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Assessing the governance capacity to implement resource-oriented sanitation and waste management systems in urban areas of Latin America and the Caribbean

– A case study of the town of Chía, Colombia

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Abstract

Sustainable approaches for waste management and sanitation are key to deal with the environmental and health challenges that growing urbanization is creating around the world. Implementing systems that allow to reuse resources contained in the organic waste streams (OWS) is an approach that can bring many benefits, especially in low-medium income areas as the Latin American and Caribbean region, where excreta, wastewater, and waste are not properly managed. The transformation towards these systems requires not only technological changes, but also changes in the way that urban waste and wastewater are governed. The aim of this study was to assess the capacity of the town of Chía (Colombia) to govern the transition towards resource-oriented sanitation and waste management systems. The Governance Capacity Framework (GCF) was used as a method to evaluate the governance capacity of the town to implement these systems. The assessment revealed that the capacity of Chía to govern the implementation of resource-oriented sanitation and waste management systems was low. Furthermore, governance factors that could be hindering the implementation of these systems were identified. Low level of knowledge of resource recovery from OWS in the public spheres, insufficient collaboration and communication across sectors and institutions that had competences on waste management and sanitation, short-term vision within the local decision-making processes and insufficient incentives to support local entrepreneurship on circular economy. Despite these challenges, analysis also revealed the existence of public-private partnerships and entrepreneurs working in successful initiatives linked with resource-oriented systems in Chía and other towns of Cundinamarca county. The study concluded that in Chía there was a gap between local initiatives of resource recovery from OWS that brought environmental, economic, and social benefits at small scale and its inclusion in the local and regional governance systems. Findings of this study touches upon many governance aspects such as knowledge, legislation, financing and even culture. Further research is needed to look closer to each of those and make concrete, feasible and effective proposals that bring change with a long-term sustainability vision. Finally, when analysing the results of the evaluation and making future proposals, strengths, and shortcomings of applying the GCF as an analytical tool for a specific case study like Chía need to be considered.

Keywords: environmental governance, resource recovery, organic waste, wastewater, circular economy, sustainable urban development.

Resumen

Los enfoques sostenibles para la gestión de los residuos sólidos y líquidos son fundamentales para hacer frente a los problemas ambientales y sanitarios que la creciente urbanización está provocando en todo el mundo. Implementar sistemas que permitan reutilizar los recursos contenidos en los flujos de residuos orgánicos es una solución que puede traer consigo muchos beneficios, especialmente en zonas de ingresos bajos y medios como es la región de América Latina y el Caribe, donde los excrementos, las aguas residuales y los residuos sólidos no se gestionan adecuadamente. La transformación hacia estos sistemas requiere no sólo cambios tecnológicos, sino también cambios en la forma en que se los residuos sólidos urbanos y las aguas residuales están gobernados. El objetivo de este estudio fue evaluar la capacidad que la ciudad de Chía (Colombia) tenía para gobernar una transición hacia sistemas de saneamiento y gestión de residuos orientados a los recursos. Se utilizó el Governance Capacity Framework (Marco de Capacidad de Gobernanza) como método para evaluar dicha capacidad. La evaluación evidenció que la capacidad de la ciudad de Chía para implementar estos sistemas en el momento del estudio era baja. Además, se identificaron los factores que obstaculizaban la implementación de estos sistemas en Chía: un bajo nivel de conocimiento en el sector público sobre la recuperación de recursos contenidos en los diferentes residuos orgánicos, insuficiente colaboración y comunicación entre diferentes sectores e instituciones con competencias en gestión de residuos y saneamiento, prevalencia de una visión cortoplacista en los procesos locales de toma de decisiones y pocos incentivos que apoyasen el emprendimiento local con una visión de economía circular. A pesar de ello, el análisis también reveló existían iniciativas público-privadas y emprendimientos exitosos en el campo del saneamiento y la gestión de residuos a nivel de Chía y de la región de Cundinamarca. El estudio concluyó que existía una brecha entre estas iniciativas locales que aportaban beneficios ambientales, económicos y sociales a pequeña escala y su inclusión en los sistemas de gobernanza local y regional. Muchos aspectos de la gobernanza, como el conocimiento, la legislación, la financiación e incluso la cultura son analizados en este estudio. Es necesario seguir investigando para examinar detalladamente cada uno de ellos y poder hacer propuestas concretas, viables y eficaces que aporten un cambio que considere una visión de sostenibilidad a largo plazo. Por último, es necesario reconocer las ventajas y desventajas de aplicar el GCF como herramienta de análisis para un caso de estudio concreto como el de Chía y analizar los resultados de la evaluación teniendo ambas en cuenta.

Palabras clave: gobernanza ambiental, recuperación de recursos, residuos orgánicos, aguas residuales, economía circular, desarrollo urbano sostenible.

Popular scientific abstract

In the context of waste management and sanitation, recovering and reusing resources contained in organic waste, wastewater and faecal sludge is a widely known solution to deal with environmental and health challenges that growing urbanization is creating around the world. However, in the Latin American and the Caribbean (LAC) region where excreta, wastewater, and waste are not properly managed, implementation of resource-oriented systems have not gone beyond a few actions on small scale. Transforming urban areas in the way that their waste management and sanitation plans include these practices requires multiple changes. Not only updating infrastructure and technology but also understanding how urban waste and wastewater is governed. Moreover, governance factors that may limit or promote the implementation of these systems need to be identified. In order to understand how a governance structure influences the transition towards resource-oriented systems in an urban context of the LAC region, the governance structure of a Colombian town called Chía was evaluated. Overall Chía had a weak capacity to govern urban waste and wastewater and therefore to promote the implementation of resource-oriented systems. At the local and regional level, public-private partnerships and entrepreneurs working in successful initiatives linked with resource-oriented systems were found out. However, a gap between these local initiatives that provided environmental, economic, and social benefits at small scale and its inclusion within the local and the regional governance systems was also identified. The weaknesses of the Chía governance system was linked to the low level of knowledge of resource recovery in the public spheres, insufficient collaboration and communication across sectors and institutions that had competences on waste management and sanitation, short-term vision within the local decision-making processes and insufficient incentives to support local entrepreneurship on circular economy. In this regard, creation of local and regional platforms that gather knowledge and data of existing initiatives as well as of physical or virtual spaces for cross-stakeholder interaction could be some recommendations to increase the governance capacity of Chía. Findings of this study touches upon many governance aspects such as knowledge, legislation, financing and even culture. Considering a long-term sustainability vision, further research is needed to look closer to each of those and make concrete, feasible and effective proposals that bring change. Finally, research tools like the Governance Capacity Framework used to assess the factors that influence positively or negatively the environmental governance in urban contexts can add a lot of value to decision-making processes in the LAC region. Using the framework for this case study increased awareness about waste and circular economy as well as strengthened connections among stakeholders who could push for sustainable practices at the local level. However, being aware of the case study specifications as well as of the strengths and shortcomings of the analytical tool might help researchers to propose the most desirable, possible, and manageable actions for a particular context like the town of Chía.

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Abbreviations

GCF	Governance Capacity Framework
LAC	Latin America and the Caribbean
LPA	Local Public Authorities
OECD	Organisation for Economic Co-operation and Development
OWS	Organic Waste Streams
PARSO	Plant for Reusing Organic Solid Waste (Planta de Aprovechamiento de Residuos Orgánicos)
PGIRS	Solid Waste Management Plan (Plan de Gestión Integral de Residuos Sólidos)
PSMV	Sanitation and Discharge Management Plan (Plan de Saneamiento y Manejo de Vertimientos)
REVAMP	Resource Value Mapping
SEI	Stockholm Environment Institute
SDG	Sustainable Development Goals
UC	Urban Circle
WWTP	Wastewater Treatment Plant

Glossary

Excreta	Collective term referring to urine and faeces, not mixed with any water (SSWM 2020).
Faecal sludge	Undigested or partially digested slurry or solids containing mostly excreta and water in combination with sand, grit, metals, solid waste and/or various chemical compounds. Faecal sludge comes from on-site sanitation services like latrines (SSWM 2020).
Organic waste	Waste that is readily degradable by microorganisms at relatively normal conditions. It includes fruits, vegetables, food residues, vegetable oil, animal fat, meat, dairy, grass, leaves, branches, unprocessed wood and manure (Mosquera, 2018).
Organic waste streams	Collective term referring to flows of organic waste, wastewater and faecal sludge
Recyclable waste	Inorganic waste such as paper, plastic, metal or electronic waste that can be transformed and reused. Urban areas frequently have different containers for recyclable waste which can make it easier to do separate collection.
Resource recovery	Action of managing and reusing resources contained in waste streams. These resources are usually energy, nutrients, organic matter or water (Andersson et al. 2016). Resource recovery can be done only when resource-oriented systems are implemented.
Sanitation	Safely collecting and hygienically disposing of excreta and wastewater for the protection of public health and the preservation of the quality of public water bodies and the environment (SSWM 2020).
Sanitation service chain	Technologies and services for the collection, containment, transport, transformation, reuse or disposal of human excreta and wastewater.
Waste	Any substance or object which the holder discards or intends or is required to discard. Collective term referring to both solid and liquid waste, including organic and recyclable waste.
Waste management service chain	Technologies and services for the collection, containment, transport, transformation, reuse or disposal of waste.
Wastewater	Collective term that includes used water from any combination of domestic, industrial, commercial or agricultural activities, surface runoff/stormwater, and any sewer inflow/infiltration (SSWM 2020).

Preface

This master thesis was conducted in collaboration with the Stockholm Environment Institute (SEI) as part of the project UrbanCircle - urban waste into circular economy benefits. Looking at the urban contexts, UrbanCircle (UC) studied how waste management, sanitation, and resource recovery practices could be integrated into a circular economy, putting emphasis on the nexus water, food, and energy. To do that, researchers of the UC project worked together with local stakeholders to perform a governance analysis and to model different resource recovery scenarios drawing on empirical studies in Stockholm, Naivasha (Kenya) and Chía (Colombia) (SEI 2019).
In addition, within the UC project, the Resource Value Mapping (REVAMP) tool was tested. REVAMP is a tool that can estimate, visualize, and value the resources contained in urban OWS (Ddiba et al. 2016).

Acknowledgments

As a result of this collaboration, I was part of a SEI research group formed by Daniel Ddiba, Kim Andersson, Sarah Dickin. Kim and Sarah were co-leading the SEI Initiative on Sustainable Sanitation and Daniel Ddiba was doing his Ph.D. within the UC project. In addition, Stef Koop, researcher at the KWR Water Research Institute, contributed to the project with his expertise on research methodologies for studying governance. I want to thank all of them for their support and guidance since the beginning of this study, in particular to Daniel who went through the same research process as I, doing an empirical study on Naivasha (Kenya).

I would like to thank Kim, who gave me the opportunity to participate in this study and the SEI, which granted me to do the fieldwork in Colombia and without which it would have been impossible to collect as much relevant information for this study and the UC project.

In Chía I had the support of a local team that was also part of UC project. This team was formed by four researchers from the University el Bosque (Juan Felipe Jaramillo, Diana Carolina Paez, Hector Rueda and Juan Manuel Díaz) and four practitioners of the Secretariat of Environment in Chia (Eduardo Gutierrez, Laura Mendoza, Laura Montealegre and Alejandro José Garzón). I want to thank all of them for their warm welcome to Colombia and their support in contacting stakeholders for the interviews. Thanks to all the respondents that took the time to participate in the study and to the rest of the people from Chía and Bogotá who I had spontaneous conversations with about waste. They made this study possible.

Rubi, I really thank you for being the best host that I could have in Chía.

Thanks to all those who I shared with the experience of the Env Euro Master Programme, teachers, and students. I am very grateful for all the people that I met in Uppsala and Copenhagen and who are already part of my life. Thanks to my family, who always supported me during this journey.

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1 Introduction

1.1 Problem formulation

The urban population of the world has been growing rapidly during the last century and it will continue in the next years. According to the revision of the World Urbanization Prospects (UN DESA 2018) 4.2 billion people lived in urban areas in 2018, which represented 55% of the world´s population. This number is expected to increase reaching over 6.7 billion urban population by 2050. In the Latin American and Caribbean (LAC) region, which has the highest rate of urban growth in the world, projections show that almost 700 million people are expected to live in urban areas by 2050, which constitutes 88% of its total projected population (UN DESA 2018, UN DESA 2019). Urban population growth as well as economic growth result in higher demand for food, water, energy and increases the amounts of waste and wastewater generated in the towns (Ddiba et al. 2016, Rodríguez et al. 2020).

Waste generation is a major problem in many urban areas of the world, especially in low and middle-income countries, where excreta, wastewater, and waste are not properly managed (Andersson et al. 2016, Hettiarachchi et al. 2018b, Otoo and Drechsel 2018). In the LAC region, more than 95% of the solid waste collected is deposited in open dumps or landfills that frequently lack controls and that are reaching their maximum capacity (Hettiarachchi et al. 2018b, UN Environment 2018). Most of them are outdated and lacking leachate treatment, which releases greenhouse gases and pollutes the soil and the groundwater (Hettiarachchi et al. 2018b, Sarralde 2018, UAESP 2019). Furthermore, more than half of the municipal solid waste can be classified as organic waste, but less than 1% is composted in the region (Kaza et al. 2018). Despite the recent expansion of sanitation services and wastewater treatment facilities in the region, wastewater management is also a main concern for its citizens (Taborda 2019). In urban areas 70% of the population approximately is connected to a sewage system but just 40% of the wastewater that is collected is treated. Most of the facilities lack efficiency and urban wastewater is discharged to water bodies without any treatment, which deteriorates the quality of the water resources (Rodríguez et al. 2020, Rubiano 2018, Taborda 2019). As a result of the inadequate waste management and sanitation practices in the LAC region, population is exposed to health problems, ecosystems and their services are damaged, and the development of the region is negatively affected (Kaza et al.2018, Hettiarachchi et al. 2018b, Rodríguez et al. 2020).

To minimize public health risks and environmental degradation caused by inadequate waste management and sanitation practices as well as to optimize the use of natural resources, it is required to "shift the focus and perceptions from treatment for waste disposal to treatment of waste as a valuable resource for safe reuse" (Otoo and Drechsel 2018 p.2, Andersson et al. 2016, Rodríguez et al. 2020, Šteflová et al. 2018). This shift implies turning "the common linear resource management into a cyclical one, keeping resources in circulation and making productive use of them at every stage" of the waste service chain (Andersson et al. 2016 p.25, Rizos et al. 2017, Rodríguez et al. 2020, UN Environment 2018). Recovering and reusing resources contained in different urban waste flows such as nutrients, organic matter, water, and energy is a way of applying circular resource management to sanitation and organic waste management (Andersson et al. 2016, Van Leeuwen et al. 2018). Many studies have recently shown that sustainable urban development requires resource-oriented approaches to resource management (Andersson et al. 2016, Ellen MacArthur Foundation 2015, Holmgren et al. 2016, Rodríguez et al. 2020, Van Leeuwen et al. 2018). According to these studies, resource-oriented approaches contribute to addressing water, food, and energy security at the urban level as well as to reducing the demand for raw materials. In addition, adding value to the resources contained in urban waste flows promotes new business along the waste service

chain and reduces maintenance and operation costs of waste management and sanitation practices (Andersson et al. 2016, Rodríguez et al. 2020).

Enabling the transition to resource-oriented sanitation and waste management systems (from now on resource-oriented systems) in urban contexts requires multiple changes. There is a need for estimating and valuing the resources that could be recovered from OWS as well as for raising public awareness about the benefits of this approach (Andersson et al. 2016, Kuokkanen et al. 2016, Rodríguez et al. 2020). Furthermore, making the right investments in infrastructure and promoting innovative financing and sustainable business models are also required (Andersson et al. 2016, Hettiarachchi et al. 2018a, Otoo and Drechsel 2018, Rodríguez et al. 2020). Policy coherence, institutional capacity to enforce regulations and coordination and collaboration between multiple stakeholders across sectors and governance levels are also crucial factors to achieve the transition (Andersson et al. 2016, Ddiba 2019, Rodríguez at al. 2020, UN Environment 2018). Therefore, not only changes and new approaches in the technological and financial arenas are necessary, but also in the way that urban waste streams are governed (Andersson et al. 2016, Hettiarachchi et al. 2018b, Holmgren et al. 2016, Rodríguez et al. 2020, Šteflová et al., 2018, Van Leuween et al. 2018).

Thus far, most of the literature that alludes to governance challenges of resource recovery practices from OWS focuses on one sector, e.g. wastewater (Andersson et al. 2016, Rodríguez et al. 2020) water (Akhmouch 2012, Holmgren et al. 2016), solid waste (Hettiarachchi et al. 2018b, Kaza et al.2018) or faecal sludge (Moya et al. 2019). In this context, few studies look at resource recovery from a broader perspective and analyse how resources like waste, water, nutrients, energy and the linkages among them are governed (Velenturf and Jopson 2019, Weitz et al. 2017, Van Leuween et al. 2018). Looking at low-medium income regions of the world as the LAC region, literature on resource-oriented systems focuses on technological developments (Lohri et al. 2017), on how to scale up these solutions from the perspective of business models (Hettiarachchi et al. 2018a, Otoo and Drechsel 2018) or on the evaluation of environmental policies (Alzate-Arias et al. 2018, Ochoa 2018). This reveals that little attention has been put to study the governance of urban waste management and sanitation practices from a cross-sectoral perspective in the region. Besides, knowledge of what governance factors are needed to enable the transition towards resource-oriented systems in the context of low-medium income towns in the LAC region is still needed.

To address the research gap mentioned above, this thesis used the case of Chía, a town in Colombia, to understand how the way of governing OWS influences the transition to resource-oriented systems in the urban context of the LAC region.

1.2 Research aim and research questions

This thesis was part of the broader project, UC. The UC project aimed to contribute to the implementation of resource-oriented systems in the urban areas of Stockholm, Naivasha, and Chía. To enable that implementation, the UC project sought to provide urban stakeholders tools and knowledge, promoting their engagement in the local policy-making processes (Ddiba 2019). In this context, this study aimed to assess the capacity of Chía to govern the transition towards resource-oriented systems. To pursue the research aim, a conceptual framework known as the Governance Capacity Framework (GCF) was used to look at the governance system of the town.

