas gracias por la información.

Appendix C – Income Statement

Item / Year	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
(+) Total Income	273.476	296.036	307.534	317.410	327.964	338.596	349.470	360.247	371.063	382.215	393.712	405.565	417.786	430.386	443.376
+ Investment remuneration	222.125	284.694	296.192	306.068	316.622	327.254	338.128	348.905	359.721	370.872	382.369	394.223	406.444	419.044	432.034
+ Operational	39.747	53.612	57.687	60.039	62.797	65.440	68.107	70.443	72.627	74.878	77.199	79.593	82.060	84.604	87.227
+ Retributive Rate	262	413	309	321	331	342	352	363	374	386	398	410	423	436	449
+ Future Funds	11.342	11.342	11.342	11.342	11.342	11.342	11.342	11.342	11.342	11.342	11.342	11.342	11.342	11.342	11.342
(-) Cost of good sold	38.132	56.996	60.155	62.744	65.357	68.092	71.107	73.337	75.611	77.955	80.371	82.863	85.432	88.080	90.811
- O&M Plant	26.975	41.203	43.993	45.943	47.954	49.976	52.084	53.810	55.478	57.198	58.971	60.799	62.684	64.627	66.630
- Interceptor maintenance	43	44	46	47	48	49	51	52	54	56	57	59	61	63	65
- Retributive Rate	0	524	301	317	326	336	347	358	369	381	392	404	417	430	443
- Taxes and others	5.227	5.718	6.014	6.331	6.609	6.990	7.551	7.699	7.938	8.184	8.437	8.699	8.969	9.247	9.533
- Administrative Staff	2.796	2.883	2.972	3.065	3.160	3.257	3.358	3.463	3.570	3.681	3.795	3.913	4.034	4.159	4.288
- General expenses	3.091	6.624	6.830	7.041	7.259	7.484	7.716	7.955	8.202	8.456	8.718	8.989	9.267	9.555	9.851
(=) EBITDA	235.344	239.040	247.380	254.666	262.608	270.504	278.363	286.910	295.453	304.260	313.340	322.702	332.354	342.306	352.566
EBITDA Margin	86%	81%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%
- Depreciation	26.713	26.713	26.713	26.713	26.713	26.713	26.713	26.713	26.713	26.713	26.713	26.713	26.713	26.713	26.713
(=) EBIT	208.631	212.327	220.666	227.953	235.895	243.791	251.650	260.197	268.739	277.547	286.627	295.989	305.641	315.593	325.852
Operation Margin	76%	72%	72%	72%	72%	72%	72%	72%	72%	73%	73%	73%	73%	73%	73%
- Interest expense	92.889	89.792	86.696	83.600	80.503	77.407	74.311	71.215	68.118	65.022	61.926	58.829	55.733	52.637	49.541
(=) Net Income Before Taxes	115.742	122.534	133.970	144.354	155.391	166.384	177.339	188.982	200.621	212.525	224.701	237.160	249.908	262.956	276.312
- Income taxes	**5.787**	**6.127**	**6.699**	**7.218**	**7.770**	**8.319**	**8.867**	**9.449**	**10.031**	**10.626**	**11.235**	**11.858**	**12.495**	**13.148**	**13.816**
(=) Net Income	109.955	116.408	127.272	137.136	147.622	158.065	168.472	179.533	190.590	201.898	213.466	225.302	237.413	249.808	262.496
Net Margin	40%	39%	41%	43%	45%	47%	48%	50%	51%	53%	54%	56%	57%	58%	59%