Considering the problem formulation and the research aim, I developed one overarching research question and three sub-questions:

How does the current governance capacity of Chía influence the implementation of resource-oriented systems?

1. How is the current capacity of Chía to govern the implementation of resource-oriented systems?
2. What are the main governance factors that could be hindering the implementation of resource-oriented systems in Chía?
3. How does the GCF help to understand the governance situation of Chía with regards to waste management and sanitation?

The study is structured as follows. Section 2 provides a literature-based overview of resource-oriented sanitation and waste management, of the concept of governance capacity and of different methods to assess governance capacity including the GCF. Section 3 presents the main characteristics of waste management and sanitation in Chía. In Section 4, there is an explanation of how the GFC is applied to the Chia case. Section 5 illustrates the findings of the governance capacity assessment in the town of Chía. Those findings are analysed through the lens of the GCF in section 6. Section 7 discusses the utility of the GCF for the case study. Finally, section 8 presents the conclusions of this study.

2 Research context

2.1 Resource-oriented sanitation and waste management systems

The concept of resource-oriented sanitation and waste management refers to the recovery and potential reuse of resources that are contained in different urban waste flows, such as nutrients, organic matter, water and energy among others (Anderson et al. 2016) (Figure 1). Amongst the different urban waste flows this study limited the scope to OWS, meaning domestic and agro-industrial food waste and other organic residues, wastewater and faecal sludge. Even though other recyclable waste such as paper, plastic or metal is sometimes mentioned throughout the report, it was not the focus of this study.

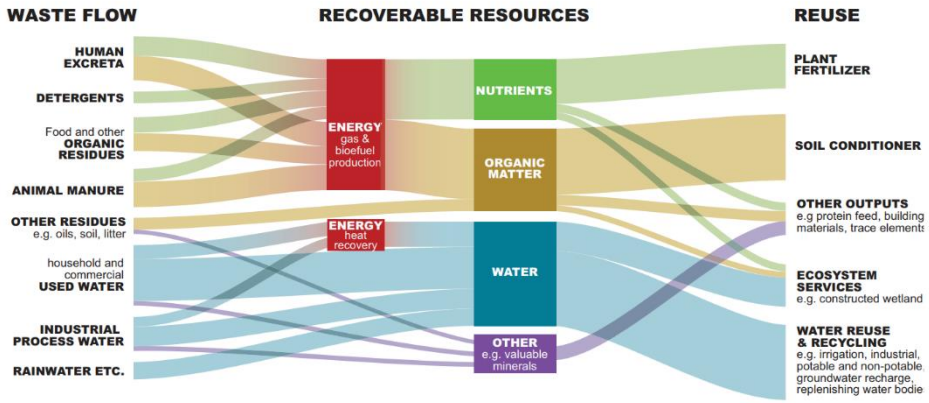


Figure 1. Overview of waste resources and potentials for improved management and recovery (Andersson et al. 2016)

2.1.1 The waste service chain

In urban contexts, studying the flows of OWS implies looking at both the waste management and the sanitation service chain. With regards to the sanitation service chain, this study focuses on wastewater and faecal sludge management. Even though in practice technologies used for waste and wastewater management are different, both service chains can be theoretically represented by similar stages. These stages are generally production, collection and storage, transport, treatment and processing, and disposal or reuse as is shown in Figure 2. The last step of reuse is also understood as resource recovery and it is the key stage of the resource-oriented systems (Andersson et al. 2016, Mosquera 2018). Waste service chain is a collective term that in this study, refers to both the waste management and sanitation service chain.

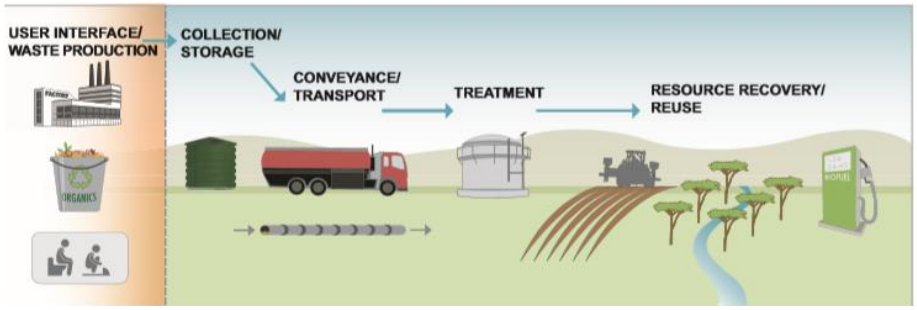


Figure 2. Theoretical scheme that shows the stages of the waste service chain (Andersson et al. 2016)

2.1.2 State of the art of resource recovery in the LAC region

During last years, solid waste and wastewater are increasingly recognised as an environmental and public health issues across all the countries in the LAC region, mainly due to the dominance of uncontrolled disposal in open dumps and discharges in water sources (Sarralde 2018, Taborda 2019, UAESP 2019, UN Environment 2018). Furthermore, at the international level, countries in the LAC region need to comply with the international agreements that promote sustainable actions such as the Paris Agreement (UN 2015) or the Sustainable Development Goals (SGDs) (UN 2020). Both facts have promoted that several countries of the region such as Colombia starts considering resource-oriented systems as part of the possible solutions to their environmental and health challenges (Departamento Nacional de Planeación 2018a, Gobierno de la República de Colombia 2019). In this regard and primarily in the urban areas of the region, progress has been made in solid waste collection and sanitation services, improving disposal practices and wastewater treatment (Rodríguez et al. 2020). Furthermore, projects for production of biogas and compost have been implemented as resource recovery actions in different parts of the region (Hettiarachchi et al. 2018a, Lohri et al. 2017, Moya et al. 2019, Otoo and Drechsel 2018). Despite these advances, implementation of resource-oriented systems has not gone beyond a few actions on small scale and many LAC countries are still missing the potential of recovering resources from OWS due to multiple challenges (Hettiarachchi et al. 2018b, Rodríguez et al. 2020, UN Environment 2018).

Most of these challenges are shared among the countries and related to the way that waste, water and faecal sludge have been historically managed in the region. The reviewed studies agree on how these challenges affect the implementation of resource recovery from OWS in the region (Hettiarachchi et al. 2018b, Holmgren et al. 2016, Rodríguez et al. 2020). In general, source separation and separated collection are not properly done in the region, which limits the extent to which resource recovery yields can be increased. Waste and especially wastewater are widely perceived as something that needs to be disposed of rather than a resource (Kuokkanen et al. 2016). Therefore, both are undervalued, which makes opening markets and attracting investments for resource recovery products not easy. Furthermore, there is a lack of data of the amount of waste that enters and exits the stages of the service waste chain in part due to the informal sector of waste pickers control many of the activities in the region. This along with the low level of technical capacity and the outdated infrastructure at the local level affect the implementation of resource-oriented systems. Finally, low level of law enforcement and absence of specific legislation that incentives resource recovery approaches prevent the implementation of resource recovery actions and projects with a long-term sustainability vision.

2.2 Governance capacity and multiple frameworks to assess it

The concept of governance capacity was applied in this study to understand how OWS were governed as well as to identify the factors that were hindering or boosting the implementation of resource-oriented systems in a specific town. Therefore, an extensive part of the literature review focuses on the concept of governance capacity and on the analytical methods to assess it. There is plenty of literature that investigates the concept of governance capacity from multiple perspectives such as public institutions (Gupta et al. 2010, Silva et al. 2018), collaboration and networks (Emerson et al 2012), environmental governance (Caffyn and Jobbins 2003, Dang et al. 2016, Pahl-Wostl 2009) or climate change adaptation (Gupta et al. 2010, Mees and Driessen 2011). Some of these studies examine the concept of governance capacity (Mees and Driessen 2011, Silva et al. 2018) and others analyse certain components of governance capacity as it can be institutional capacity (Dang et al. 2016).

The concept of governance capacity has been used in the field of studies of climate change adaptation. For instance, Mees and Driessen (2011) assess climate change adaptation of urban areas and study the governance capacity of towns for adapting to climate change by means of green space. In their study, they define governance capacity as "the degree to which a public – private network of actors is able to resolve societal issues*"* (p. 253). They also develop an analytical framework to study the capacity of urban planning (Figure 6 in Annex I). Their framework is formed by five key sub capacities of the governance capacity: learning, legal, managerial, political and resource capacity. Furthermore, each of these sub capacities is broken down into critical aspects as political will or knowledge resources that they consider crucial for urban planning adaptation for the climate greening of towns (Mees and Driessen 2011, pp. 254-257). Moving towards studies of environmental governance, Dang and her team (2016) use the concept of governance capacity to illustrate the quality of governance using a specific context as the policy of forest land allocation in Vietnam. They understand governance capacity as:

> The ability that societal actors have to cooperate to solve collective problems ... Governance capacity is shaped both by the agencies of individual actors and the wider institutional and structural settings influencing the prospects of collaboration (p. 1155).

According to them, the concept of governance capacity should be broken down into two aspects, institutional capacity, and governance performance. Institutional capacity or potential governance capacity refers to the extent that a policy arrangement has to promote cooperation of actors to solve problems. Governance performance or realized governance capacity refers to the actual performance of a policy arrangement in collective problem solving. Considering this, Dang creates a framework to assess governance capacity, which is formed by three elements: rules, discourses and resources, and specific criteria such as social learning or cost effectiveness (Dang et al. 2016, pp 1159-1160). Focusing in the role of public institutions to pursue climate change adaptation, Gupta and her team (2010) study the conditions under which institutions can stimulate the adaptive capacity of society to deal with environmental change and especially to adapt to climate change. Without referring to governance capacity, they use the concept of adaptive capacity and define it as:

> The inherent characteristics of the institutions that empower social actors to respond to short and long-term impacts either through planned measures or through allowing and encouraging creative responses from society both ex ante and ex post (p. 4).

They develop the Adaptive Capacity Wheel, a conceptual framework to assess the extent to which different characteristics of institutions enable the adaptive capacity of societies. Their framework is formed by six dimensions of the adaptive capacity and 22 criteria (Gupta et al. 2010, pp 9-15, Figure 7 in Annex I). Under the wide range of environmental governance literature Pahl-Wostl (2009) also studies the concept of adaptive capacity. She develops a conceptual framework to analyse the dynamics and adaptive capacity of resource governance regimes as multi-level learning processes, which she applies to analyse water governance regimes. She understands adaptive capacity as:

> The ability of a resource governance system to first alter processes and if required convert structural elements as response to experienced or expected changes in the societal or natural environment *(*p. 355).

Her framework captures key characteristics of environmental governance regimes as the formal and informal institutions, the role of state and non-state actors, the nature of multi-level interactions and the bureaucratic hierarchies, markets and networks (Pahl-Wostl 2009,

pp. 355-358). Furthermore, it analyses how these governance characteristics should transform according to three different levels of social learning, which is needed to get change in the whole governance structure (Pahl-Wostl 2009, p. 360). Looking at the research field of public institutions and seeking to assess the governance capacity of Portuguese intermunicipal associations, Silva and her team (2018) present in their study the concept of governance capacity in the form of five dimensions and several ways of operationalization. These five dimensions are the scope of cooperation, efficiency, nature of institutional structures, democracy, and stability (Silva et al. 2018, pp. 612-623). In addition, and focusing again on the public institutions, Emerson and his team (2012) work with the concept of collaborative governance and define an integrative framework to assess it. They define collaborative governance as:

> The processes and structures of public policy decision making and management that engage people constructively across the boundaries of public agencies, levels of government, and/or the public, private and civic spheres in order to carry out a public purpose that could not otherwise be accomplished (p.2).

Their framework is formed by a system context that is influenced by political, legal, socioeconomic, and environmental factors among others. This system context creates opportunities and constraints and influences the dynamics and performance of collaboration over time. From this system context, it emerges different drivers as leadership, consequential incentives, interdependence, and uncertainty, which set the initial steps for collaborative governance (Emerson et al. 2012). In the literature field of sustainable tourism management and integrated coastal management, Caffyn and Jobbins (2003) use the concepts of governance capacity and stakeholder interactions to discuss the question: to what extent can coastal tourism be developed and managed in a sustainable and integrated way in countries with centralised governance systems and a deficit of local participation. Furthermore, they create a theoretical framework that is based in those two concepts. According to them, governance capacity is formed by images, tools, and action potential. They explain that images refer to the ideas about a current situation and its potential alternatives held by the stakeholders. Tools are the instruments that stakeholders have to address the governance needs and action potential refers to the socio-political room for action that stakeholders have (Caffyn and Jobbins 2003, pp. 227-229). Apart from the previous studies and considering the aim of this paper, it is important to review the good governance principles on Water Governance developed by the Organisation for Economic Co-operation and Development (OECD, 2015) (Figure 8 in Annex I). The OECD Water Principles provide for an integrated framework to analyse if water governance systems are performing optimally and if not where there is a need of adjustment as well as improving from policy design to implementation (OECD 2015).

Finally, Koop and his team (2017) use the concept of governance capacity to study the challenges of water, waste, and climate change in towns from the governance perspective. In their study, after doing a deep literature review of the concept of governance capacity, they claim that the definition of this term is still under discussion. Despite this, they underline three commonalities regarding the concept of governance capacity. First, governance capacity encompasses the ability of actors to jointly identify and act in the face of collective challenges (Koop et al. 2017). This collaborative perspective of the concept can be recognized by Dang et al. (2016), Emerson et al. (2012) and Mees and Driessen (2011). Second, governance capacity is shaped by the interaction of actors that is influenced by the socio-institutional settings and distribution of resources (Koop et al. 2017). The role that institutional structures plays in providing governance capacity is highlighted by Dang et al. (2016), Gupta et al. (2010) and Silva et al. (2018). Third, governance capacity refers to the values, culture and interest of actors that shape their interactions as well as influence

collective problem solving (Koop et al. 2017). Values and culture are important aspects of the understanding of governance capacity by Caffyn and Jobbins (2003). Considering these three similarities and the purpose of their study, Koop et al. (2017) define governance capacity as:

> The set of governance conditions that should be developed to enable change that will be effective in finding dynamic solutions for governance challenges of water, waste, and climate change in towns (p. 3430).

They also claim that:

> Governance capacity is determined by a balanced set of conditions that need to be well developed to lead to efficacious change…Hence, governance capacity is a precondition or enabler for effective change (p. 3430).

The argument that governance capacity should solve collecting problems and bring changes to society is supported by many of the studies reviewed (Dang et al. 2016, Emerson et al. 2012, Gupta et al. 2010, Mees and Driessen 2011, Pahl-Wostl 2009).

Most of the previous conceptual frameworks rely on similar literature and they include elements such as resources, leadership, social learning, or responsibilities. When thinking of these frameworks as a possible analytical tool to looking at waste management and sanitation, it is important to reflect on their advantages and disadvantages. On one hand, the framework developed by Mees and Driessen (2011) the Adaptive Capacity Wheel and the OECD framework (OECD 2015) seem to cover many different governance aspects, which might make easier the identification of key issues that affect the governance of OWS (See Figure 6, 7 and 8 in Annex I). The Adaptive Capacity Wheel also allows qualitative assessment of the governance aspects, which would also prioritise the development of concrete solutions. On the other hand, institutional capacity, governance performance (Dang et al. 2016) and perceptions (Silva et al. 2018) are terms that might be difficult to differentiate and applied in the context of the waste service chain. In their study, Koop et al. (2017) also review some of these frameworks. They remark that none of them enable to understand the underlying processes that enhance or limit governance capacity in urban contexts. Thus, according to them, a diagnostic framework is needed to bring together coherent knowledge in the field of governance processes used to understand barriers, opportunities, and lessons beyond case studies. Following this argument, Koop and his team develop:

> A coherent framework that assesses different contexts consistently, provides an empirical-based understanding of underlying processes and searches for transferable lessons that enhance governance effectiveness. (p. 3429):

This framework is known as the Governance Capacity Framework (GCF) and it was applied in this study.

2.2.1 The Governance Capacity Framework

The GCF is an empirically based diagnostic indicator approach to assess the factors that influence positively or negatively the environmental governance in urban contexts (Koop et al. 2017). These factors are known as barriers and enablers of the governance capacity. The GCF is formed by three dimensions and nine conditions that frame environmental governance. Each of these nine conditions is defined by three indicators, making a total of

27 indicators for the whole framework. Table 1 presents the three dimensions, nine conditions and 27 indicators that form the GCF.

Looking at the framework, the *knowing* dimension refers to the awareness, knowledge and learning processes that stakeholders have about challenges, policies, actions, and strategies in the urban environmental context. The *wanting* dimension refers to the cooperation, commitment and ambitious that stakeholders need to show to find long-term solutions to the urban environmental governance challenges. The *enabling* dimension refers the network, resources, and tools that stakeholders need to have to make possible changes.

Table 1. Overview of the three dimensions, nine conditions and 27 indicators that form the Governance Capacity Framework. Each of the conditions, placed in the second column, is defined by three indicators, placed in the third column (Koop et al. 2017)

Dimensions	**Conditions**	**Indicators**
Knowing	1. Awareness	1.1 Community knowledge
		1.2 Local sense of urgency
		1.3 Behavioural internalization
	2. Useful knowledge	2.1 Information availability
		2.2 Information transparency
		2.3 Knowledge cohesion
	3. Continuous learning	3.1 Smart monitoring
		3.2 Evaluation
		3.3 Cross-stakeholder learning
Wanting	4. Stakeholder engagement process	4.1 Stakeholder inclusiveness
		4.2 Protection of core values
		4.3 Progress and variety of options
	5. Management ambition	5.1 Ambitious and realistic management
		5.2 Discourse embedding
		5.3 Policy cohesion
	6. Agents of change	6.1 Entrepreneurial agents
		6.2 Collaborative agents
		6.3 Visionary agents
Enabling	7. Multi-level network potential	7.1 Room to maneuver
		7.2 Clear division of responsibilities
		7.3 Authority
	8. Finacial viability	8.1 Affordability
		8.2 Consumer willingness to pay
		8.3 Financial continuation
	9. Implementing capacity	9.1. Policy instruments
		9.2. Statutory compliance
		9.3 Preparedness

The nine conditions and 27 indicators of Table 1 are described in the following paragraphs. The descriptions are adapted to the specific case study of Chía and they are based on the previous work done by Koop et al. (2017). Each paragraph describes one condition and its three corresponding indicators, which are referred to between parenthesis.

Awareness is understood as the level of knowledge that stakeholders in Chía had of the environmental, economic, and social benefits and trade-offs of implementing resource-oriented systems. It also refers to the level of knowledge that they had of causes and impacts of inadequate sanitation and waste management in urban contexts *(1.1 Community knowledge).* Moreover, this condition was about the perception that stakeholders held about the importance of implementing resource-oriented strategies in Chía *(1.2 Local sense of urgency)*. A higher level of awareness among stakeholders would potentially result in behavioural change, which is essential to push forward sustainable strategies and actions *(1.3 Behavioural internalization).*

Useful knowledge relates to the quality of information regarding resource recovery from OWS that was available for stakeholders and that enabled their effective engagement in decision-making processes (*2.1 Information availability*). In addition, it also refers to the transparency and consistency of that information (*2.2 Information transparency* and *2.3 Knowledge cohesion*).

Continuous learning refers to the existence of proper tools that allow regular monitoring and evaluation of processes, policies, and actions, at the local level but also at the regional or national one *(3.1 Smart monitoring* and *3.2 Evaluation*). This condition also refers to the way in which different stakeholders that were connected to resource-oriented sanitation and waste management could interact and learn from each other (*3.3 Cross-stakeholder learning*).

Stakeholder engagement process implies to look at the characteristics of the decision-making processes concerning resource-oriented systems. It also relates to whether those processes were unilateral, or stakeholders could influence the outcome (*4.1 Stakeholder inclusiveness* and *4.3 Progress and variety of options*). Furthermore, it relates to the transparency, the trustful environment, and the procedures within decision-making processes (*4.2 Protection of core values).*

Policy and management ambition refer to the character of goals for resource-oriented systems within the local policies or action plans. The character of these goals is highly influenced by the prevalence of long-term or short-term vision among relevant stakeholders *(5.1 Ambitious and realistic goals)*. Moreover, this condition looks at whether the existing and future challenges of water, waste, food and energy in Chía and the need for sustainable approaches were part of the political discourses *(5.2 Discourse embedding*). It also relates to the coherence of sanitation and waste management strategies among local institutions and different administrative and geographical levels (*5.3 Policy cohesion*).

Agents of change looks at the business opportunities on resource-oriented systems at the local and national level *(6.1 Entrepreneurial agents*). It also refers to the existing or potential collaborations among stakeholders and institutions working in different stages of the waste chain and the quality of those collaborations to implement resource-oriented systems *(6.2 Collaborative agents)*. Moreover, it looks at the existence of long-term adaptive approaches to push forward strategies to act in the local context (*6.3 Visionary agents*).

Multi-level network potential refers to the responsibilities and legitimate forms of power and authority within the networks that could be held accountable to address a long-term integrated implementation of resource-oriented systems *(7.2 Clear division of*

responsibilities and *7.3 Authority)*. It also refers to the freedom and opportunity to innovate and collaborate within those networks for implementing sustainability approaches (*7.1 Room to manoeuvre*).

Financial viability relates to the availability and affordability of sanitation, waste management and resource-oriented services for all the citizens, including the most vulnerable groups (*8.1 Affordability*). Furthermore, it looks at the financial continuation for those services to enable improvements at the local level (*8.3 Financial continuation*). It also describes how investments and allocation of resources for resource-oriented practices were perceived by stakeholders (*8.2 Willingness to pay*).

Implementing capacity relates to the different policy instruments that prevailed at the local and national level to promote effective implementation of sustainable practices, specifically those that were linked with sanitation and waste management (*9.1 Policy instruments*). It also looks at the level of compliance to the existing environmental regulations (*9.2 Statutory compliance*). In addition, this condition refers to the existence of action plans that prepared the town to deal with emergency situations (*9.3 Preparedness*).

To assess the capacity of a town to deal with certain environmental challenge through the GCF, its 27 indicators need to be scored using a Likert-type scale. The Likert scale is a tool used to measure responses to a set of given statements using a metric scale (Joshi 2015). For the GCF, the scale has five scores which show how enabling or limiting is the capacity of the town to govern the environmental challenge. Table 2 presents a guide to understanding this scale. For each of the 27 indicators, there is a specific Likert-type scale with a predefined question and five predefined answers that are related to the definition of each of the indicators. Annex II and Annex III gather the predefined questions and answers for each of the 27 indicators of the GCF that were used for this study (Based on EIP Water 2017, Ddiba et al. 2019).

Table 2. Guide to understanding the GCF indicator scores (EIP Water 2017)

Possible score of the indicators	Description
++	The indicator performs as a good enabler with regards to the environmental challenge
+	The indicator performs as an enabler with regards to the environmental challenge
0	The indicator performs as neutral with regards to the environmental challenge
-	The indicator performs as limiting with regards to the environmental challenge
--	The indicator performs as very limiting with regards to the environmental challenge

2.3 The GCF in the broader context of the governance literature

The GCF has already been tested in several European cities, towns, or high-income urban contexts as a method for assessing their capacity to govern specific environmental challenges. The results are presented in different studies (Brockhoff et al. 2019, Koop et al. 2017, Kim

et al. 2018, Madonsela et al 2019, Schreurs et al. 2017, Šteflová et al 2018, Van Leeuwen et al. 2018), which have the commonality of looking at look at urban environmental governance capacity from the perspective of water governance. First, Koop and his team (2017) uses the GCF to assess the governance capacity of Amsterdam city (Netherlands) to deal with multiple challenges: water scarcity, flood risk, wastewater treatment and urban heat islands. Later on and using this framework, Kim and his team (2018) assesses the urban water management of the megacity of Seoul (South Korea) and Madosela and her team (2018) evaluate the governance capacity of Cape Town (South Africa) to address water scarcity, wastewater treatment and flood risk. Šteflová and her team (2018) investigate how to enhance the governance capacity of a small Spanish city to implement systems for non-potable reuse of treated wastewater. Brockhoff et al. (2019) also utilise also the GCF to examine the capacity of local actors to govern pluvial flood risk in the city of Utrech (Netherlands). Looking at low-medium income urban contexts as the cities in the LAC region, Quito in Ecuador is the only metropolis in the region where the GCF has been used to assess the challenges of urban water management (Schreurs et al. 2018). Just one study applies the GCF to assess an environmental challenge from a broader governance perspective considering multiple resources other than water. In this study, Van Leeuwen and his team (2018) evaluate the governance challenge of moving towards circular economy when recovering resources as clean water cellulose, bioplastics, phosphate and biogas from municipal wastewater in the city of Amsterdam (Netherlands).

In the field of resource recovery from OWS, most of the literature that alludes to challenges in the governance arena look at those from a single perspective. For instance, Andersson et al. (2016) and Rodríguez et al. (2020) refer to those challenges from the wastewater perspective. Holmgren et al. (2016) and the Organisation for Economic Co-operation and Development (OECD 2015) describe how water governance challenges affect resource recovery practices. Hettiarachchi et al. (2018b) and Kaza et al. (2018) relate to challenges from the perspective of the organic waste and recyclable waste. Moya et al (2019) explain changes needed in the governance system to allow resource recovery from human excreta. In this context, few studies look at resource recovery from a broader perspective and analyse how resources like waste, water, nutrients, energy, and the linkages among them are governed (Velenturf and Jopson 2019, Weitz et al. 2017). This reveals that more research on governance aspects of urban waste management and sanitation from a cross-sectoral perspective is needed; looking at how resources like waste, water, nutrients, energy and the linkages among them are governed within the urban contexts, specifically in the LAC region.

Considering the existence of all the previous studies where the GCF has been applied and taking the argument that “there is no single best approach to address governance challenges” (Koop et al. 2017, pp. 3428), the CGF is selected for this study because of several reasons. The most important reason is that the GCF integrates a large amount of governance and transformation processes literature including some of the studies previously discussed (Emerson et al. 2012, Gupta et al. 2010, Mees and Driessen 2011, Pahl-Wostl 2009, OECD 2015). Furthermore, it is possible to use the GCF as an evaluation method for any type of challenge where multi-organizational networks have to collaborate to find common solutions (Koop et al. 2017). The transition towards resource-oriented sanitation and waste management systems requires collaboration and cooperation across governance levels and sectors including the environmental, agricultural, energy, health, industrial and infrastructure sector (Rodríguez et al. 2020, Van Leeuwen et al. 2018). Therefore, the GCF can be used as a tool to assess the governance challenge of implementing resource-oriented sanitation and waste management systems in urban contexts. Schreurs and his team (2018) remark in their study that there is a strong need for applying the GCF in low-income and middle-income urban contexts, which also supports the assessment of the governance capacity of a town in the LAC region. In addition, the Likert scale included in the GCF provides an easy and

transparent way of showing what is the current governance situation in a city especially when compared to some of the previous frameworks (Emerson et al. 2012, Silva et al. 2018). This way of showing results allows to easily identify what are the main issues and what actions can be taken to improve that situation (Koop et al. 2017).

Therefore, the GCF is a tool that promotes communication and collaboration in urban environmental decision-making processes among all types of actors, from policymakers to citizens. The GCF is also a standardised approach that allows easy systematic research in the field or urban environmental governance (Koop et al. 2017). In this way, since UC is a multi-case study project, the GCF provides a consistent and reproducible way of generating information and enables cross-learning experiences between the three urban contexts where the framework was applied, Stockholm, Naivasha (Kenya) and Chía (Colombia) (Ddiba 2019).

3 Case context: Waste management and sanitation in Chía (Colombia)

Chía is a town located 20 km north of Bogotá, the capital of Colombia. It belongs to Cundinamarca county, a region that includes many towns that are part of the metropolitan area of Bogotá. Chía has its own government and this one is represented within the Municipality. The Municipality is formed by public institutions, known as Secretariats, that are responsible of different areas including public health, environment, and economic issues among others (Alcaldía Municipal de Chía 2019).

During last years, Chía has increased its population because of the high rates of migration from the Colombian rural areas and Venezuela to urban areas, in particular to those close to Bogotá (Alcaldía Municipal de Chía 2015). Last data registered shows that by 2015 Chía had 126,647 inhabitants; a number that is expected to increase reaching almost 200,000 inhabitants by 2027 (Alcaldía Municipal de Chía 2015). Like other Latin American and Colombian towns, Chía has shifted from a rural area to an urban town. Nowadays, the economy in Chía is driven by the service sector, mainly restaurants, shops as well as other business. Despite that most of the farming activities have disappeared, in the surroundings of the town there are still fields for livestock and agricultural activities where mainly flowers are grown for exportation (CMGRD 2015*).*

In Cundinamarca, soil and water resources are under an increasing pressure due to population growth in the towns and to the land use changes in the territory (CMGRD 2015). Furthermore, the inadequate management of waste generated by the increasing number of inhabitants in Chía is endangering the public health of their inhabitants and the ecosystems of the town and its surroundings (Consultoría y Dirección de Proyectos SAS 2016a). A risk assessment study of the town shows that the prevailing inadequate disposal of waste in the closest rivers, Bogotá and Frío together with the high amount of non-treated wastewater discharged there, is causing the pollution of water sources and soil resources in the area as well as increasing the risk of flooding. Moreover, according to the study, public sanitary emergencies are also foreseen because of these practices (CMGRD 2015).

When looking at the waste generated in the Chía, 66% of the 2680 tons generated per month is organic waste (Consultoría de Dirección y Proyectos SAS 2016a). This data refers to 2014 and therefore it can be assumed that currently, the number is higher considering the mentioned increase in the population (Alcaldía Municipal de Chía 2015). According to formal studies, the main sources of OWS in Chía are households, restaurants, local markets, floriculture, public landscaping, and the slaughterhouse (Mosquera 2018) (Figure 3).

Waste collection services cover almost 90% of the population in Chía and are provided by the Public Utility EMSERCHÍA (CMGRD 2015). Until two years ago, all organic waste was collected, transported, and disposed of in Mondoñedo, the regional landfill (Consultoría de Dirección y Proyectos SAS 2016a). To reduce the amount of organic waste disposed of in the landfill, the Public Utility together with the Municipality put into practice two resource recovery initiatives in the town (Consultoría de Dirección y Proyectos SAS 2016a, Alcaldía Municipal de Chía 2016). The pilot program Circuito Verde, which is managed by EMSERCHÍA, aims to collect organic waste from households and other small waste generators in the town and transport it to private companies that elaborate compost. In the municipal nursery managed by the Secretary of Economic Development, liquid and solid fertilizer is also made from organic waste coming from the main town market and the slaughterhouse. This fertilizer is delivered free of charge to farmers cultivating agricultural

fields in the surrounding areas (Oral source[1]). Despite that both initiatives have been ongoing for around two years, there is no official data or information on the impacts and results of these initiatives. Regarding the recyclable waste generated in the town, some is sorted out at households, restaurants, and workplaces. Most of it is collected by different associations of waste pickers that are trying to leave the informal sector and function as private companies. These associations take the recyclable materials to warehouses and sell them to other companies that use them as raw materials for their production processes (Consultoría de Dirección y Proyectos SAS 2016a). The rest of the organic and recyclable waste generated in Chía is transported and disposed of in the regional landfill (Oral source[2]).

In Chía, the Public Utility EMSERCHÍA has also the competence of the proper functioning of the sanitation services (EMSERCHÍA 2019). Concerning wastewater, only 85% of the population in the town has access to the sewage system (Sánchez 2015). Therefore, there is still an uncountable number of households that use latrines or septic tanks as on-site sanitation services and most of them are not properly maintained (CMGRD 2015). Besides, the local Wastewater Treatment Plant (WWTP1), also operated by EMSERCHÍA, treates only 37,2 % of the collected wastewater by 2015 (CMGRD 2015). Due to the outdated systems and technologies, its efficiency is below 50% (Oral source[3]). Regarding the sludge produced at the WWTP1, some years ago it was manually extracted and buried in the same facilities (Sanchez 2015). Nowadays the absence of proper equipment makes that it cannot be managed in a different way (Oral source[4]). As a direct consequence of this situation, uncollected wastewater and untreated wastewater are directly discharged into the Bogotá and Frío rivers (CMGRD 2015). To try to solve the urgent need of treating a higher amount of wastewater, the Municipality decided to build a new WWTP in the town (Sanchez 2015). Even though this was foreseen in the last local development plan, the construction is still pending.

Based on the above description, the OWS flows in Chía as well as the waste service chain can be presented as in Figure 3 and Figure 4:

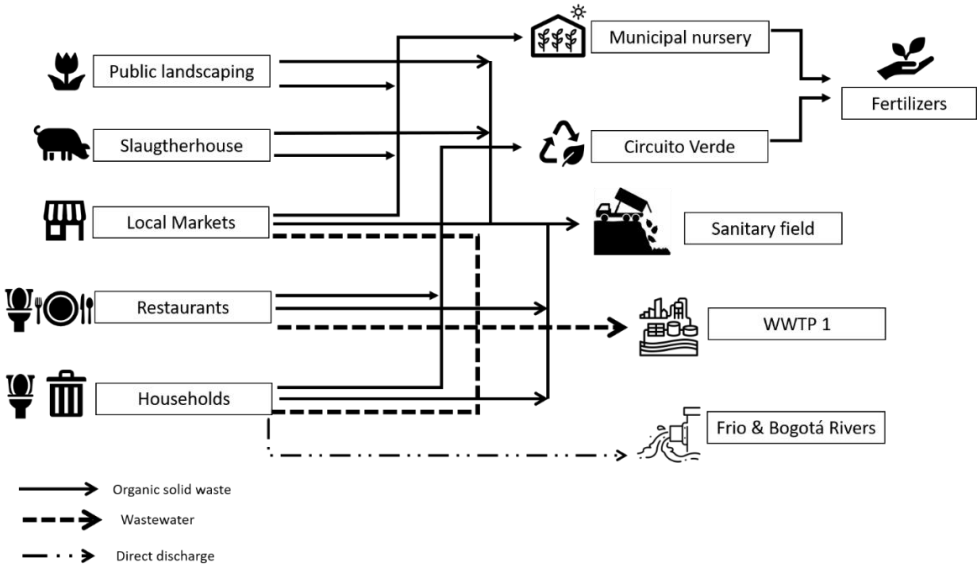


Figure 3. Scheme of OWS flows in Chía. On the left, the sources where waste is generated. On the right the different disposal places. The municipal nursery and Circuito Verde are the current two resource recovery initiatives in the town (Based on Mosquera 2018)

[1] Engineer of the Municipal nursery, interview 28-04-2019
[2] Waste picker, interview 29-04-2019
[3] Engineer in charge of the operation of the WWTP 1, interview 03-05-2019
[4] Operator of the WWTP, interview, 21-05-2019

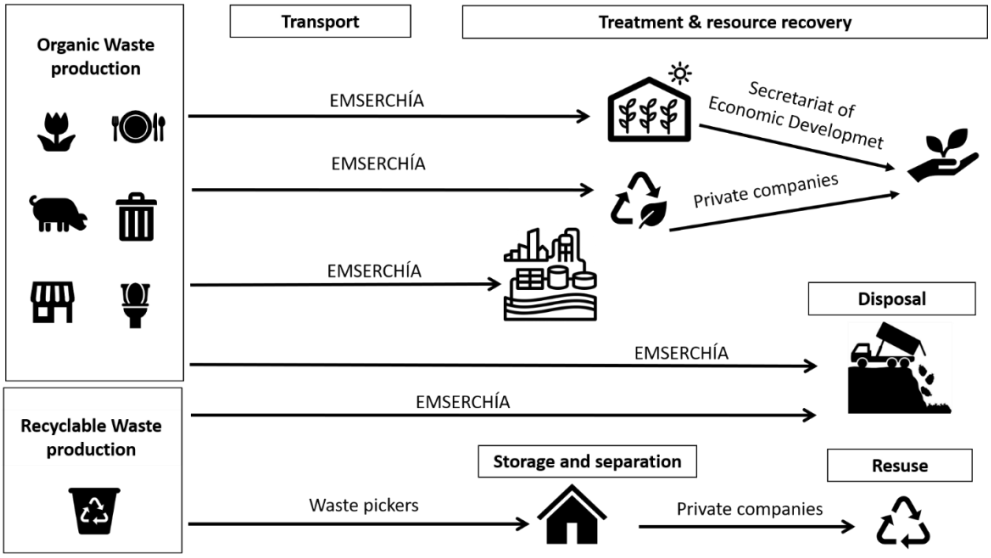


Figure 4. Scheme of waste service chain in Chía that also depicts the main actors involved in sanitation and waste management activities. From the left to the right: organic and recyclable waste production, in the middle and over the arrows the actors that transport, store and separate the waste and on the right and over the arrows the actors that treat, dispose or reuse the waste.