Item / Year	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047
(+) Total Income	456.769	470.578	484.814	499.491	514.624	530.226	546.311	562.895	579.993	597.622	615.796	634.534	653.853	673.771	694.306
+ Investment remuneration	445.427	459.235	473.472	488.149	503.282	518.883	534.969	551.553	568.651	586.279	604.454	623.192	642.511	662.429	682.964
+ Operational	89.931	92.718	95.593	98.556	101.611	104.761	108.009	111.357	114.809	118.368	122.038	125.821	129.721	133.743	137.889
+ Retributive Rate	463	478	493	508	524	540	557	574	592	610	629	648	668	689	711
+ Future Funds	11.342	11.342	11.342	11.342	11.342	11.342	11.342	11.342	11.342	11.342	11.342	11.342	11.342	11.342	11.342
(-) Cost of good sold	93.626	96.528	99.520	102.606	105.786	109.066	112.447	115.933	119.527	123.232	127.052	130.991	135.051	139.238	143.554
- O&M Plant	68.696	70.826	73.021	75.285	77.619	80.025	82.506	85.063	87.700	90.419	93.222	96.112	99.091	102.163	105.330
- Interceptor maintenance	67	69	71	73	75	78	80	83	85	88	91	93	96	99	102
- Retributive Rate	457	471	486	501	516	532	549	566	583	602	620	639	659	680	701
- Taxes and others	9.829	10.134	10.448	10.772	11.106	11.450	11.805	12.171	12.548	12.937	13.338	13.751	14.178	14.617	15.070
- Administrative Staff	4.421	4.558	4.699	4.845	4.995	5.150	5.310	5.474	5.644	5.819	5.999	6.185	6.377	6.575	6.779
- General expenses	10.156	10.471	10.796	11.130	11.475	11.831	12.198	12.576	12.966	13.368	13.782	14.209	14.650	15.104	15.572
(=) EBITDA	363.144	374.049	385.293	396.886	408.838	421.160	433.864	446.963	460.467	474.390	488.744	503.544	518.802	534.533	550.752
EBITDA Margin	80%	79%	79%	79%	79%	79%	79%	79%	79%	79%	79%	79%	79%	79%	79%
- Depreciation	26.713	26.713	26.713	26.713	26.713	26.713	26.713	26.713	26.713	26.713	26.713	26.713	26.713	26.713	26.713
(=) EBIT	336.430	347.336	358.580	370.173	382.124	394.447	407.151	420.249	433.754	447.676	462.031	476.830	492.089	507.820	524.039
Operation Margin	74%	74%	74%	74%	74%	74%	75%	75%	75%	75%	75%	75%	75%	75%	75%
- Interest expense	46.444	43.348	40.252	37.155	34.059	30.963	27.867	24.770	21.674	18.578	15.481	12.385	9.289	6.193	3.096
(=) Net Income Before Taxes	289.986	303.988	318.328	333.017	348.065	363.484	379.285	395.479	412.080	429.099	446.549	464.445	482.800	501.627	520.942
- Income taxes	**14.499**	**15.199**	**15.916**	**16.651**	**17.403**	**18.174**	**18.964**	**19.774**	**20.604**	**21.455**	**22.327**	**23.222**	**24.140**	**25.081**	**130.236**
(=) Net Income	275.487	288.789	302.412	316.366	330.662	345.310	360.320	375.705	391.476	407.644	424.222	441.223	458.660	476.546	390.707
Net Margin	60%	61%	62%	63%	64%	65%	66%	67%	67%	68%	69%	70%	70%	71%	56%

Appendix D – Balance Sheet

Item / Year	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Cash	6.664	15.205	24.090	33.272	42.771	52.589	62.732	73.200	83.991	95.117	106.589	118.415	130.609	143.180	156.141
Net fixed assets	1.674.641	1.647.928	1.621.214	1.594.501	1.567.788	1.541.075	1.514.361	1.487.648	1.460.935	1.434.222	1.407.508	1.380.795	1.354.082	1.327.369	1.300.655
Land	157.338	157.338	157.338	157.338	157.338	157.338	157.338	157.338	157.338	157.338	157.338	157.338	157.338	157.338	157.338
Construction in progress															
Building	1.544.016	1.544.016	1.544.016	1.544.016	1.544.016	1.544.016	1.544.016	1.544.016	1.544.016	1.544.016	1.544.016	1.544.016	1.544.016	1.544.016	1.544.016
Accumulated depreciation	-26.713	-53.426	-80.140	-106.853	-133.566	-160.279	-186.993	-213.706	-240.419	-267.132	-293.846	-320.559	-347.272	-373.985	-400.699
Asset	**1.681.305**	**1.663.132**	**1.645.305**	**1.627.773**	**1.610.559**	**1.593.663**	**1.577.094**	**1.560.848**	**1.544.926**	**1.529.339**	**1.514.097**	**1.499.210**	**1.484.690**	**1.470.549**	**1.456.796**
Accrued taxes	5.787	6.127	6.699	7.218	7.770	8.319	8.867	9.449	10.031	10.626	11.235	11.858	12.495	13.148	13.816
Current Debt	5.787	6.127	6.699	7.218	7.770	8.319	8.867	9.449	10.031	10.626	11.235	11.858	12.495	13.148	13.816
Long-term debt	988.850	954.751	920.653	886.555	852.457	818.358	784.260	750.162	716.063	681.965	647.867	613.769	579.670	545.572	511.474
Blue Bonds	988.850	954.751	920.653	886.555	852.457	818.358	784.260	750.162	716.063	681.965	647.867	613.769	579.670	545.572	511.474
Debt	**994.637**	**960.878**	**927.352**	**893.772**	**860.226**	**826.677**	**793.127**	**759.611**	**726.095**	**692.591**	**659.102**	**625.627**	**592.166**	**558.720**	**525.290**
Common Stock	678.406	678.406	678.406	678.406	678.406	678.406	678.406	678.406	678.406	678.406	678.406	678.406	678.406	678.406	678.406
Additional paid in capital	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Reserves		8.262	23.848	39.547	55.595	71.927	88.580	105.561	122.831	140.425	158.341	176.589	195.177	214.118	233.422
Net Income	8.262	15.586	15.699	16.048	16.332	16.653	16.981	17.270	17.595	17.916	18.247	18.589	18.941	19.304	19.678
Equity	686.668	702.254	717.953	734.001	750.333	766.986	783.967	801.237	818.832	836.748	854.995	873.584	892.525	911.829	931.507