At the local level, Chía has municipal planning tools that contain the goals, actions, resources and timelines for collection, transportation, treatment and final disposal of solid waste and wastewater. With regards to solid waste management, the instrument that outlines that information is the Solid Waste Local Management Plan (PGIRS) (Plan de Gestión Integral de Residuos Sólidos) (Consultoría y Dirección de Proyectos SAS 2106a, Consultoría y Dirección de Proyectos SAS 2106b, Consultoría y Dirección de Proyectos SAS 2106c). Regarding wastewater, the local planning tool that includes that information is the Sanitation and Discharge Management Plan (PSMV) (Plan de Saneamiento y Manejo de Vertimientos) (Sanchez 2015).

In the context of urban planning, Chía as other Colombian urban areas has an interest in applying circular economy approaches to mitigate the environmental and health problems as well as to increase sustainable business opportunities. Among these approaches, the integration of waste management into a circular economy is emphasized within the last national strategies (Departamento Nacional de Planeación 2018a, Departamento Nacional de Planeación 2018b, Gobierno de la República de Colombia 2019). However, looking at the OWS in Chía, waste management and sanitation continue with business as usual and implementation of circular approaches as resource recovery practices has not gone beyond the mentioned initiatives, which do not show concrete results. Therefore, Chía and its governance system face the challenge of implementing resource-oriented systems with a long-term sustainability vision (Universidad el Bosque 2017).

4 Methodology: Application of the GCF to the Chía case

Applying the GCF to the governance challenge of implementing resource-oriented systems in the town of Chía implied adapting the concept of governance capacity as well as of the nine conditions and 27 indicators identified by Koop et al. (2017). For this study, governance capacity was understood as the set of governance conditions that should be developed to find dynamic solutions and enable effective change to implement resource-oriented systems in the town of Chía. The nine governance conditions together with the 27 indicators used for the Chía case are defined in section 2.2.1.

According to what is explained in that section, assessing the governance capacity of Chía to deal with that challenge entails that the 27 GCF indicators need to be scored using a triangular approach. In this way different sources validate the findings through four consecutive steps (Koop et al. 2017):

1. A desk study consisting of analysis of policy documents, scientific literature, grey literature, etc.
2. Conducting 15-20 interviews with relevant stakeholders.
3. The researcher gives a summary of each interview back to each of the respondents separately and asks them to provide constructive feedback or additional information that can support their arguments as reports or examples.
4. The researcher brings together the information obtained during the desk study, the interviews as well as the feedback provided by the interviewees and gives a final score to each indicator.

This triangular approach was followed in the study. However, the third step was not implemented due to certain limitations as it is explained in the next section.

4.1 Data collection

4.1.1 Desk study

The goal of the desk study was to get familiar with the conditions and indicators of the GCF as well as with the sanitation and waste management systems in Chía, Colombia and the LAC region. For that, I reviewed studies where the GCF had been applied, scientific literature of resource recovery in Colombia and the LAC region, local regional and national legislation and grey literature such as newspaper articles on sanitation and waste management in Colombia. Most of this information was obtained from online sources. Annex IV shows an overview of the documents reviewed for the desk study.

Moreover, I had access to several interviews that researchers from the UC project had previously conducted with actors that worked with sanitation and waste management in Chia (Universidad el Bosque 2019). Those interviews were done to obtain quantitative data on the OWS for the REVAMP tool. However, respondents also mentioned socioeconomic characteristics and challenges of sanitation and waste management in Chía. Those interviews provided preliminary information for setting up the context of the study.

The desk study was also used to identify relevant stakeholders for interviewing during the fieldwork. With the help of the local team of the UC project, I mapped the institutions,

sectors, public authorities, private companies, waste pickers associations and any other stakeholders that were involved in sanitation and waste management in Chía and Cundinamarca county. Some of the stakeholders mapped are shown in the scheme of the waste service chain in Chía (Figure 4). Based on that mapping, I selected a list of 25-30 potential interviewees who could provide relevant information to the study. The idea was that each of the 27 predefined questions that correspond to the GCF methodology (Annex II) could be discussed by at least three or four interviewees. Finally, to have a diverse range of stakeholders, those potential interviewees were categorized by stakeholder role, stakeholder type and stage of the waste service chain (Daniel et al. 2020). Annex V describes the categories of stakeholder roles, types and stages of the waste chain used for the study.

4.1.2 Filedwork and interviews

Fieldwork was carried out in Chía during the last week of April and May 2019 with the main purpose of conducting interviews. During this time and aiming to know as much as possible about sanitation and waste management in Chía, I joined the local team of the UC project there and helped them with different tasks of the project. I was involved in the collection and separation of solid waste, wastewater sampling from the WWTP1 as well as of faecal sludge from latrines and septic tanks of several households. Participating in these activities gave me the chance to meet other relevant stakeholders that later I would interview and helped me to understand better how sanitation and waste management worked at the local level.

The final selection of the interviewees was done on the field. Taking into consideration the list of potential interviewees that I created during the desk study, their availability and the suggestions given by the local team of the UC project, I conducted the first interviews. Those first interviewees suggested other possible respondents. Following their advice, I conducted the rest of the interviews. In total 21 stakeholders were interviewed in snowball sampling. Table 3 describes shortly the function of these 21 interviewees within their organisations and classifies them by their role, type, and the stage of the waste service chain to which their work belonged.

Table 3. Function and organization of the 21 stakeholders interviewed. They were classified by stakeholder role, type, and stage of the waste chain. In some cases, two people from the same organisation were interviewed.

Function of the interviewees	Organisation	Stakeholder type	Stakeholder role	Stage of the waste service chain
Operator of the WWTP1	EMSERCHÍA	Local Public Authority	Implementer	Treatment and Processing
Cleaning staff of a private residential area	-	Private Company - SME	Implementer	Emptying and transport
Legal Representative + Routes coordinator of a waste picker association	Asoambiental	Private Company - SME	Implementer	Emptying and transport
Coordination of the Interinstitutional Committee for Environmental Education	Secretatiat of Environment	Local Public Authority	Coordinator	Policy/Overarching
First Authority	Secretatiat of Environment	Local Public Authority	Decision-maker	Policy/Overarching

Function of the interviewees	Organisation	Stakeholder type	Stakeholder role	Stage of the waste service chain
Engineer in charge of the operation of the WWTP 1	EMSERCHÍA	Local Public Authority	Implementer	Treatment and Processing
Coordinator of the Program Ciclo Reciclo, which included reuse of organic waste	CAR (Regional Environmental Authority)	Regional Public Authority	Decision-maker	Policy/Overarching
Director of Surveillance and Control + Administrative Technician	Secretariat of Health	Local Public Authority	Implementer	Policy/Overarching
Professor and Researcher	Institute of Health and Environment	Researcher	Expert	Policy/Overarching
Manager	Jumbo Supermarket	Private Company-Large	Affected	Waste generator
Environmental Technician in charge of the program Circuito Verde	EMSERCHÍA	Local Public Authority	Implementer	Emptying and transport
Sales Executive of a company that collects used vegetable oil and transforms it into biogas	Greenfuel	Private Company - SME	Implementer	Emptying and transport
Environmental Journalist	Blog El Río, El Espectador Newspaper	Private Company-Large	Expert	Policy/Overarching
Civil servant	Secretariat of Environment	Local Public Authority	Implementer	Policy/Overarching
Engineer in the Municipal nursery, supervisor of the process of fertilizer production and in charge of the bioreactor	Secretariat of Economic Development	Local Public Authority	Implementer	Treatment and Processing
Co-founder and general manager of a company that transforms organic food waste into compost	Bioambientar	Private Company - SME	Expert	Treatment and Processing
Chemical engineer in a company that generates energy and biofuels from solid waste (organic and recyclable) using anoxic pyrolysis or thermolysis	Ecocracking	Private Company - SME	Affected /implementer	Treatment and Processing
Communications Coordinator	Office of Citizen Participation in Chía	Local Public Authority	Coordinator	Policy/Overarching

Function of the interviewees	Organisation	Stakeholder type	Stakeholder role	Stage of the waste service chain
Councillor in charge of environmental issues	Parliament of Chía	Local Public Authority	Decision-maker	Policy/Overarching
President of a neighbourhood association located in the outskirts of Chía	Junta de Acción Comunal de Yerbabuena Baja	Citizen	Affected	Waste generator
Environmental and Operations Coordinator of a company that connects waste generators with companies that want to buy waste (hazardous, special waste and also wastewater) as input to their production processes	Ecociclus	Private Company - SME	Coordinator	Disposal/End-use
Total 21				

Interviews were conducted face to face, usually at the workplace of the respondent. I scheduled interviews with one person, but on several occasions, two or three people working for the same institution or company joined the conversation. I did not see it as an inconvenience, on the contrary, it helped me to get more insights and perspectives on the topic discussed. The duration of the interviews varied from 20 minutes to more than an hour and the language used was Spanish. They were semi-structured, starting with some guided questions, and continuing with follow-up questions to target specific GCF indicators or to achieve further clarifications. If some of the respondents asked to have a draft of the questionnaire before the interview, I sent it via email in advance. According to Koop et al. (2017), GCF pre-defined questions (Annex II) should serve as guidance for the researcher to prepare and conduct the interviews, so they were never asked directly to the respondents. Concerning the ethics of the research, all the respondents except one gave their consent to record the interviewees using an audio recorder. Furthermore, at the beginning of the interview, a document that included a short summary of the study and its purpose and a declaration of consent to participate was signed up by each respondent.

During the fieldwork, apart from the interviews, I had spontaneous conversations with citizens from Chía and Bogotá about sanitation and waste management. Although this information cannot be considered as proper data collected for the study, I consider it as complementary data. This is because it helped to reinforce some arguments got during the interviews especially regarding topics as community knowledge or local sense of urgency, in which the opinions of citizens were valuable.

4.1.3 Limitations

Several limitations affected the data collection and influenced the four steps suggested by Koop and his team. Following the triangular approach, they claim that GCF scores should be scored after each step. In this study, I did not score the indicators until I analysed all the information collected through the desk study and the interviews. Rather than scoring the indicators, my goal as a researcher was to get as much as possible diverse information of sanitation and waste management in the town and of each of the GCF indicators. Besides and

due to the thesis timeline, after conducting the interviews I did not contact the respondents to ask them for feedback or additional information regarding their interviews. I left Colombia after conducting the last interview and it would have been challenging to do that via email or phone.

In addition, selection of interviewees was influenced by the suggestions of the local team of the UC project and other respondents as well as by the availability of the stakeholders. Furthermore, it was challenging getting the agreement of private companies to participate in the study and some of them declined to participate. Thus, several of the relevant stakeholders previously identified in the desk study were finally not interviewed. It was also difficult to categorise the interviewees according to their role, type, and stage of the waste chain because most of them could fit in several categories. The classification of stakeholder types also foresaw two other categories, NGOs, and funders, of which I did not interview any stakeholders.

4.2 Data analysis

The first step in the data analysis process was transcribing the information got in the interviews. Transcription was done manually without using any software. To guarantee the respondents anonymity, a coding system was applied to refer to each of the interviewees from [CH001] ...to [CH021].

After that, the information transcribed was coded according to 27 categories, which were created based on the 27 indicators of the GCF. The categorization of the information was done using an Excel sheet where I also noted quotes from the interviews, documents of the desk study that were linked with the arguments of the interviewees, complementary data from the field and challenges that I found regarding the use of GCF methodology. An example of the Excel Sheet used for the data analysis can be found in Annex VI.

4.2.1 Scoring the GCF indicators

The 27 GCF indicators need to be scored based on the scoring framework formed by the predefined questions, the predefined answers and the corresponding the Likert-type scale (Annex II and Annex III). After analyzing the information collected in the desk study and the interviews, scores were assigned to the indicators based on how the summary of findings related to the info on the scoring framework. Final scores of the 27 indicators are shown in section 6.

4.3 Author´s relation to this study

The qualitative character of this work implies that the worldview of the author and her background bring assumptions to the study, influencing its analysis and discussion. Worldview is "a general philosophical orientation about the world and the nature of" research that the author holds (Creswell 2017, p. 5). In this regard, I brought a constructivist and transformative worldview to this study.

First, holding a constructivist worldview, I tried to look as different views as possible and to make sense of the meaning individuals that participated in this study had about the world. It is important to acknowledge that my background and experiences might have shaped the interpretation of these views (Creswell 2017). As an environmental engineer, I believe in the benefits of applying sustainable and circular approaches to natural resource management. Therefore, I always try to push these approaches in any field of my life and work as it can be

the field of waste management and sanitation. Despite this, I had no previous knowledge or practical experience in the field of waste management, sanitation, and resource recovery. This together with that I was not familiar with the concept of governance and its applicability within a study might have influenced the way that interviews were conducted, and the data analysed. Furthermore, as a social constructivist, I focused on the specific context in which participants lived and worked (Creswell 2017). In this regard, I decided to spend five weeks in Colombia rather than conducting the interviews via skype to be able to understand as better as possible the setting of the study. I had not been in Colombia before, thus my previous knowledge of the historical and cultural context of the country and the town of Chía was minimum. On one side, I saw this as something positive because I could not easily drive the interviews or judge the information that I reviewed during the desk study. On the downside, having certain knowledge on the topic and the local setting might have helped me to interpret faster the views of the participants.

In addition, from my transformative worldview, I believe that participatory processes can bring different parts of society together to develop solutions and fight for change. I also believe that research needs to call to change through actions in the political and social agenda. In this regard, through the involvement of 21 stakeholders and the researchers of the UC local team, this study gave voice for those participants and provided an agenda that sought to bring change for the citizens in Chía, multiple stakeholders involved in the resource recovery business as well as national and local institutions in Colombia.

5 Results

In this section I describe the findings of applying the GCF to the governance challenge of implementing resource-oriented systems in the town of Chía. Results are organised in sections 5.1 to 5.9 according to the to the nine conditions of the GCF (See Table 1). Furthermore, using parenthesis, I point out which specific GCF indicators related to which statements of these findings. Indicators are numbered according to Table 1 (See section 2.2.1).

5.1 Awareness

In general, the community of Chía seemed to have more knowledge and be more aware of the potential uses of reusing organic waste than of reusing resources contained on wastewater (Indicator 1.1, Indicator 1.3). However, interviews revealed differences among stakeholders. On one hand, stakeholders involved in the waste service chain commonly showed more sense of urgency about implementing recovery of resources for OWS (Indicator 1.2). Workers that collected waste were especially aware of this because they were concerned about the status of Mondoñedo landfill, which had already exceeded its capacity (Sarralde 2018). Private companies working in the field of composting or energy production were the ones that appeared to be more aware of the environmental, economic, and social benefits and trade-offs of implementing these systems in Colombian towns (Indicator 1.1, Indicator 1.3). Stakeholders working on the value chain of resource recovery products were the ones that exhibited more knowledge about the scientific processes and technologies required for closing the loop of using waste resources (Indicator 1.1). On the other hand, most of the local public authorities (LPA) that worked for the energy, health and environmental sector seemed to be unaware of the benefits that implementing resource-oriented systems would bring to Chía (Indicator 1.1, Indicator 1.2, Indicator 1.3). One respondent working for the Municipality reinforced that argument:

> There are civil servants that do not know the topic, the only thing that we know is that we need to separate our waste. – LPA [CH004]

Interviews also revealed that thanks to the implementation of the two-resource recovery local initiatives, citizens in Chía started being aware of the benefits of using organic waste as a resource (Indicator 1.3). For instance, beneficiaries of the program Circuito Verde and residents of private areas were willing to learn about waste management for household-scale fertilizer production. Farmers growing commercial flowers had also increased their interest in resource recovery from OWS since they had noticed positive impacts like a thicker stem by using organic waste as fertilizer. In this context, one respondent explained how the perception of waste was changing among some citizens:

> Nobody realized that before, everything was always garbage! But now they see the chance to transforming it, there are a lot of people who wants to create an ECA (separation and reusing station) for recyclable waste. There are many others who want to create a small biogas plant or a system to make compost at the household level - LPA [CH011]

Regarding causes and existing and future impacts of inadequate sanitation and waste management in the urban context, interviews and spontaneous conversations during the fieldwork showed that citizens, stakeholders and public authorities generally perceived waste and wastewater management as one of the main factors causing environmental and health problems in Chía (Indicator 1.1). For example, during the interviews common concerns were raised on how the presence of rats in areas where waste is inadequately disposed of increases disease transmission among the population and on how the amount of waste disposed of in the Bogotá river basins affects negatively the quality of the soil and water. In addition, previous studies, local strategies and policies and newspapers also raised awareness of the

impacts of the non-sustainable character of the waste management and sanitation systems in Chía and other Colombian cities (See Annex VI).

5.2 Useful knowledge

Public information about waste management and sanitation was rarely available in Colombia (Indicator 2.1). In this regard, the National Strategy to implement the SDGs underlines that public institutions in Colombia have an information gap regarding collection and disposal of urban waste as well as the amount of treated wastewater in the towns (Departamento Nacional de Planeación 2018a) (Indicator 2.1). In addition, interviewees claimed that municipalities did not have information on the amount, type of waste generated, sources of waste generation nor on the potential uses of the resources contained in that waste (Indicator 2.1):

> No municipality has done a characterization of its solid waste, neither studying the energy potential, much less getting to know its combustion power, or giving waste an economic value. The reason behind is that the government has never required this information. If it has never been needed, then it does not exist. - Private sector [CH017]

> There are other types of waste generated by large actors that other companies may need, but not knowing that it is very difficult to encourage its reuse. There is a huge lack of information. We have tried to do that creating our online platform, get closer to that information, but it takes time. – Private sector [CH021]

In general, specific technical and scientific information on resource recovery processes was not publicly available either (Indicator 2.1). For instance, the municipal nursery in Chía had a bioreactor that was not in operation in part because there was not reliable and practical information about the process of getting biogas from organic waste:

> We tried to find out if there was this type of bioreactor in Colombia, and there is no ... there is no knowledge about biogas processes, there is no one to advise us. As far as I know, there is no experience with biogas in Colombia. - LPA [CH011]

In addition, looking at the individual waste management practices, insufficient public information prevented putting in practice certain resource recovery processes (Indicator 2.1). Some interviewees mentioned that residents and waste pickers in Chía did not have specific information on how to separate waste in the source in a way that would enable its collection, transformation, and reuse. Other respondents explained that some farmers did not have information on how to manage organic fertilizers properly which caused problems, mainly leaching and bad odour.

According to the respondents, transparency and access to environmental public information was generally limited (Indicator 2.1, Indicator 2.2). At the local level in Chia, if there was information available regarding waste management and sanitation it appeared to be fragmented among public institutions such as Secretariat of Environment, Secretariat of Health, EMSERCHÍA or the regional authority responsible for sanctioning environmental practices. Consequently, acquisition of information seemed to require a high input of resources in terms of time and bureaucratic effort as one interviewee pointed out:

> Information is neither public nor accessible to anyone. It is very difficult to get the information that is supposed to be public ... Environmental information is very difficult to get; everything needs a previous formal request. Different procedures are needed to obtain the information and people do not know about it. For example, you log on the page of the Ministry and it is very difficult to find the information you need – Private sector [CH013]

Furthermore, if information available about resource recovery was non-cohesive it was due to that different methods were used to collect data such as water quality or amount of waste generated (Indicator 2.3).

Interviews also revealed that despite the existence of successful experiences on the implementation of resource recovery practices in both the public and the private sector in different areas of Colombia, information was only known by stakeholders involved in those initiatives as the private sector or universities, but hardly ever included in local decision-making processes or translated into higher governance levels (Indicator 2.1).

5.3 Continuous learning

In general, in the Colombian public spheres regular monitoring, follow-up or assessment of results for the environmental policies, programs or actions seemed to be insufficient (Hettiarachchi et al. 2018a, Rodríguez et al. 2020) (Indicator 3.1, Indicator 3.2). For instance, according to one respondent not all the PGIRS of the towns of Cundinamarca county were evaluated by the institution responsible of their assessment. In this regard, one interviewee explained how in the context of environmental projects or strategies in Chia there were not proper assessment methods to evaluate ongoing processes and results:

> There is some follow- up and evaluation procedures, but I think that all of them are very basic. Most of the time, assessment tools are created by the Secretariat of Urban Planning instead of by the Secretariat of Environment...and they are quite abstract...There is a need for doing a more responsible follow - up...Paper "holds everything", and then you can present as much as reports as you want, but if there is not a proper follow-up and assessment on the results…- LPA [CH014]

Besides, Chia had not a proper system to monitor local resource recovery processes (Indicator 3.1). Despite some respondents claimed that the amount of organic waste generated the town market and the slaughterhouse as well as the quality and quantity of fertilizer produced in the municipal nursery were monitored, it was impossible to find reliable data on the two local resource recovery initiatives in any official source (Indicator 3.1). When this study was conducted, the sampling and chemical analysis of OWS for the REVAMP tool could be considered as the only monitoring action done in terms of resource-oriented systems in Chía.

Unlike the public sector, the private sector in Colombia monitored processes to recognise underlying trends or alarming situations that could affect their economic benefits or to ensure that they complied with the regulations (Indicator 3.1). For example, supermarkets monitored the amount of organic waste produced and checked that it was effectively managed to comply with health regulations. The organizations of waste pickers monitored the type and quantity of recyclable waste that they collect to comply with the national law. However, none of this information was publicly available or shared with potential interested stakeholders (Indicator 3.3).

Regarding cross-stakeholder learning processes in Chía, training activities seemed to provide stakeholders with the main opportunity to interact and learn from each other (Indicator 3.3). Interviewees explained that EMSERCHÍA and several Secretariats working in the waste service chain at the local level had implemented training programs for citizens and waste pickers. Common topics of these programs were waste separation at the source and enforcement of waste management regulations. In addition, certain entrepreneurs who had knowledge about composting or management of used vegetable oil frequently offered trainings to waste generators as citizens or other companies as part of their job. However, the existence of cross-sectorial platforms that brought together multiple stakeholders with interest on resource recovery practices was not known (Indicator 3.3).

5.4 Stakeholder engagement process

At the local and regional level, decision-making processes presented different characteristics. On one hand, it seemed that there had been opportunities for stakeholder inclusiveness that turned out in public-private partnerships. Examples of those partnerships that work with resource-oriented systems are mentioned in section 5.6 (Indicator 4.1, Indicator 4.3). On the other hand, local and national institutions appeared to have limited collaboration and communication among them, which triggered that all the relevant stakeholders who could promote change were not generally involved in the decision-making (Akhmouch 2012, Hettiarachchi et al. 2018b, Holmgren et al. 2016, Rodríguez et al. 2020) (Indicator 4.1). According to respondents, actors involved in cross-sectoral strategies in the public sector as is waste management, did have not enough power to take relevant political and economic decisions (Indicator 4.3). Hence, it seemed to be a slow and ineffective implementation of actions in the public sphere (Indicator 4.3).

Regarding citizen participation in local decision-making in Chía, there were different mechanisms, institutions, and spaces that promoted their involvement (Indicator 4.1). A Citizen Participation Office through which the Municipality empowered citizens by providing tools and information to actively engage them in any public decision-making processes, making these processes more transparent (Alcaldía Municipal de Chía 2020). There were also 59 neighbourhood associations (Juntas de Acción Comunal) that served as a transparent communication channel between citizens and the public institutions. In this regard, several Juntas de Acción Communal had played a key role involving citizens in the decision-making process of the project that aimed to connect the sewage system to the surrounding areas of Chía. In addition, citizens had the legal right to challenge local initiatives in the local council and councillors were obliged to review their concerns. Nevertheless, despite the existence of different ways of public involvement, respondents remarked that citizens had little effective influence on the decision-making processes (Indicator 4.1):

> In general, citizens have no interest in engaging in public decision-making, because they lack confidence. Public administration is always linked to bad things…For example, if there is a public call for 200 people only 40 attends…That is one of the main problems - LPA [CH018]

> Public administration has the mechanisms and the spaces, but citizens do not participate – Citizen [CH020]

5.5 Policy and Management Ambition

At the national level, plans and strategies published during the last two years included certain goals and indicators to improve both organic waste reuse and wastewater treatment in the country (Indicator 5.1). For instance, the National Strategy for Circular Economy mentioned that the goal for 2030 was to increase 30% its reuse of organic waste respect the baseline. Regarding energy production from organic waste, a 10% increase in the existing capacity of generation was expected for 2022. Reaching 54% of urban wastewater treated was also expected for 2022 (Gobierno de la República de Colombia 2019). The National Strategy for the implementation of the Sustainable Development Goals also contained a huge list of indicators and goals in terms of waste reuse and wastewater treatment for 2030 (Departamento Nacional de Planeación 2018a). Despite these strategies were more ambitious than ones from previous years, resource recovery actions from wastewater were absent in those documents as well as clear paths on how to act and to achieve the mentioned goals (Indicator 5.1). Besides, none of those documents contained long-term goals for 2050 (Indicator 5.1). In this regard, participants highlighted that policies and their implementation in Colombia were highly affected by a four-year political cycle. Because of this, ambitious

and long-term goals were not common in any of the national and local policies or action plans (Indicator 5.1):

> Governments always have a short-term vision. I govern for 4 years, but those 4 years end up being 3... There is not long-term thinking, the way of thinking is always how to accomplish things in the short-term... - LPA [CH014]

At the local level, short-term vision also seemed to be the common approach for waste management and sanitation in Chía (Indicator 5.1). Looking at resource recovery practices the updated version of the PGIRS mentioned proposals for reusing organic waste. Proposals such as composting and vermiculture, building a plant for reusing organic solid waste (PARSO), implementing selective routes for collecting organic waste through the town and training large organic waste generators or assisting with self-management organic waste projects (Consultoría y Dirección de Proyectos SAS 2016c). Nevertheless, the PGIRS did not foresee explicit targets or goals linked with those proposals in the short, medium, or long-term (Indicator 5.1). Furthermore, and despite the implementation of the two local resource recovery initiatives in Chía, there were no concrete plans for upscaling these initiatives and reusing all the organic waste generated in Chía. Regarding wastewater, implementing options such as reusing water for non-potable purposes or using sludge as an input for energy production or nutrient recovery of soils were not foreseen in the PSMV (Sánchez 2015). Besides, interviews revealed that although the Municipality recognised the urgency of having the two WWTPs in proper operation to control discharges, efforts of the public institutions focused on the first stage of the waste chain when waste was generated (Indicator 5.1):

> So far, we are at the point of saying well let's try to separate our waste. Let´s separate the stormwater from the wastewater too. We are behind in the process if we compare ourselves to other countries that have been working in resource recovery for a long time. Those countries think; since we are separating our waste what else can we get from it?... We need to implement adequate waste management approaches until we can get to that point where we can look for benefits of reusing waste or even doing business with it. - LPA [CH005]

> It is no secret to anyone that the plant is not functioning at 100% efficient. The current efficiency rate is 50- 60%. If we do not get to a 90% efficiency rate, as the regulation requires, we cannot reuse or recycle the water coming from there. – LPA [CH006]

According to respondents, coherence of sanitation and waste management strategies among institutions, administrative and geographical levels was affected by the limited cross-sectoral collaboration to solving environmental challenges (Indicator 5.3). Due to the limited cross-sectoral collaboration in the public sphere, policy on sanitation and waste management in Colombia was fragmented across different sectors such as economy, health, environment or urban planning (Akhmouch 2012, Holmgren et al. 2016, Rodríguez et al. 2020,) as one interviewee explained (Indicator 5.3):

> One regulation is created by the Secretariat of Environment and other by the Secretariat of Health. They should work together and create one unique regulation signed by both. For waste management, the Environment Department of the Municipality created its regulation and the Health Department did the same. Not too many regulations bring together different departments... - LPA [CH008]

Finally, interviews revealed that short-term vision prevailed also in the political discourses. Whereas improving waste collection and recycling systems was in certain way part of those discourses, using resources contained in OWS was not (Indicator 5.2).

5.6 Agents of change

At the local and regional level, there were collaborations among stakeholders and institutions working together to implement resource-oriented systems (Indicator 6.2). These collaborations seemed to be mostly public-private partnerships. For instance, in Chía several

Secretariats, EMSERCHÍA, private companies, and citizens had been involved in the implementation of the Program Circuito Verde. Furthermore, in Cundinamarca, one private company had engaged with 11 municipalities to collect their urban waste and generate energy and biofuel. Moreover, the Municipality in Cajicá, a town like Chía in Cundinamarca county had implemented a composting program thanks to the agreement with a private vendor who transformed organic waste into compost and delivered it to the citizens (Hettiarachchi et al. 2018b). Apart from those, there were examples of entrepreneurs working in successful initiatives linked with resource-oriented systems including the companies GreenFuel, BioAmbientar, Ecocracking and Ecociclus (Indicator 6.1). While these businesses had included resource recovery processes in the production and consumption chains, it appeared that they faced challenges when starting a business with a vision of a circular economy in Colombia. Entrepreneurs interviewed remarked that in Colombia there was no economic, institutional, and academic support or incentives from the state to develop projects with that vision (Indicator 6.1):

> Circular economy projects have to be private entrepreneurship or a" private fight". Even though the state has created some laws that provide room for entrepreneurs, it is not investing in companies like ours. Therefore, it is a private risk. - Private company [CH017]

According to respondents, this was due to several reasons. The four-year political cycle in Colombia hindered that visionary stakeholders, such as the ones involved in the previous initiatives, could push forward long-term strategies in Chía and other Colombian towns (Indicator 6.3). Generally, the elected public authorities prioritized short-term actions within the Local Development Plans (POTs) to fulfil promises to the community. Those actions were usually not linked with waste management and sanitation systems because public authorities in Colombia usually saw those as areas that did not generate economic benefits. Therefore, the implementation of resource-oriented systems would highly depend on the political willingness of the mayor, as one respondent explained (Indicator 6.3):

> We need to create a municipal law to establish the need for implementing resource recovery…we need to strengthen the PGIRS… the problem is that people who have political power do not have the willingness to work in those issues. – LPA [CH011]

> (Talking about urban waste into circular economy) If I were the mayor of this town or I could have the change to tell the next mayor about the importance of the topic, I would tell that person: if we are working on waste management, let´s try to get and reuse all the resources and energy that those contain at the same time...– LPA [CH005]

5.7 Multi-level network potential

Within the Colombian public sector competencies on sanitation and waste management were fragmented across different sectors (Indicator 7.2). Furthermore, according to interviewees, despite competencies of each institution and responsibilities of actors were clearly defined in theory, there was confusion about what those competencies imply in practice (Indicator 7.2). This together with the limited collaboration and communication between local institutions makes that no institution or actor could lead concrete actions for resource recovery strategies (Indicator 7.3):

> There is no articulation between different departments of the Municipality. Instead of working together, Secretariat of Environment requires actions to EMSERCHÍA and the same happens with the Secretariat of Health. When it comes to waste management and sanitation, all the public institutions require EMSERCHÍA to take action. However, there is no articulation to work together – LPA [CH006]

> The responsibilities of each local institution do not help to succeed in the implementation of action in Chia. For example, the WWTP1 is owned by the Municipality. However, its operation and maintenance are done by EMSERCHÍA, then Secretariat of Environment is responsible for the reuse of sludge of the WWTP1... Concerning water discharges, EMSERCHÍA is the

> one in charge of assessing if users comply with the discharge parameters, but then a different institution is the ones that must do the follow-up and sanctioning.- LPA [CH006]

Consequently, it seemed that in Chía there were no legitimate forms of power or authority that could be held accountable for the implementation of resource recovery practices from OWS (Indicator 7.3). The same seemed to occur for the recyclable waste. In this regard, there was a common complaint about how the low level of accountability of the public services in charge of waste collection at the household level prevented the achievement of sustainable actions (Indicator 7.2):

> I do recycle at home using different bags when I sort out the waste. However, since there is no proper waste management in the town, you can see how the garbage truck collects everything and transport it in the same truck. When you see that as a citizen you think: why I am doing this if in the end everything is going to the same landfill site?...You as a citizen can implement actions but it there is not a change in the system about waste management and reuse, it is very difficult to achieve changes – Private sector [CH013]

> The community knows that waste needs to be sorted out, shopping malls know that there is a need of classifying too, but then the garbage truck collects everything in the same truck... there is no impact if we want close loops- LPA [CH004]

Regarding the opportunity to innovate for implementing sustainability approaches, insufficient infrastructure and technologies hindered the opportunities to put in practice resource recovery actions (Andersson et al. 2016, Rodríguez et al. 2020) (Indicator 7.1). A clear example was the missed opportunity to generate electricity from organic waste in Chia because of the bioreactor was not operating and no replacement for a new one was foreseen. Moreover, vacuums in existing regulations also prevented certain resource recovery actions (Ochoa 2018) (Indicator 7.1). For instance, several residential areas in Chía wanted to transform their organic waste into compost. However, there was no specific regulation allowing this process, nor the reuse of sludge in households or small businesses that had their WWTP. Lack of regulation prevented initiatives as transforming waste into energy to use it in the country during the past years.

Looking specifically at the networks that worked with recyclable waste, according to interviews the main challenge that prevented innovation and collaboration in that business sector was that prices of the reusable material were controlled by the associations of waste pickers. That gave limited opportunities to get new actors on the market (Indicator 7.1).

5.8 Financial viability

In Colombia, regulation states that high-income sectors of the society must pay higher taxes to subsidize public services like waste management and sanitation of lower-income sectors (CRA 2016). These taxes also include the service of transformation of recyclable waste (CRA 2016) (Indicator 8.1). Therefore, the whole population of Chía should had access to waste collection and sanitation services. However, interviews and fieldwork revealed that in practice it was not like that. There was still an unknown number of households that used septic tanks or latrines as on-site sanitation systems and that had no access to the sewage system, mainly in the outskirts of Chía (CMGRD 2015, Municipio de Chia 2016) (Indicator 8.1). Furthermore, services of collection of recyclable waste were more common in the private residential areas than in other sectors of the town (Indicator 8.1).

Regarding how stakeholders perceived investments and allocation of resources for resource-oriented systems, interviews and reports showed that there was a general perception among public authorities that implementing these systems entailed more costs than benefits (Rodríguez et al. 2020) (Indicator 8.2). For instance, when looking to the sanitation infrastructure, respondents explained that paying for immediate solutions would bring more benefits to the community than investing in long-term solutions. In this regard, repairing

damages of the WWTP1 had been the common trend for more than 30 years in Chía rather than updating the infrastructure and investing in new technologies that could boost resource recovery practices. That perception was also shared by private companies since they perceived investing resources in resource-oriented sanitation and waste management systems as a risk (Indicator 8.2). According to the respondents implementing these systems implied a huge investment and benefits were not easily seen (Indicator 8.2). Therefore, a common approach for many companies in Colombia was continuing the "business as usual". For instance, when asked about constructing a small WWTP inside a factory to reuse water, one respondent who managed a main supermarket in Chía answered:

> ...It is true that we are mismanaging water, but at the same time that is very difficult to do... it would imply more money spent in the process, and we would need to look for a person to take maintain it...That is more than one million pesos per month...We as a company do not want to take the risk if you are ensured about how this is going to affect the company. - Private company [CH010]

Furthermore, respondents who belonged to the private sector explain how they needed to get support from international stakeholders to start their projects (Indicator 8.2):

> (Talking with one company that transform waste into energy and biofuel) There are not investments by the state. We are associated with other companies, mainly with the ones that provide us the technology to make possible this process. We needed a huge investment to be able to start. The state is creating regulations now, however, generating budgets to make this happen is going to be difficult…- Private company [CH017]

> (Talking with a private company that wants to promote composting in 1000 households in Bogotá) ... *Did you have a positive response from the government*? No, anything. We started the project with international support. Until the municipalities see the feasible results of the project, they will not support us. – Private company [CH016]

Respondents also revealed how citizens perceived investments in sanitation and waste management systems. According to them, citizens did recognise the need for certain actions as waste collection, but they just did not want to have an increase in their taxes (Indicator 8.2). They also thought that citizens did not comprehend the importance of public investments in infrastructure either, as the construction of the WWTP2 in Chía (Indicator 8.2):

> There is a huge lack of knowledge about how important these investments are. For example, people perceive the investments done to build another WWTP in the town as something wrong, especially citizens that are living close by. They are worried about odour, noise...but they do not see the future benefits of having a new WWTP in the town. -LPA [CH014]

Supporting the long-term implementation of sustainable sanitation and waste management systems by financial continuation seemed not to be common in Colombia (Hettiarachchi et al. 2018b, Rodríguez et al. 2020) (Indicator 8.3). According to interviewees, this was due to several factors: the prevalent short-term way of thinking in the public sector, the wrong distribution of available resources, few national regulations that pursue sustainable urban development, and corruption (Indicator 8.3). In this regard, corruption could have prevented the improvement plans for the WWTP1 and it seemed to be the reason delaying the construction of the WWTP2 (Bogotá 2018, Rubiano 2019). One participant showed her concern about it:

> (Talking about the construction of WWTPs) ...there is a huge amount of money that goes to corruption. Then, it is very difficult to pay for these projects.... corruption is part of the system. It is very sad to recognise it, but it is something that is always considered when calculating the costs for these projects - Private company [CH013]

Nevertheless, interviews also revealed that certain actions led by the Municipality in Chía contributed to the availability and affordability of sanitation, waste management and resource-oriented services for all citizens (Indicator 8.1). During the last years, citizens from the most vulnerable areas of the town had had access to financial support to clean dirty ditches and other areas where amounts of waste were continually disposed of. Moreover, the fertilizer

that was produced within the municipal nursery was delivered free of charge to all the farmers that asked for it (Indicator 8.1).