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Item / Year	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047
Cash	169.504	183.281	197.485	212.129	227.228	242.794	258.843	275.390	292.449	310.038	328.171	346.867	366.143	386.015	483.785
Net fixed assets	1.273.942	1.247.229	1.220.516	1.193.803	1.167.089	1.140.376	1.113.663	1.086.950	1.060.236	1.033.523	1.006.810	980.097	953.383	926.670	899.957
Land	157.338	157.338	157.338	157.338	157.338	157.338	157.338	157.338	157.338	157.338	157.338	157.338	157.338	157.338	157.338
Construction in progress															
Building	1.544.016	1.544.016	1.544.016	1.544.016	1.544.016	1.544.016	1.544.016	1.544.016	1.544.016	1.544.016	1.544.016	1.544.016	1.544.016	1.544.016	1.544.016
Accumulated depreciation	-427.412	-454.125	-480.838	-507.552	-534.265	-560.978	-587.691	-614.405	-641.118	-667.831	-694.544	-721.257	-747.971	-774.684	-801.397
Asset	**1.443.446**	**1.430.510**	**1.418.001**	**1.405.932**	**1.394.317**	**1.383.170**	**1.372.506**	**1.362.340**	**1.352.686**	**1.343.561**	**1.334.981**	**1.326.964**	**1.319.526**	**1.312.686**	**1.383.742**
Accrued taxes	14.499	15.199	15.916	16.651	17.403	18.174	18.964	19.774	20.604	21.455	22.327	23.222	24.140	25.081	130.236
Current Debt	14.499	15.199	15.916	16.651	17.403	18.174	18.964	19.774	20.604	21.455	22.327	23.222	24.140	25.081	130.236
Long-term debt	477.376	443.277	409.179	375.081	340.983	306.884	272.786	238.688	204.590	170.491	136.393	102.295	68.197	34.098	0
Blue Bonds	477.376	443.277	409.179	375.081	340.983	306.884	272.786	238.688	204.590	170.491	136.393	102.295	68.197	34.098	0
Debt	**491.875**	**458.477**	**425.096**	**391.732**	**358.386**	**325.059**	**291.750**	**258.462**	**225.194**	**191.946**	**158.721**	**125.517**	**92.337**	**59.180**	**130.236**
Common Stock	678.406	678.406	678.406	678.406	678.406	678.406	678.406	678.406	678.406	678.406	678.406	678.406	678.406	678.406	678.406
Additional paid in capital	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Reserves	253.101	273.165	293.627	314.499	335.794	357.525	379.706	402.350	425.471	449.086	473.208	497.855	523.041	548.783	575.100
Net Income	20.064	20.462	20.872	21.295	21.731	22.181	22.644	23.122	23.615	24.122	24.646	25.186	25.743	26.317	0
Equity	951.571	972.033	992.905	1.014.200	1.035.931	1.058.112	1.080.756	1.103.878	1.127.492	1.151.615	1.176.261	1.201.447	1.227.189	1.253.506	1.253.506

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Appendix E – Cash Flows

Item / Year	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
(+) EBIT	208.631	212.327	220.666	227.953	235.895	243.791	251.650	260.197	268.739	277.547	286.627	295.989	305.641	315.593	325.852
(-) Operating Taxes		10.432	10.616	11.033	11.398	11.795	12.190	12.583	13.010	13.437	13.877	14.331	14.799	15.282	15.780
(=) NOPLAT	208.631	201.895	210.050	216.920	224.497	231.996	239.461	247.614	255.729	264.110	272.750	281.658	290.842	300.311	310.073
(+) Depreciation	26.713	26.713	26.713	26.713	26.713	26.713	26.713	26.713	26.713	26.713	26.713	26.713	26.713	26.713	26.713
(=) Gross Cash Flow	235.344	228.608	236.763	243.633	251.210	258.709	266.174	274.327	282.443	290.823	299.463	308.371	317.555	327.024	336.786
(-) Net Working Capital	25.174	7.091	1.303	1.119	1.196	1.205	1.232	1.221	1.226	1.264	1.303	1.343	1.385	1.428	1.472
(-) Capex --> $1.567.650															
Free Cash Flow --> 13,10%	210.170	221.517	235.460	242.514	250.014	257.504	264.941	273.106	281.217	289.559	298.160	307.028	316.170	325.596	335.314