5.9 Implementing capacity

Interviews and previous studies showed that policy instruments in Colombia frequently lacked incentives to enhance sustainable behaviour (Ochoa 2018) (Indicator 9.1). Looking at waste management, regulatory instruments that put economic sanctions to the waste generator prevailed if waste disposal was inadequate. Besides, existing regulations seemed to lack policy instruments that forced users to reuse waste (Indicator 9.1). The exception in the national regulation was the incentives that promoted recycling of construction and demolition waste and electronic equipment waste (Ochoa 2018). When asked about environmental regulations, respondents shared the view that economic sanctioning instruments were the only ones that encouraged adequate compliance (Indicator 9.1):

> The only way that it works here is if "someone" touches your pocket. The intention is educating with punishment. Norms have not a positive side, they only have a negative one. Norms only sanction. Here everything is learned by punishing…- Researcher [CH009]

Despite the predominantly discouraging character of the regulations, respondents underlined the positive effects of new national regulations for waste management activities. Some stakeholders thought that those regulations opened the room for sustainable urban waste entrepreneurship (Indicator 9.1). For example, permission given for private companies to sell their own energy might boost actions to transform urban waste into energy (Official Journal of the Colombian Government 2015b). Furthermore, another regulation forced all generators to do proper source management of used vegetable oil and encouraged them to transform into biofuel (Official Journal of the Colombian Government 2015a). Many respondents also acknowledged the good outcomes of the new regulation that gives legal recognition to the waste pickers 'associations With the new legal changes, they are recognised as legal workers involved in the waste sanitation chain who have social benefits and who must monitor the amount of recyclable waste collected (Extrategia 2017, Official Journal of the Colombian Government 2016) (Indicator 9.1).

With regards to environmental statutory compliance and based on the respondents, there were different levels of compliance across stakeholders of the waste service chain (Indicator 9.2). On one hand, large companies within the private sector tended to respect the legislation, because non-compliance might bring them economic consequences (Indicator 9.2). For example, supermarkets had audits that checked adequate organic waste disposal as well as proper management of used vegetable oil. Frequent control by the public authorities as well as social benefits for the workers, were the drivers of statutory compliance for the associations of waste pickers. On the other hand, users at the household level, tanneries, sports clubs, or slaughterhouses located in towns nearby Chia were examples mentioned by respondents of non-compliance when discharging wastewater directly into the rivers (Indicator 9.2).

In this regard, when looking at the non-environmental statutory compliance in Colombia, interviews and documents reviewed revealed different reasons. The most recurrent argument was that sanctioning institutions did not have enough capacity to evaluate that all users respect regulations (Holmgren et al. 2016, Otoo and Drechsel 2018, Rodríguez et al, 2020, UN Environment 2018) (Indicator 9.2):

> There are normative instruments, but there is a lack of personnel or resources to follow up on the activities. Companies know that this occurs, then, they do not comply with the norm. Unfortunately, if no one is doing the follow-up, they fail to comply. - LPA [CH005]

Besides, some respondents insisted that many people either ignored regulations or they did not understand what to do to comply in the context of certain activities (Indicator 9.2). For example, regarding the quality of water discharges into the rivers:

> Many users have come to us saying that it is not specified what they need to measure ...There is a lot to do in terms of sharing and communicating knowledge ... a lot of information is needed because people do not know the regulations. Likewise, not knowing it does not mean that you do not have to. Many people ignore the regulations, justifying that it has nothing to do with them. – LPA [CH006]

Other reasons for not respecting regulations was that complying with environmental requirements implied high costs for small companies (Indicator 9.2):

> Even though that institution imposes fines, close factories... they try to open again and comply with the regulations, but this requires high costs for them. - LPA [CH001]

Regarding the existence of action plans that prepared Chía to extreme scenarios, inadequate urban planning and short-term thinking affected how the town faced uncertain events (Indicator 9.3). In this context, two respondents remarked that in Chia solutions were taken when the problems had already happened:

> In general, we worry about problems only when we are facing it, but we do not think about solving them otherwise... There is a lack of urban planning...This is something really common in our culture. LPA [CH014]

> Here, we work as opposed to how it should be. First, we construct a lot of buildings and then we realize that there are no basic services such as water, sewage systems... This is one of the main mistakes of this town...There has never been strategic urban planning. Problems were solved in the way... LPA [CH008]

Interviewees also explained that based on the extreme flooding that took place in Cundinamarca region during 2010-2011 a Municipal Management Risk Council was created in 2012 to prevent future risk scenarios (Indicator 9.3). Since then, actions at the local level had been implemented as reforestation of areas located in the mountains to avoid erosion or construction of small dams to prevent flooding. However, in terms of waste management and sanitation no concrete actions were mentioned in the Risk Management Plan (CMGRD 2015) (Indicator 9.3).

6 Analysis

After using the GCF to look at the governance challenge of implementing resource-oriented systems in Chía, in this section I analyse the previous findings while reflecting on the theoretical framework. Through the analysis, this section gives answer to the research question: how the current governance capacity of Chía influences the implementation of resource-oriented systems.

6.1 Assessment of the governance capacity

To assess the capacity of an urban area to deal with a certain environmental challenge, the 27 indicators of the GCF need to be scored. After compiling the results, I went back to the theoretical framework and evaluate the governance capacity of Chía to deal with the challenge of implementing resource-oriented systems. Using the scoring framework formed by the predefined questions, predefined answers and the corresponding the Likert-type scale (Annex III), I gave scores to the 27 indicators based on how the summary of findings related to the info on the scoring framework. The outcome of this scoring exercise is represented in Figure 5, which shows the governance capacity profile of Chía to implement resource-oriented systems. The 27 indicators are ranked clockwise in a spiderweb from the most limiting (--) to the most enabling (++) concerning the capacity to govern the implementation of resource-oriented systems in the town. To guide the reader, Table 4 explains the meaning of this ranking and classifies the number of GCF indicators by score.

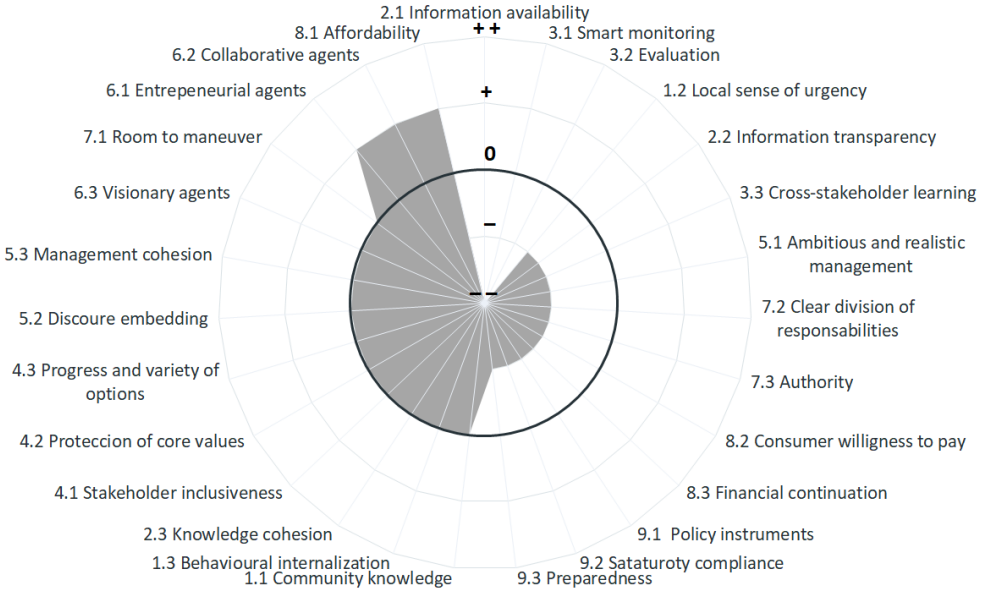


Figure 5. Governance capacity assessment to implement resource-oriented sanitation and waste management systems in the town of Chía, Colombia. The 27 indicators of the Governance Capacity Framework are ranked clockwise in a spiderweb from the most limiting (--) to the most enabling (++) concerning the capacity to govern the implementation of resource-oriented sanitation and waste management systems in the town.

The assessment revealed that the capacity of Chía to govern the implementation of resource-oriented systems was low. A low or weak governance capacity is justified because most of the indicators, 24 out of 27; were limiting this implementation or were neutral as regards to it. Besides, as Table 4 shows, there were no indicators that could be considered good enablers and just three indicators were considered as enablers.

Figure 5 allows to identify the factors that influenced negatively or positively the governance capacity of Chía, also known as barriers and enablers (Koop et al. 2017). Indicators *2.1 Information availability*, *3.1 Evaluation* and *3.2 Smart monitoring* were identified as the main barriers. Indicators *6.1. Entrepreneurial agents*, *6.2 Collaborative agents* and *8.1 Affordability* are identified as the main enablers. Enablers in Figure 5 are shown as the three green areas covered outside of the black circle.

Table 4. GCF scoring scale for the Chía case study

Score	**Description**	**N*umber of indicators***
++	The indicator performs as a good enabler with regards to the implementation of resource-oriented systems in Chía	0
+	The indicator performs as an enabler with regards to the implementation of resource-oriented systems in Chía	3
0	The indicator performs as neutral with regards to the implementation of resource-oriented systems in Chía	11
-	The indicator performs as limiting with regards to the implementation of resource-oriented systems in Chía	*10*
--	The indicator performs as very limiting with regards to the implementation of resource-oriented systems in Chía	3
		T*otal 2**7***

6.2 Factors that hinder the implementation

As a result of using the GCF to look at the governance challenge of implementing resource-oriented systems in Chía, governance factors that could be hindered the implementation of these systems were revealed. Analysis indicated that these factors were: low level of knowledge of resource recovery from OWS in the public spheres, insufficient collaboration and communication across sectors and institutions that had competences on waste management and sanitation, short-term vision within the local decision-making processes and insufficient incentives to support local entrepreneurship on circular economy.

Through the analysis of the first condition, *Awareness*; it was revealed that most of the LPA that worked for the agricultural, energy, health and even environmental sector seemed to be unaware of the benefits that implementing resource-oriented systems from OWS would bring to Chía. Besides, there was almost no knowledge of the revenue that could be obtained from reusing products made from waste and wastewater resources. This condition also brought to light that citizens and stakeholders seemed to be more aware of the potential uses of reusing organic waste than wastewater. In this regard, wastewater appeared to be a concept that still held negative associations as one researcher showed when he talked about reusing sludge:

> I have never seen sludge from a positive perspective, it is always seen as: what does the sludge have? how does it affect the watercourse if it is discharged? Always considering what the effects on water and ecosystems are… thinking about the negative impacts, but never from a positive perspective, trying to know how the sludge could be reused and studying its potential benefits – Researcher [CH009]

Probably the limited understanding that LAP and other stakeholders had of resource-oriented systems contributed to the general perception that public authorities held about that implementing these systems entailed more costs than benefits, a factor that was brought to light when looking at the indicator *8.2 Willingness to pay*.

Analysis of the second condition, *Useful knowledge*; evidenced that the Municipality of Chía and other public institutions in Colombia that had competences on waste management and sanitation did not have enough public information to promote the implementation of resource-oriented systems. In general, information on the amount and type of waste generated in towns was not available, nor of the sources of waste generation or the potential uses of the resources contained OWS. Besides, indicators *3.1 Smart monitoring* and *3.2 Evaluation* showed that regular monitoring, follow-up, or assessment of results for the environmental policies, programs or actions seemed to be insufficient. Lack of data and monitoring of the fertilizer produced in the municipal nursery as well as of the amount of organic matter recovered thanks to the Program Circuito Verde were examples of these issues in Chía. Consequently, it was difficult to know what worked, what did not work and what needed to be improved or changed to ensure long-term sustainability of resource-oriented systems at the local level.

Insufficient collaboration and communication across sectors, institutions and governance levels that had competences on waste management and sanitation was a recurring element that emerged when looking at the indicator *2.1 Information availability*, *2.2 Information transparency*, *5.3. Policy cohesion*, *7.2 Clear Division of Responsibilities*, *7.3 Authority* and the fourth condition *Stakeholder Engagement Process*. Insufficient collaboration and communication together with the traditional way of thinking and working in silos in the Colombian public sector probably hindered the creation of multidisciplinary teams and cross-sectoral platforms that could bring together multiple stakeholders with an interest in resource-recovery practices, as showed indicator *3.3. Cross- stakeholder learning*.

Analysis of the fifth and sixth conditions *Policy and Management Ambition* and *Agents of change* as well as the indicator *8.3 Financial continuation* revealed that due to the four-year political cycle short-term vision seemed to prevail within the local decision-making processes in Colombia. Moreover, the short-term thinking was also reflected in the way that the town faced uncertain events as evidenced the indicator *9.3 Preparedness*. Short-term vision seemed to be the common approach for waste management and sanitation actions in Chía. The indicator *5.1. Ambitious and realistic goals* and the eighth condition *Financial viability* showed that in Chía economic, human, and physical resources seemed to be channelled into the first stage of the waste service chain. Into waste collection and recyclable waste classification as well as the separation of stormwater from wastewater. Furthermore, no concrete plans or actions for upscaling the two local resource recovery initiatives and reusing all the organic waste generated in the town were included in the PGIRS. Regarding wastewater, implementing options such as reusing wastewater for non-potable purposes or using sludge as input for other processes such as energy production or nutrient recovery of soils were not foreseen in the PSMV. Therefore, it could be concluded that medium- and long-term goals that considered resource recovery strategies and clear paths to achieve sustainable waste management and sanitation were missing in the local plans of Chía.

Finally, indicator *6.1 Entrepreneurial agents* also showed that despite the existence of resource recovery initiatives promoted by the private sector or by public-private partnerships, entrepreneurs with a vision of circular economy had insufficient economic, institutional and academic support or incentives from the state to develop their business. For this reason, many companies perceived investing resources in resource-oriented sanitation and waste management systems in Colombia as a risk. Likewise, they needed to get support from

international stakeholders to start their projects as indicator *8.2 Willingness to pay* also brought to light.

6.3 Gap between local initiatives and its inclusion in the governance systems

Looking at the governance challenge of with the lens of the GCF also revealed that there were factors that could enhance the implementation of resource-oriented systems in Chía: Analysis indicated that these factors were: existence of public-private partnerships and entrepreneurs working in successful initiatives linked with resource-oriented systems in Chía and other towns of Cundinamarca and the availability and affordability of sanitation, waste management and services for most of the citizens in Chía as well as of the existing resource recovery products.

Analysis of the indicators *6.2 Collaborative agents* and *4.1 Stakeholder inclusiveness* brought to light the existence of collaborations among stakeholders and institutions working together to implement resource-oriented systems at the local and regional level. Most of these collaborations seemed to be public-private partnerships. In Chía several Secretariats, EMSERCHÍA, private companies, and citizens had been involved in the Program Circuito Verde. In the municipal nursery of the town, liquid and solid fertilizer was made from organic waste coming from the town market and the slaughterhouse. That fertilizer was delivered free of charge to farmers cultivating agricultural fields in the surrounding areas. In Cundinamarca county, one private company had engaged with 11 municipalities to collect their urban waste and generate energy and biofuel. Moreover, the Municipality of Cajicá, a town of the county, had implemented a composting program thanks to the agreement with a private vendor who transformed organic waste into compost and delivered it to the citizens. Apart from those, indicator *6.1 Entrepreneurial agents* revealed that there were entrepreneurs working in successful initiatives linked with resource-oriented systems such as the private companies GreenFuel, BioAmbientar, Ecocracking and Ecociclus. In this context, indicator *1.1 Community knowledge* showed that stakeholders involved in these initiatives exhibited knowledge about the scientific processes and technologies required for closing the loop of using waste resources. Indicator *1.3 Behavioural internalization* also reveals that these stakeholders were aware of the environmental, economic, and social benefits and trade-offs of implementing these systems in Colombian urban areas.

Nevertheless, through the second condition *Useful knowledge* it was found out that despite most of these projects had positive impacts at the local level, information about them was only known by stakeholders involved in those initiatives as the private sector. Information was hardly ever spread out among potential actors who could push forward long-term sustainable actions as LPA working with waste management and sanitation nor translated into higher governance levels. Moreover, as the fifth condition *Policy and Management ambition* showed, knowledge and experience got from these actions were hardly ever included in the urban policy-making with the goal of scaling these actions up while ensuring long-term sustainability of resource-oriented systems.

Taken together, the analysis suggested that in Chía there was a gap between local initiatives of resource recovery from OWS that brought environmental, economic, and social benefits at small scale and its inclusion in the local and regional governance systems. This gap could be also transferred to the rest of the towns in Cundinamarca county.

7 Discussion: the GCF and its applicability

Looking at the research problem with the lens of the GCF reveals pros and cons of this framework. On one hand, the GCF allowed to quickly assess the existing capacity of Chía to govern the implementation of resource-oriented systems. Furthermore, the GCF helped to easily identify governance aspects that could be preventing and boosting the implementation of these systems. On the other hand, the identification of those aspects was driven by the fixed template of 27 questions and answers provided by the GCF methodology. Using that template might have resulted in that other aspects that affect the governance of the town were left out the assessment.

Moreover, thinking on future research, I want to discuss how concrete characteristics of a case study may influence the validity of the GCF. In mi opinion and thinking in the Colombian society, resource recovery from OWS was a new topic. Especially if it is compared to countries like the Netherlands, where the National Circular Economy program has been promoting the reuse of resources including organic waste, in all governance levels (Van Leeuwen et al. 2018). The fact of perceiving resource recovery something new triggered that during the interviews and the spontaneous conversations of the fieldwork many stakeholders tended to think only in recyclable waste. Organic waste and wastewater were automatically excluded. It was me who had to bring the topic up to light and explain what certain terms meant. From my view, the low level of knowledge about resource-oriented systems in Chía influenced the information that I collected. For future studies, it might be useful to do a pre assessment or quick diagnosis of the environmental challenge in the town before applying the GCF. The results of that pre-assessment could guide the researcher and if necessary, the template with the 27 questions and answers of the GCF could be modified with the goal of getting as much as information as possible when doing the interviews.

In addition, as researcher it was difficult to define the boundaries of the study. Sanitation, waste management and resource recovery are broad fields that can be investigated from multiple perspectives such as environment, industry agriculture, health, or urban planning among others. Since the study sought to look at governance aspects of urban waste management and sanitation from a cross-sectoral perspective and to have a more complete picture of the governance capacity of Chía, it would have been useful to consider all of them. However, this was impossible. From the desk study, I decided to focus on waste management and sanitation from the environmental and health perspective because those were the most recurrent in the documents reviewed. In this way, I left out most of the information that linked waste and wastewater with agriculture or industry. Similarly, when looking for interviewees my tendency was to prioritise actors that were working in the environmental or water sector, considering that the GCF methodology recommends interviewing a maximum of 20 stakeholders.

Furthermore, it is important to reflect on the fact that the result of the GCF assessment was highly influenced by the stakeholders interviewed. In this study, ten out of 21 respondents were local public authorities; therefore, it could be assumed that assessment had an inherent bias towards the views of the public sector. On the contrary, just one citizen was interviewed, which means that their views might be misrepresented in the assessment. During the fieldwork, more stakeholders that belonged to the private sector were contacted. However, some of them refuse to participate in the study probably because they did not see the benefits of it. I also think that some of them were reluctant to share information.

Despite that the GCF methodology recommends that each of the 27 predefined questions that (Annex II) can be discussed by at least three or four interviewees, for this case some indicators as *1.1 Community knowledge* got input from more that six respondents and some

other indicators from just two. In my case, it was impossible to get enough information to score the indicator *4.2 Protection of core values* and *2.3. Knowledge cohesion*. For this reason, I scored them 0, considering them as neutral with regards to the implementation of resource-oriented systems in Chía. The difference on stakeholder input for each indicator influenced the scoring exercise and therefore the governance capacity assessment.

Since the GCF integrates a large amount of governance and transformation processes literature (Koop et al. 2017), it is implicit that the GCF conditions and indicators are going to be linked with each other. For example, from my point of view indicators 1.*1. Community knowledge, 2.1. Information availability* and *2.2. Information transparency* are similar to each other. This can be seen in this way: level of public knowledge in the community of Chía was low in part because there was no information available about resource recovery practices in the local context. Information was not available because access to information was nor easy or transparent. Furthermore, indicators *3.1. Smart monitoring* and *3.2. Evaluation* with *9.3. Preparedness* are also linked. This is because to recognise alarming situations, identifying underlying trends and predict future trends, process and policies need to be assessed, evaluated, and improved. Looking at the policy area, there is also a link between 5.*3. Policy cohesion* and *9.1. Policy instruments* because both refer to the existing regulations that cover waste management and sanitation. Indicators *3.3 Cross stakeholder learning*, 4.*1. Stakeholder inclusiveness* and *6.2. Collaborative agents* had points in common regarding cooperation of multiple actors and the availability of networks. These similarities between indicators have pros and cons for the study. On one hand, the relation among indicators provides a form to validate the information got by the researcher (Daniel et al. 2020). This form of validation can be seen in this study because the indicators 1.1, 2.1 and 2.2 performed as limiting or very limiting and the same occurs with the indicators 3.1, 3.2 and 9.3. On the other hand, the similarity between indicators may confuse the researcher, especially when categorising the information collected.

Besides, some indicators are difficult to contextualize in practical situations because of their abstract character. Despite of having the supporting documents such as the study of Koop et al. as well as the corresponding questions and answers where the indicators and conditions are described, I struggled with the meaning of the indicator *4.3. Progress and variety of options* and *7.1. Room to manoeuvre*. Consequently, it was challenging to prepare questions related to these indicators for the interviews as well as finding supportive literature.

Considering all the previous challenges mentioned, I think that in some cases scoring the 27 indicators might bring confusion to the study. For those cases, I propose to give scores just to the 9 conditions as Daniel et al. (2020) did in their study.

Regarding the language, the fact that the GCF questions and answers were originally in English was not a problem. Nevertheless, I think that having a template in Spanish for future studies in the LAC region would be useful because otherwise the researcher needs to invest time in translation.

Finally, it is important to have in mind the GCF is a subjective method since scores are given only by the researcher. Therefore, the same governance assessment performed by a different researcher might bring different results.

8 Conclusion

Sustainable approaches for waste management and sanitation are key to deal with the environmental and health challenges that growing urbanization is creating around the world. Implementing systems that allow to reuse resources contained in OWS is an approach that can bring many benefits, especially in low-medium income areas as the LAC region, where excreta, wastewater, and waste are not properly managed. The transformation towards these systems requires not only technological changes, but also changes in the way that urban waste and wastewater are governed. This study contributes to understanding how the capacity to govern organic waste streams influences the implementation of resource-oriented sanitation and waste management systems in the context of a low-medium income urban town of the LAC region.

The Governance Capacity Framework (GCF) was used as an analytical tool to assess the governance structure of Chía, a town in Colombia. Results revealed that the existing capacity of the town to govern the implementation of resource-oriented systems was low. In addition, the governance capacity assessment suggested that in Chía there was a gap between local initiatives of resource recovery from OWS that brought environmental, economic, and social benefits at small scale and its inclusion in the local and regional governance systems. Creation of local and regional platforms that gather knowledge and data of existing resource recovery initiatives as well as of physical or virtual spaces for cross-stakeholder interaction could be some recommendations to increase the governance capacity of Chía. Likewise, these recommendations should aim at closing the mentioned gap. However, since the results of this study touches upon many governance aspects such as knowledge, legislation, financing and even culture, further research is needed to look closer to each of those and make concrete and effective proposals that bring change.

Research participatory tools as the GCF add a lot of value to decision-making processes in the LAC region. The application of GCF to this case study is an example of a method by which awareness about waste and circular economy could be increased and connections among many stakeholders created or strengthened. Urban planning participatory approaches are not very common in Colombia nor in the LAC region. Therefore, I encourage future researchers to use this type of tools to work with local stakeholders to promote effective societal change. However, being aware of the case study specifications as well as of the strengths and shortcomings of the GCF as an analytical tool might help researchers to propose the most desirable, possible, and manageable actions for a particular context like the town of Chía.

Finally, this work can serve local decision-makers and other stakeholders as valuable information to start thinking on how to close the mentioned gap and include resource recovery approaches at higher governance levels not only in Chía, but also in other towns of the LAC region. Furthermore, insights of this study can be a starting point to further explore the correlation between governance of natural resources, circular economy, and sustainable urban planning in the region.

References

Akhmouch, A. (2012). ”Water Governance in Latin Amercia and the Caribeean: A Multi-Level Approach”, *OECD Regional Development Working Papers*, 2012/04, OECD Publising. http://dx.doi.org/10.1787/5k9crzqk3ttj-en

Alcaldía Municipal de Chía (2015). *Caracterización poblacional*. Alcaldía Municipal de Chía. Available at: http://chia-cundinamarca.gov.co/planeacion/AnalisisdemografiaChia2015.pdf [2019-03-12]

Alcaldía Municipal de Chía (2016). *Decreto Número 29 de 2016 (22 de Julio)" Por el cual se adopta la actualización del plan de gestión integral de residuos sólidos (PGIRS) para el municipio de Chía"*. Available at: https://www.chia-cundinamarca.gov.co/normatividad/DECRETOS2016/DECRETO%2029%20de%202016.pdf [2019-03-15]

Alcaldía Municipal de Chía (2020). *Organization chart.* Available at: http://www.chia-cundinamarca.gov.co/2019/galerias/Organigrama%202019.jpg [2020-08-19]

Alcaldía Municipal de Chía (2020). *Oficina de Participación Ciudadana. ¿Quiénes somos?*. Available at: http://opc.chia-cundinamarca.gov.co/index.php/aseguramiento/quienessomos [2020-06-19]

Alzate-Arias, S., Jaramillo-Duqu,e A., Villada, F., Restrepo- Cuestas, B. (2018). Assessment of Government Incentives for Energy from Waste in Colombia. *Sustainability*, vol. 10, pp 1-16.

Andersson, K., Rosemarin, A., Lamizana, B., Kvarnström, E., McConville, J., Seidu, R., Dickin, S., Trimmer, C. (2016) *Sanitation, Wastewater Management and Sustainability: from waste disposal to resource recovery*. Nairobi and Stockholm: United Nations Environment Programme and Stockholm Environment Institute.

Bogotá (2018) Los líos de la Ptar de Chía que enredan a tres exfuncionarios. *El Tiempo*. Noviembre 12. Available: https://www.eltiempo.com/bogota/corrupcion-en-la-ptar-de-chia-afecta-a-exalcalde-292612 [2019-07-12]

Bogotá (2019) ¿Por qué hubo suspensión provisional del POT de Chía? *El Tiempo*. Abril 23. Available at: https://www.eltiempo.com/bogota/por-que-suspendieron-provisonalmente-el-pot-de-chia-consecuencias-352758 [2019-07-12]

Brockhoff, R.C., Koop S., Snel, K. A. W. (2019). Pluvial Flooding in Utrecht: On Its Way to a Flood-Proof City. *Water*, vol 11 (1501), pp.1-17. doi:10.3390/w11071501

Caffyn, A. & Jobbins, G. (2003). Governance capacity and stakeholder Interactions in the Development and Management of Coastal Tourism. *Journal of Sustainable Tourism*, vol 11, pp 224 -245

Cámara de Comercio de Bogotá (2017). *Se consolida el Comité de Integración Territorial (CIT)*. Available at: https://www.ccb.org.co/Sala-de-prensa/Noticias-Boletin-Regional/Boletin-Regional-2017/Septiembre-2017/Se-consolida-el-Comite-de-Integracion-Territorial-CIT [2019-03-06]

Comisión de Regulación de Agua Potable y Saneamiento (CRA) (2016). *¿Cómo se factura el acueducto, alcantarillado y aseo en Colombia?* Available at: https://www.youtube.com/watch?v=vZiBzVnbVk0 [2019-09-10]

Consejo Municipal de Gestión de Riesgos de Desastres (CMGRD) (2015). *Plan Municipal de Gestión del Riesgo de Desastres*. (Unpublised). Municipio de Chía, Cundinamarca.

Consultoría y Dirección de Proyectos SAS (2016a) *Actualización del Plan de Gestión Integral de Residuos Sólidos (PGIRS) para el municipio de Chía*. (Unpublished). Volumen I. Abril, 2016.

Consultoría y Dirección de Proyectos SAS (2016b) *Actualización del Plan de Gestión Integral de Residuos Sólidos (PGIRS) para el municipio de Chía*. (Unpublished). Volumen II. Abril, 2016.

Consultoría y Dirección de Proyectos SAS (2016c) *Actualización del Plan de Gestión Integral de Residuos Sólidos (PGIRS) para el municipio de Chía.* (Unpublished). Volumen III. Abril, 2016.

Creswell, J. W. (2017). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches* Fourth International Student Edition. London: SAGE Publications.

Dang, T.K. P, Visseren-Hamakers, I.J., Arts, B., (2016). A framework for assessing governance capacity: An illustration from Vietnam's forestry reforms. *Environment and Planning C: Government and Policy*, vol. 34(6), pp.1154–1174.

Ddiba, D. (2019) *Urban Waste into Circular Economy Benefits*. (Unpublished). Concept note for Governance Capacity Assessment study.

Ddiba, D., Andersson, K., Koop, S. H., Ekener, E., Finnveden, G. & Dickin, S. (2020). Governing the circular economy: Assessing the capacity to implement resource-oriented sanitation and waste management systems in low-and middle-income countries. *Earth System Governance*, 100063. DOI: 10.1016/j.esg.2020.100063

Ddida, D. I. W., Andresson, K. and Rosemarin, A. (2016). *Resource Value Mapping (REVAMP): A tool for evaluating the resource recovery potential of urban waste streams*. Discussion Brief. Stockholm Environment Institute. Stockholm. Avilable at: https://www.susana.org/_resources/documents/default/3-2638-7-1474632188.pdf [2019-07-21]

Departamento Nacional de Planeación (2016). *Documento CONPES 3874. Política nacional para la gestión integral de residuos sólidos.* Available at: https://colaboracion.dnp.gov.co/CDT/Conpes/Econ%C3%B3micos/3874.pdf [2019-11-02]

Departamento Nacional de Planeación (2018a). *Documento CONPES 3918. Estrategia para la implementación de los objeticos de Desarrollo Sostenible (ODS) en Colombia.* Available at: https://colaboracion.dnp.gov.co/CDT/Conpes/Econ%C3%B3micos/3918.pdf [2020-05-20]

Departamento Nacional de Planeación (2018b). *Documento CONPES 3934. Política de Crecimiento Verde. Resumen Ejecutivo* Available at: https://www.dnp.gov.co/Crecimiento-Verde/Documents/Pol%C3%ADtica%20CONPES%203934/Resumen%20Pol%C3%ADtica%20de%20Crecimiento%20Verde%20-%20diagramaci%C3%B3n%20FINAL.pdf [2020-05-20]

EIP Water (2017). *Indicators of the governance capacity framework. European Innovation Partnership on Water (EIP-Water)*. Available at: https://www.power-h2020.eu/wp-content/uploads/Indicators-of-the-Water-Governance-Capacity-Framework.pdf [2019-3-03]

Ellen MacArthur Foundation (2015). *Towards a circular economy. Business rationale for an accelerated transition*. Ellen MacArthur Foundation. Cowes, United Kingdom.

Emerson, K., Nabatchi, T, Balogh, S.(2012). An Integrative Framework for Collaborative Governance. *Journal of Public Administration Research and Theory*, vol 22, pp. 1-29. doi:10.1093/jopart/mur011

EMSERCHÍA (2019). *Nuestros servicios*. https://emserchia.gov.co/wordem/servicios/ [2019-03-06]

Extrategia (2017). Recicladores de Chía se formalizarán. *Extrategia*. 15 November. Available at: http://www.extrategiamedios.com/noticias/medio-ambiente/2977-recicladores-de-chia-se-formalizaran [2019-03-06]

Gobierno de la República de Colombia (2019). *Estrategia Nacional de Economía Circular. Cierre de ciclos de materiales, innovación tecnológica, colaboración y nuevos modelos de negocio*. Bogotá D.C.: Colombia. Presidencia de la República. Ministerio de Ambiente y Desarrollo Sostenible; Ministerio de Comercio, Industria y Turismo. Available at: http://www.andi.com.co/Uploads/Estrategia%20Nacional%20de%20EconA%CC%83%C2%B3mia%20Circular-2019%20Final.pdf_637176135049017259.pdf [2020-05-20]

Gupta, J., Termeer, C., Klostermann, J., Meijerink, S., Van Den Brink, M., Jong, P., Nooteboom, S., Bergsma, E. (2010) The adaptive capacity wheel: a method to assess the inherent characteristics of institutions to enable the adaptive capacity of society. *Environmental Science & Policy*, vol. 13 (6), pp. 459–471

Hettiarachchi, H., Meegoda, J.N., Ryu, S. (2018a.) Organic Waste Buyback as a Viable Method to Enhance Sustainable Municipal Solid Waste Management in Developing Countries. International *Journal of Environmental Research and Public Health*, vol. 15 (2483), pp. 1-15. doi:10.3390/ijerph15112483

Hettiarachchi, H.; Ryu, S.; Caucci, S.; Silva, R. (2018b) Municipal Solid Waste Management in Latin America and the Caribbean: Issues and Potential Solutions from the Governance Perspective. *Recycling*, vol. 3 (18), pp. 1-15. doi:10.3390/recycling3020019

Holmgren, K. E., Li, H., Verstraete, W., Cornel, P., (2016) *State of the art compendium report on resource recovery from water*. International Water Association, The Hague. Available at: https://iwa-network.org/wp-content/uploads/2015/12/1440858039-web-State-of-the-Art-Compendium-Report-on-Resource-Recovery-from-Water-2105-.pdf [2020-05-11]

Joshi, A., Kale, S., Chandel, S. and Pal, D.K. (2015). Likert Scale: Explored and Explained. *British Journal of Applied Science & Technology*, vol. 7(4), pp. 396-403. DOI: 10.9734/BJAST/2015/14975

Kaza, S., Yao, L., Bhada-Tata, P., Van Woerden, F. (2018) *What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050*. Washington, D.C: World Bank Group. doi: 10.1596/978-1-4648 -1329-0.

Kim, H., Son J, Lee S., Koop S., Van Leeuwen K., Choi Y. J., Park J. 2018 Assessing Urban Water Management Sustainability of a Megacity: Case Study of Seoul, South Korea. *Water*, vol. 10 (682), pp.1-16.