(-) Interest	92.889	89.792	86.696	83.600	80.503	77.407	74.311	71.215	68.118	65.022	61.926	58.829	55.733	52.637	49.541
(-) Principal	34.098	34.098	34.098	34.098	34.098	34.098	34.098	34.098	34.098	34.098	34.098	34.098	34.098	34.098	34.098
(+) Tax Shield		4.644	4.490	4.335	4.180	4.025	3.870	3.716	3.561	3.406	3.251	3.096	2.941	2.787	2.632
(=) Outstanding Debt	988.850	954.751	920.653	886.555	852.457	818.358	784.260	750.162	716.063	681.965	647.867	613.769	579.670	545.572	511.474

Debt Cash Flow --> 9,08%	126.987	123.891	120.794	117.698	114.602	111.505	108.409	105.313	102.217	99.120	96.024	92.928	89.831	86.735	83.639
DCSR	1,7X	1,8X	1,9X	2,1X	2,2X	2,3X	2,4X	2,6X	2,8X	2,9X	3,1X	3,3X	3,5X	3,8X	4,0X
LLCR	3,1X	3,2X	3,4X	3,6X	3,8X	3,9X	4,2X	4,4X	4,6X	4,9X	5,1X	5,4X	5,7X	6,0X	6,3X

Equity Cash Flow --> 15,56%	83.183	102.271	119.156	129.151	139.592	150.024	160.403	171.509	182.561	193.845	205.387	217.196	229.280	241.647	254.307

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Item / Year	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047
(+) EBIT	336.430	347.336	358.580	370.173	382.124	394.447	407.151	420.249	433.754	447.676	462.031	476.830	492.089	507.820	524.039
(-) Operating Taxes	16.293	16.822	17.367	17.929	18.509	19.106	19.722	20.358	21.012	21.688	22.384	23.102	77.264	123.022	126.955
(=) NOPLAT	320.138	330.515	341.213	352.244	363.616	375.341	387.429	399.892	412.741	425.989	439.647	453.729	414.825	384.798	397.084
(+) Depreciation	26.713	26.713	26.713	26.713	26.713	26.713	26.713	26.713	26.713	26.713	26.713	26.713	26.713	26.713	26.713
(=) Gross Cash Flow	346.851	357.228	367.927	378.957	390.329	402.054	414.142	426.605	439.454	452.702	466.360	480.442	441.538	411.511	423.797
(-) Net Working Capital	1.518	1.565	1.613	1.663	1.715	1.768	1.823	1.880	1.938	1.998	2.060	2.124	2.189	2.257	2.327
(-) Capex --> $1.567.650															
Free Cash Flow --> 13,10%	345.333	355.663	366.313	377.293	388.614	400.286	412.319	424.726	437.517	450.704	464.301	478.318	439.349	409.254	498.872

(-) Interest	46.444	43.348	40.252	37.155	34.059	30.963	27.867	24.770	21.674	18.578	15.481	12.385	9.289	6.193	3.096
(-) Principal	34.098	34.098	34.098	34.098	34.098	34.098	34.098	34.098	34.098	34.098	34.098	34.098	34.098	34.098	34.098
(+) Tax Shield	2.477	2.322	2.167	2.013	1.858	1.703	1.548	1.393	1.239	1.084	929	774	54.041	98.882	101.874
(=) Outstanding Debt	477.376	443.277	409.179	375.081	340.983	306.884	272.786	238.688	204.590	170.491	136.393	102.295	68.197	34.098	0

Debt Cash Flow --> 9,08%	80.543	77.446	74.350	71.254	68.157	65.061	61.965	58.869	55.772	52.676	49.580	46.483	43.387	40.291	37.195
DCSR	4,3X	4,6X	4,9X	5,3X	5,7X	6,2X	6,7X	7,2X	7,8X	8,6X	9,4X	10,3X	10,1X	10,2X	13,4X
LLCR	6,6X	7,0X	7,4X	7,8X	8,2X	8,6X	9,1X	9,5X	10,0X	10,4X	10,8X	11,1X	11,6X	13,4X	0,0X

Equity Cash Flow --> 15,56%	267.268	280.539	294.131	308.052	322.314	336.927	351.902	367.250	382.983	399.112	415.650	432.609	450.003	467.845	563.551

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Appendix F – Base Information

Item	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
+ Investment remuneration	222.125	230.669	238.196	245.708	253.494	261.472	269.669	278.099	286.720	295.608	304.772	314.220	323.961	334.004	344.358
+ Operational	39.747	53.612	57.687	60.039	62.797	65.440	68.107	70.443	72.627	74.878	77.199	79.593	82.060	84.604	87.227
+ Retributive Rate	262	413	309	321	331	342	352	363	374	386	398	410	423	436	449
Total Income	262.134	284.694	296.192	306.068	316.622	327.254	338.128	348.905	359.721	370.872	382.369	394.223	406.444	419.044	432.034
O&M Plant	28.395	43.372	46.308	48.361	50.478	52.606	54.825	56.642	58.398	60.208	62.075	63.999	65.983	68.028	70.137
Interceptor maintenance	45	46	48	49	51	52	54	55	57	58	60	62	64	66	68
Retributive Rate		524	301	317	326	336	347	358	369	381	392	404	417	430	443
Taxes and others	5.227	5.718	6.014	6.331	6.609	6.990	7.551	7.699	7.938	8.184	8.437	8.699	8.969	9.247	9.533
Administrative Staff	2.796	2.883	2.972	3.065	3.160	3.257	3.358	3.463	3.570	3.681	3.795	3.913	4.034	4.159	4.288
General expenses	3.254	6.973	7.189	7.412	7.641	7.878	8.122	8.374	8.634	8.901	9.177	9.462	9.755	10.057	10.369
Total Costs and Expenses	0	59.516	62.832	65.535	68.265	71.119	74.257	76.591	78.965	81.413	83.937	86.539	89.222	91.988	94.839
Inflation rate COL --> Bancolombia	3,10%	3,10%	3,10%	3,10%	3,10%	3,10%	3,10%	3,10%	3,10%	3,10%	3,10%	3,10%	3,10%	3,10%	3,10%
Inflation rate USA	2,00%	2,00%	2,00%	2,00%	2,00%	2,00%	2,00%	2,00%	2,00%	2,00%	2,00%	2,00%	2,00%	2,00%	2,00%
IBR (AE)	5,35%	5,35%	5,35%	5,35%	5,35%	5,35%	5,35%	5,35%	5,35%	5,35%	5,35%	5,35%	5,35%	5,35%	5,35%
Spread MV	3,50%	3,50%	3,50%	3,50%	3,50%	3,50%	3,50%	3,50%	3,50%	3,50%	3,50%	3,50%	3,50%	3,50%	3,50%
Operating Income Tax with Environ.	10.432	10.616	11.033	11.398	11.795	12.190	12.583	13.010	13.437	13.877	14.331	14.799	15.282	15.780	16.293
Taxable Income	52.158	53.082	55.167	56.988	58.974	60.948	62.913	65.049	67.185	69.387	71.657	73.997	76.410	78.898	81.463
Income Tax Rate	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%
Adjusted EBIT	208.631	212.327	220.666	227.953	235.895	243.791	251.650	260.197	268.739	277.547	286.627	295.989	305.641	315.593	325.852
EBIT	208.631	212.327	220.666	227.953	235.895	243.791	251.650	260.197	268.739	277.547	286.627	295.989	305.641	315.593	325.852
- Adjustments and other Deductions															
Presumptive income tax	20.352	20.600	21.068	21.539	22.020	22.510	23.010	23.519	24.037	24.565	25.102	25.650	26.208	26.776	27.355
Equity	678.406	686.668	702.254	717.953	734.001	750.333	766.986	783.967	801.237	818.832	836.748	854.995	873.584	892.525	911.829
Equity Tax Rate	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Environmental Tax reduction %	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
Environmental Tax reduction $	41.726	42.465	44.133	45.591	47.179	48.758	50.330	52.039	53.748	55.509	57.325	59.198	61.128	63.119	65.170
Accumulated Environmental Tax reduction	1.659.628	1.632.175	1.603.794	1.575.624	1.547.322	1.519.030	1.490.745	1.462.322	1.433.900	1.405.426	1.376.896	1.348.311	1.319.667	1.290.963	1.262.198
Net Income Taxes	5.787	6.127	6.699	7.218	7.770	8.319	8.867	9.449	10.031	10.626	11.235	11.858	12.495	13.148	13.816
Taxable income	115.742	122.534	133.970	144.354	155.391	166.384	177.339	188.982	200.621	212.525	224.701	237.160	249.908	262.956	276.312
- Net Income Before Taxes	115.742	122.534	133.970	144.354	155.391	166.384	177.339	188.982	200.621	212.525	224.701	237.160	249.908	262.956	276.312
- Adjustments and other Deductions	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Environmental Tax reduction $	23.148	24.507	26.794	28.871	31.078	33.277	35.468	37.796	40.124	42.505	44.940	47.432	49.982	52.591	55.262
Balance	1.678.206	1.653.699	1.626.905	1.598.034	1.566.956	1.533.679	1.498.211	1.460.415	1.420.291	1.377.786	1.332.845	1.285.413	1.235.432	1.182.841	1.127.578
Tax Shield	4.644	4.490	4.335	4.180	4.025	3.870	3.716	3.561	3.406	3.251	3.096	2.941	2.787	2.632	2.477
Sustainabily Factor	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%

Item	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047
+ Investment remuneration	355.033	366.039	377.386	389.085	401.147	413.582	426.403	439.622	453.250	467.301	481.787	496.723	512.121	527.997	544.365
+ Operational	89.931	92.718	95.593	98.556	101.611	104.761	108.009	111.357	114.809	118.368	122.038	125.821	129.721	133.743	137.889
+ Retributive Rate	463	478	493	508	524	540	557	574	592	610	629	648	668	689	711
Total Income	445.427	459.235	473.472	488.149	503.282	518.883	534.969	551.553	568.651	586.279	604.454	623.192	642.511	662.429	682.964
O&M Plant	72.312	74.553	76.864	79.247	81.704	84.237	86.848	89.540	92.316	95.178	98.128	101.170	104.307	107.540	110.874
Interceptor maintenance	70	72	75	77	79	82	84	87	90	92	95	98	101	104	108
Retributive Rate	457	471	486	501	516	532	549	566	583	602	620	639	659	680	701
Taxes and others	9.829	10.134	10.448	10.772	11.106	11.450	11.805	12.171	12.548	12.937	13.338	13.751	14.178	14.617	15.070
Administrative Staff	4.421	4.558	4.699	4.845	4.995	5.150	5.310	5.474	5.644	5.819	5.999	6.185	6.377	6.575	6.779
General expenses	10.691	11.022	11.364	11.716	12.079	12.454	12.840	13.238	13.648	14.071	14.507	14.957	15.421	15.899	16.392
Total Costs and Expenses	97.779	100.810	103.936	107.158	110.480	113.904	117.435	121.076	124.829	128.699	132.689	136.802	141.043	145.415	149.923
Inflation rate COL --> Bancolombia	3,10%	3,10%	3,10%	3,10%	3,10%	3,10%	3,10%	3,10%	3,10%	3,10%	3,10%	3,10%	3,10%	3,10%	3,10%
Inflation rate USA	2,00%	2,00%	2,00%	2,00%	2,00%	2,00%	2,00%	2,00%	2,00%	2,00%	2,00%	2,00%	2,00%	2,00%	2,00%
IBR (AE)	5,35%	5,35%	5,35%	5,35%	5,35%	5,35%	5,35%	5,35%	5,35%	5,35%	5,35%	5,35%	5,35%	5,35%	5,35%
Spread MV	3,50%	3,50%	3,50%	3,50%	3,50%	3,50%	3,50%	3,50%	3,50%	3,50%	3,50%	3,50%	3,50%	3,50%	3,50%
Operating Income Tax with Environ.	16.822	17.367	17.929	18.509	19.106	19.722	20.358	21.012	21.688	22.384	23.102	77.264	123.022	126.955	131.010
Taxable Income	84.108	86.834	89.645	92.543	95.531	98.612	101.788	105.062	108.438	111.919	115.508	119.208	123.022	126.955	131.010
Income Tax Rate	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%
Adjusted EBIT	336.430	347.336	358.580	370.173	382.124	394.447	407.151	420.249	433.754	447.676	462.031	476.830	492.089	507.820	524.039
EBIT	336.430	347.336	358.580	370.173	382.124	394.447	407.151	420.249	433.754	447.676	462.031	476.830	492.089	507.820	524.039
- Adjustments and other Deductions															
Presumptive income tax	27.945	28.547	29.161	29.787	30.426	31.078	31.743	32.423	33.116	33.825	34.548	35.288	36.043	36.816	37.605
Equity	931.507	951.571	972.033	992.905	1.014.200	1.035.931	1.058.112	1.080.756	1.103.878	1.127.492	1.151.615	1.176.261	1.201.447	1.227.189	1.253.506
Equity Tax Rate	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Environmental Tax reduction %	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
Environmental Tax reduction $	67.286	69.467	71.716	74.035	76.425	78.889	81.430	84.050	86.751	89.535	92.406	41.944	0	0	0
Accumulated Environmental Tax reduction	1.233.369	1.204.475	1.175.513	1.146.481	1.117.378	1.088.200	1.058.946	1.029.613	1.000.199	970.701	941.117	964.866	980.097	953.383	926.670
Net Income Taxes	14.499	15.199	15.916	16.651	17.403	18.174	18.964	19.774	20.604	21.455	22.327	23.222	24.140	25.081	130.236
Taxable income	289.986	303.988	318.328	333.017	348.065	363.484	379.285	395.479	412.080	429.099	446.549	464.445	482.800	501.627	520.942
- Net Income Before Taxes	289.986	303.988	318.328	333.017	348.065	363.484	379.285	395.479	412.080	429.099	446.549	464.445	482.800	501.627	520.942
- Adjustments and other Deductions	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Environmental Tax reduction $	57.997	60.798	63.666	66.603	69.613	72.697	75.857	79.096	82.416	85.820	89.310	92.889	96.560	100.325	0
Balance	1.069.581	1.008.783	945.118	878.514	808.901	736.204	660.347	581.252	498.836	413.016	323.706	230.817	134.257	33.932	33.932
Tax Shield	2.322	2.167	2.013	1.858	1.703	1.548	1.393	1.239	1.084	929	774	54.041	98.882	101.874	774
Sustainabily Factor	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%

Appendix G – WACC

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
1. Equity																					
(=) Risk Free Rate (USD)	1,83%	3,02%	2,24%	2,25%	2,38%	2,38%	2,38%	2,38%	2,38%	2,38%	2,38%	2,38%	2,38%	2,38%	2,38%	2,38%	2,38%	2,38%	2,38%	2,38%	2,38%
(+) Leveraged Beta Water Treatment Plants	0,510	0,578	1,412	1,742	1,966	2,100	2,050	1,990	1,933	1,878	1,825	1,774	1,725	1,677	1,632	1,588	1,545	1,505	1,465	1,428	1,391
Unleveraged Beta Sector --> Emergin Countries	0,510	0,510	0,985	0,985	0,985	0,985	0,985	0,985	0,985	0,985	0,985	0,985	0,985	0,985	0,985	0,985	0,985	0,985	0,985	0,985	0,985
Long Term Debt / Equity	0,0%	20,0%	57,7%	102,3%	132,7%	150,8%	144,0%	136,0%	128,2%	120,8%	113,6%	106,7%	100,0%	93,6%	87,4%	81,5%	75,8%	70,3%	64,9%	59,8%	54,9%
Tax Rate	33,00%	33,00%	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%
(X) Risk Premium USA	6,26%	6,26%	6,26%	6,26%	6,26%	5,00%	5,00%	5,00%	5,00%	5,00%	5,00%	5,00%	5,00%	5,00%	5,00%	5,00%	5,00%	5,00%	5,00%	5,00%	5,00%
(=) Prima Inversión Water Treatment Plants	3,19%	3,62%	8,84%	10,90%	12,31%	10,50%	10,25%	9,95%	9,67%	9,39%	9,12%	8,87%	8,62%	8,39%	8,16%	7,94%	7,73%	7,52%	7,33%	7,14%	6,96%
(+) Prima Riesgo País	3,00%	3,00%	1,97%	1,97%	1,97%	1,97%	2,50%	2,50%	2,50%	2,50%	2,50%	2,50%	2,50%	2,50%	2,50%	2,50%	2,50%	2,50%	2,50%	2,50%	2,50%
(=) Costo de Patrimonio (Nominal en USD)	8,0%	9,6%	13,0%	15,1%	16,7%	14,8%	15,1%	14,8%	14,5%	14,3%	14,0%	13,7%	13,5%	13,3%	13,0%	12,8%	12,6%	12,4%	12,2%	12,0%	11,8%
Inflation rate USA	2,0%	2,0%	2,0%	2,0%	2,0%	2,0%	2,0%	2,0%	2,0%	2,0%	2,0%	2,0%	2,0%	2,0%	2,0%	2,0%	2,0%	2,0%	2,0%	2,0%	2,0%
Inflation rate COP	2,40%	1,90%	3,70%	6,77%	5,90%	3,90%	3,10%	3,10%	3,10%	3,10%	3,10%	3,10%	3,10%	3,10%	3,10%	3,10%	3,10%	3,10%	3,10%	3,10%	3,10%
Devaluation	0,39%	-0,10%	1,67%	4,68%	3,82%	1,86%	1,08%	1,08%	1,08%	1,08%	1,08%	1,08%	1,08%	1,08%	1,08%	1,08%	1,08%	1,08%	1,08%	1,08%	1,08%
(=) Costo de Patrimonio (COP)	8,45%	9,53%	14,93%	20,51%	21,12%	16,99%	16,37%	16,07%	15,78%	15,50%	15,23%	14,98%	14,73%	14,49%	14,26%	14,04%	13,82%	13,62%	13,42%	13,23%	13,04%
2. Debt	8,73%	7,06%	7,52%	8,39%	10,89%	9,03%	9,08%	9,08%	9,08%	9,08%	9,08%	9,08%	9,08%	9,08%	9,08%	9,08%	9,08%	9,08%	9,08%	9,08%	9,08%
IBR (AE)	5,01%	3,39%	3,84%	4,69%	7,10%	5,30%	5,35%	5,35%	5,35%	5,35%	5,35%	5,35%	5,35%	5,35%	5,35%	5,35%	5,35%	5,35%	5,35%	5,35%	5,35%
Spread MV	3,50%	3,50%	3,50%	3,50%	3,50%	3,50%	3,50%	3,50%	3,50%	3,50%	3,50%	3,50%	3,50%	3,50%	3,50%	3,50%	3,50%	3,50%	3,50%	3,50%	3,50%
Income Tax Rate	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%
Debt cost with tax shield	6,54%	5,29%	5,64%	6,30%	8,17%	6,77%	6,81%	6,81%	6,81%	6,81%	6,81%	6,81%	6,81%	6,81%	6,81%	6,81%	6,81%	6,81%	6,81%	6,81%	6,81%
3. Capital Structure																					
% Debt Mezzanine	0%	17%	37%	51%	57%	60%	59%	58%	56%	55%	53%	52%	50%	48%	47%	45%	43%	41%	39%	37%	35%
% Equity	100%	83%	63%	49%	43%	40%	41%	42%	44%	45%	47%	48%	50%	52%	53%	55%	57%	59%	61%	63%	65%
WACC (COP)	**8,45%**	**8,83%**	**11,53%**	**13,32%**	**13,73%**	**10,85%**	**10,73%**	**10,73%**	**10,74%**	**10,75%**	**10,75%**	**10,76%**	**10,77%**	**10,78%**	**10,78%**	**10,79%**	**10,80%**	**10,81%**	**10,82%**	**10,82%**	**10,83%**

	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047
1. Equity															
(=) Risk Free Rate (USD)	2,38%	2,38%	2,38%	2,38%	2,38%	2,38%	2,38%	2,38%	2,38%	2,38%	2,38%	2,38%	2,38%	2,38%	2,38%
(+) Leveraged Beta Water Treatment Plants	1,356	1,322	1,290	1,259	1,229	1,200	1,172	1,145	1,119	1,095	1,071	1,048	1,026	1,005	0,985
Unleveraged Beta Sector --> Emergin Countries	0,985	0,985	0,985	0,985	0,985	0,985	0,985	0,985	0,985	0,985	0,985	0,985	0,985	0,985	0,985
Long Term Debt / Equity	50,2%	45,6%	41,2%	37,0%	32,9%	29,0%	25,2%	21,6%	18,1%	14,8%	11,6%	8,5%	5,6%	2,7%	0,0%
Tax Rate	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%
(X) Risk Premium USA	5,00%	5,00%	5,00%	5,00%	5,00%	5,00%	5,00%	5,00%	5,00%	5,00%	5,00%	5,00%	5,00%	5,00%	5,00%
(=) Prima Inversión Water Treatment Plants	6,78%	6,61%	6,45%	6,29%	6,14%	6,00%	5,86%	5,73%	5,60%	5,47%	5,36%	5,24%	5,13%	5,03%	4,93%
(+) Prima Riesgo País	2,50%	2,50%	2,50%	2,50%	2,50%	2,50%	2,50%	2,50%	2,50%	2,50%	2,50%	2,50%	2,50%	2,50%	2,50%
(=) Costo de Patrimonio (Nominal en USD)	11,7%	11,5%	11,3%	11,2%	11,0%	10,9%	10,7%	10,6%	10,5%	10,4%	10,2%	10,1%	10,0%	9,9%	9,8%
Inflation rate USA	2,0%	2,0%	2,0%	2,0%	2,0%	2,0%	2,0%	2,0%	2,0%	2,0%	2,0%	2,0%	2,0%	2,0%	2,0%
Inflation rate COP	3,10%	3,10%	3,10%	3,10%	3,10%	3,10%	3,10%	3,10%	3,10%	3,10%	3,10%	3,10%	3,10%	3,10%	3,10%
Devaluation	1,08%	1,08%	1,08%	1,08%	1,08%	1,08%	1,08%	1,08%	1,08%	1,08%	1,08%	1,08%	1,08%	1,08%	1,08%
(=) Costo de Patrimonio (COP)	12,86%	12,69%	12,53%	12,37%	12,22%	12,07%	11,93%	11,80%	11,67%	11,54%	11,42%	11,31%	11,20%	11,09%	10,99%
2. Debt	9,08%	9,08%	9,08%	9,08%	9,08%	9,08%	9,08%	9,08%	9,08%	9,08%	9,08%	9,08%	9,08%	9,08%	9,08%
IBR (AE)	5,35%	5,35%	5,35%	5,35%	5,35%	5,35%	5,35%	5,35%	5,35%	5,35%	5,35%	5,35%	5,35%	5,35%	5,35%
Spread MV	3,50%	3,50%	3,50%	3,50%	3,50%	3,50%	3,50%	3,50%	3,50%	3,50%	3,50%	3,50%	3,50%	3,50%	3,50%
Income Tax Rate	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%	25,00%
Debt cost with tax shield	6,81%	6,81%	6,81%	6,81%	6,81%	6,81%	6,81%	6,81%	6,81%	6,81%	6,81%	6,81%	6,81%	6,81%	6,81%
3. Capital Structure															
% Debt Mezzanine	33%	31%	29%	27%	25%	22%	20%	18%	15%	13%	10%	8%	5%	3%	0%
% Equity	67%	69%	71%	73%	75%	78%	80%	82%	85%	87%	90%	92%	95%	97%	100%
WACC (COP)	**10,84%**	**10,85%**	**10,86%**	**10,87%**	**10,88%**	**10,89%**	**10,90%**	**10,91%**	**10,92%**	**10,93%**	**10,94%**	**10,96%**	**10,97%**	**10,98%**	**10,99%**

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