Koop, S.H.A., Koetsier, L., Doornhof, A., Reinstra, O., Van Leeuwen, C.J., Brouwer, S., Dieperink, C., Driessen, P.P.J. (2017). Assessing the Governance Capacity of Towns to Address Challenges of Water, Waste, and Climate Change. *Water Resource Management*, vol. 31, pp. 3427–3443. DOI 10.1007/s11269-017-1677-7

Kuokkanen, A., Mikkilä, M., Kahiluoto, H., Kuisma, M., Linnanen, L. (2016). Not only peasants' issue: Stakeholders' perceptions of failures inhibiting system innovation in nutrient economy. *Environmental Innovation and Societal Transitions*, vol. 20, pp. 75–85. https://doi.org/10.1016/j.eist.2015.11.001

Lohri, C. R., Diener, S., Zabaleta, I., Mertenat, A., & Zurbrügg, C. (2017). Treatment technologies for urban solid biowaste to create value products: a review with focus on low- and middle-income settings. *Reviews in Environmental Science and Bio/Technology*, vol. 16 (1), pp. 81–130. doi:10.1007/s11157- 017-9422-5

Madonsela, B., Koop, S., Van Leeuwen, K., Carden, K., (2019). Evaluation of water governance processes required to transition towards Water Sensitive Urban Design-An indicator assessment approach for the City of Cape Town. *Water*, vol. 11 (292), pp-1-14. doi:10.3390/w11020292

Mees, H.L.P., Driessen, P.P.J. (2011). Adaptation to climate change in urban areas: Climate-greening London, Rotterdam, and Toronto. *Climate Law*, vol. 2, pp. 251–280. DOI 10.3233/CL-2011-036

Mosquera, J (2018). *Analysis of energy recovery alternatives from organic waste streams in Chía, Colombia*. (Unpublished) Royal Institute of Technology. Department of Energy Technology.

Moya, B., Sakrabani, R., Parker, A. (2019). Realizing the Circular Economy for Sanitation: Assessing Enabling Conditions and Barriers to the Commercialization of Human Excreta Derived Fertilizer in Haiti and Kenya. *Sustainability* , vol. 11 (3154), pp-1-15. doi:10.3390/su11113154

Municipio de Chía (2016). *Proyecto de Acuerdo Plan de Ordenamiento Territorial*. Available at: https://www.chia-cundinamarca.gov.co/POT2016/Acuerdo%20100%20POT%202016.pdf [2019-07-11]

Muñoz, D.A., Ortiz M.I., Suarez C., Romero G., Dueñas M., Sanchez L. M., Saenz Y. J., Pardo M., Castillo D.M. (2015). *Plan Estrategico Sectorial 2015-2018. Sector de Ambiente y Desarrollo Sostenible*. Ministerio de Ambiente y Desarrollo Sostenible. República de Colombia. Available at: http://www.ideam.gov.co/documents/24189/73417452/PLAN_ESTRATEGICO_SECTORIAL_2015-2018_versi%C3%B3n_1.pdf/3a67d845-e9d4-4bf6-bfc6-8def83e3c12c?version=1.0 [2020-05-23]

Ochoa, M. (2018). Panorama normativo nacional y enfoque de la implementación. In: *Gestión Integral de los Residuos. Análisis normativo y herramientas para su implementación*. (2ed.) Universidad del Rosario. Colombia, pp:115-145.

OECD (2015). *OECD Principles on Water Governance*. OECD Studies on Water, OECD Publising. Available at: https://www.oecd.org/governance/oecd-principles-on-water-governance.htm [2019-06-10]

Official Journal of the Colombian Government (2015a*). Decree 1077 of 26 May 2015* (In Spanish). Bogotá: National Press; 2015; 1–793.

Official Journal of the Colombian Government (2015b). *Resolution 1377 of 9 June of 2015* (In Spanish). Bogotá: National Press; 2015: 1–6.

Official Journal of the Colombian Government (2016). *Decree 596 of 11 April of 2016* (In Spanish). Bogotá: National Press; 2015: 1–13.

Otoo, M. & Drechsel, P. (2018). *Resource Recovery from Waste: Business Models for Energy, Nutrient and Water Reuse in Low- and Middle-income Countries*, 1st Edition. ed. Routledge, London.

Pahl-Wostl, C. (2009). A conceptual framework for analysing adaptive capacity and multi-level learning processes in resource governance regimes. *Global Environmental Change*, vol.19, pp. 354–365. doi:10.1016/j.gloenvcha.2009.06.001

Rizos, V., Tuokko, K., Behrens, A. (2017). *The Circular Economy: A review of definitions, processes and impacts.* CEPS Research Report No 2017/8, April 2017. Center for European Policy Studies.

Rodríguez, D. J., Serrano, H. A.; Delgado, A.; Nolasco, D.; Saltiel, G. (2020). *From Waste to Resource: Shifting paradigms for smarter wastewater interventions in Latin America and the Caribbean*." World Bank, Washington, DC. Available at: https://openknowledge.worldbank.org/handle/10986/33436 [2020-04-18]

Rubiano, M.P. (2018) PTAR2 de Chía: una bomba a punto de estallar. *El Espectador*. Julio 12. Available: http://blogs.elespectador.com/actualidad/el-rio/ptar-2-chia-una-bomba-punto-estallar [2019-07-12]

Sánchez, Y. A. (2015). *Plan de Saneamiento y Manejo de Vertimientos*. (Unpublished). Municipio de Chía- Cundinamarca.

Sarralde, M. (2018) Los cuatro rellenos en crisis que pueden causar emergencias sanitarias. El Tiempo. Octubre 12. Available at: https://www.eltiempo.com/justicia/investigacion/colombia-no-tiene-rellenos-sanitarios-y-mantiene-un-mal-manejo-de-basuras-279956 [2019-09-09]

Schreurs, E., Koop, S., van Leeuwen, K., (2017). Application of the City Blueprint Approach to assess the challenges of water management and governance in Quito (Ecuador). *Environment Development and Sustainability*, vol. (29), pp. 509-525. https://doi.org/10.1007/s10668-017-9916-x

Silva, P., Teles, F., Ferreira, J. (2018). Intermunicipal cooperation: The quest for governance capacity? *International Review of Administrative Sciences*, vol. 84(4), pp. 619-638. https://doi.org/10.1177/0020852317740411

Šteflová, M., Koop, S., Elelman, R., Vinyoles, J., Van Leeuwen, K., 2018. Governing Non-Potable Water-Reuse to Alleviate Water Stress: The Case of Sabadell, Spain. *Water*, vol. 10 (739), pp. 1-16. doi:10.3390/w10060739

Stockholm Environment Institute (SEI) (2019). *UrbanCicle.* Available at: https://www.sei.org/projects-and-tools/projects/urban-waste-into-circular-economy-benefits-urbancircle/ [2019-09-19]

Sustainable Sanitaiton Water Management , SSWM 2020. *Glossary*. https://sswm.info/glossary/ [2020-09-05]

Taborda, C. 2019. Se contaminó la única parte limpia del río Bogotá. El Espectador. 21 Marzo. Available at: https://blogs.elespectador.com/actualidad/el-rio/se-contamino-la-unica-parte-limpia-del-rio-bogota [2019-07-12]

United Nations, UN (2015). *Paris Agreement.* Available at: https://unfccc.int/files/essential_background/convention/application/pdf/english_paris_agreement.pdf [2020-08-13]

United Nations, UN (2020). *About the Sustainable Development Goals.* Available at: https://www.un.org/sustainabledevelopment/sustainable-development-goals/ [2020-08-13]

UN Environment (2018). *Waste Management Outlook for Latin America and the Caribbean*. United Nations Environment Programme, Shutterstock.com Latin America and the Caribbean Office. Panama City, Panama. Available at https://www.unenvironment.org/ietc/resources/publication/waste-management-outlook-latin-america-and-caribbean [2020-05-13]

Unidad Administrativa Especial De Servicios Públicos (UAESP) (2019). *Periódico Doña Juana*. Available at: http://www.uaesp.gov.co/content/periodico-dona-juana [2019-07-17]

United Nations, Department of Economic and Social Affairs (UN DESA) (2019). Population Division. *World Population Prospects 2019: Ten Key Findings*. Available at: https://population.un.org/wpp/Publications/Files/WPP2019_Highlights.pdf [2019-06-03]

United Nations, Department of Economic and Social Affairs (UN DESA) (2018). *World Urbanization Prospects: the 2018 Revision - Key Facts.* Available at: https://population.un.org/wup/Publications/Files/WUP2018-KeyFacts.pdf [2019-06-03]

Universidad el Bosque (2017). *Formulación de la Propuesta de investigación, innovación tecnológica y creación*. Proyecto UrbanCircle. (Unpublished).

Universidad el Bosque (2019). *Interviews with stakeholders involved in waste management and sanitation in Chía*. Proyecto UrbanCircle. (Unpublished).

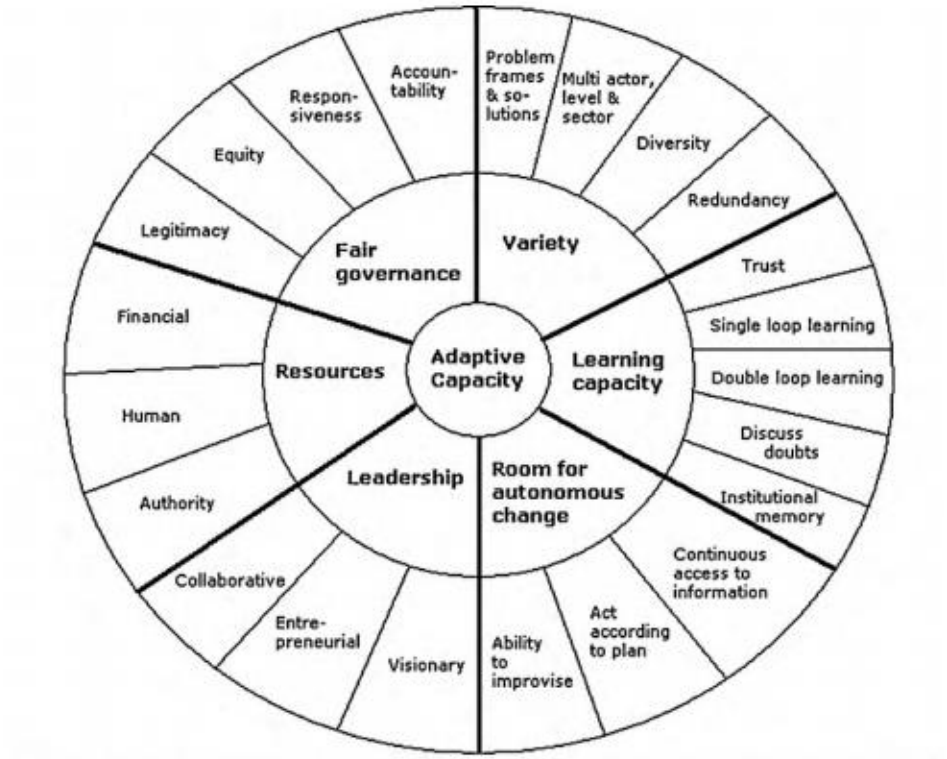
Van Leeuwen, K., de Vries, E., Koop, S., Roest, K. (2018). The Energy & Raw Materials Factory: Role and Potential Contribution to the Circular Economy of the Netherlands. *Environmental Management*, vol. (61), pp. 786–795. https://doi.org/10.1007/s00267-018-0995-8

Weitz, N., Strambo, C., Kemp-Benedict, E., Nilsson, M. (2017). Closing the governance gaps in the water-energy-food nexus: Insights from integrative governance. *Global Environment Change*, vol (45), pp. 165–173. http://dx.doi.org/10.1016/j.gloenvcha.2017.06.006

Velenturf, A.P.M., Jopson, J.S. (2019). Making the business case for resource recovery. *Science of the Total Environent*, vol. (648), pp 1031–1041. https://doi.org/10.1016/j.scitotenv.2018.08.224 0048-9697

Annex I

Figure 6. Framework for the analysis of governance capacity that combines five sub capacities and different critical aspects (Mees and Driessen 2011)



Effect of institution on adaptive capacity	Score	Aggregated scores for dimensions and adaptive capacity as a whole
Positive effect	2	1.01 to 2.00
Slightly positive effect	1	0.01 to 1.00
Neutral or no effect	0	0
Slightly negative effect	-1	-0.01 to –1.00
Negative effect	-2	-1.01 to –2.00

Figure 7. The Adpative Capacity Wheel and its scoring framework to assess the extent to which different characteristics of institutions enable the adaptive capacity of societies. The framework is formed by six dimensions of the adaptive capacity: variety, learning capacity, room for autonomous change, leadership, availability of resources and fair governance and 22 criteria such as trust or continuous access to information (Gupta et al. 2010)

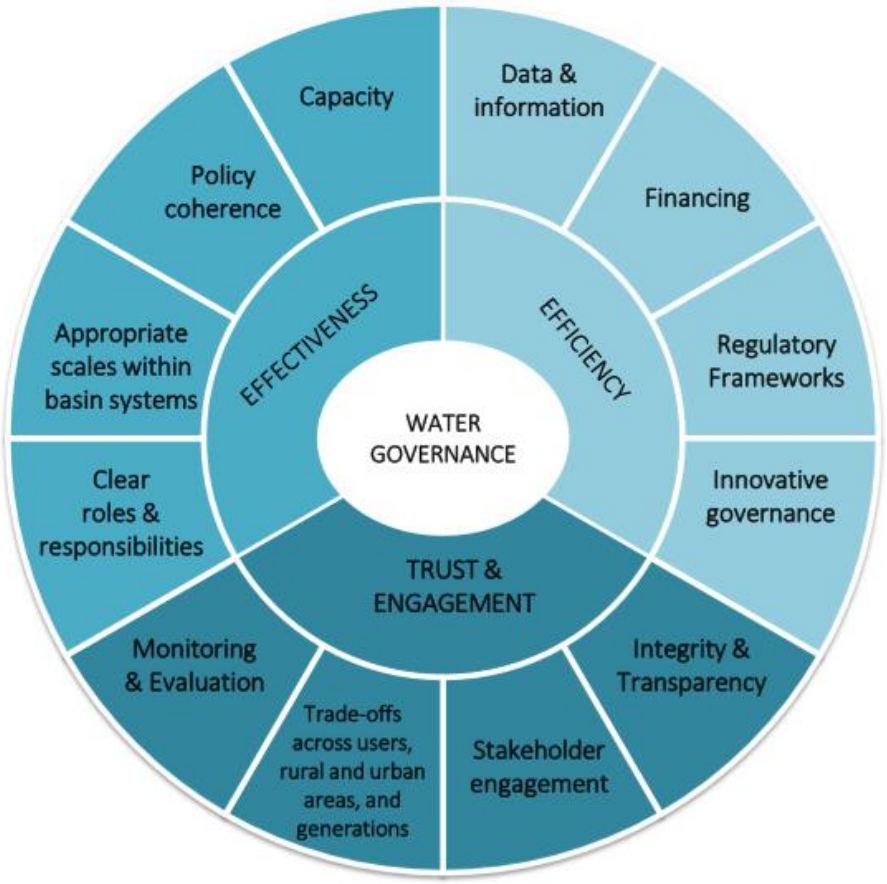


Figure 8. OECD principles on Water governance (OECD 2015)

Annex II

Indicators	Predefined questions
1.1. Community knowledge	What is the level of public knowledge in the community regarding resource recovery from organic waste streams?
1.2 Local sense of urgency	To what extent do local stakeholders have a sense of urgency about resource recovery from organic waste streams?
1.3 Behavioural internalization	To what extent do local communities and stakeholders try to change their behaviour in order to implement resource-oriented sanitation and waste management systems?
2.1. Information availability	How well is useful information regarding resource-oriented sanitation and waste management systems readily available in the local context?
2.2. Information transparency	To what extent is information on resource-oriented sanitation and waste management systems accessible and understandable for interested stakeholders, including experts and non-experts-
2.3. Knowledge cohesion	To what extent is information about resource-oriented sanitation and waste management systems cohesive in terms of using. Producing and sharing different kinds of information amongst different policy fields and stakeholders?
3.1. Smart monitoring	To what extent is the monitoring of resource-oriented sanitation and waste management processes able to quickly recognise alarming situations, identify underlying trends and have predictive value?
3.2. Evaluation	To what extent is current policy and implementation regarding sanitation, waste and natural resource management continuously assessed, evaluated and improved?
3.3 Cross-stakeholder learning	To what extent do stakeholders connected to resource-oriented sanitation and waste management have the opportunity to interact with each other and deliberately choose to learn from each other?
4.1. Stakeholder inclusiveness	To what extent are all relevant stakeholders able to join any decision-making process concerning resource-oriented sanitation and waste management systems? Are the engagement processes transparent and are stakeholders able to speak on behalf of their interest group?
4.2. Protection of core values	To what extent do stakeholders feel confident that their core values will not be harmed during their engagement in any decision-making process concerning resource-oriented sanitation and waste management systems
4.3. Progress and variety of options	To what extent to do stakeholders have the prospect of gain during their active involvement in any decision-making process concerning resource-oriented sanitation and waste management systems?
5.1. Ambitious and realistic management	To what extent are goals for resource-oriented sanitation and waste management systems ambitious and yet realistic (supported by realistic intermittent targets that adequately deal with uncertainties)
5.2. Discourse embedding	To what extent are ambitions regarding resource-oriented sanitation and waste management systems interwoven in the historical, cultural, normative and political context of the city?
5.3. Policy cohesion	To what extent are policies relevant for resource-oriented sanitation and waste management systems and coherent across geographic, administrative, sectoral boundaries and government levels?
6.1. Entrepreneurial agents	To what extent are the entrepreneurial agents of change able to gain access to resources, seek and seize opportunities and have influence on decision-making regarding resource-oriented sanitation and waste management?
6.2. Collaborative agents	To what extent are stakeholders enabled to engage, collaborate with and connect business, government and civil society actors in order to implement resource-oriented sanitation and waste management systems?

6.3. Visionary agents	To what extent are visionary actors in the city able to effectively push forward and manage long-term integrated strategies for resource-oriented sanitation and waste management systems?
7.1. Room to maneuver	To what extent do actors have the freedom and opportunity to develop a variety of innovative approaches and fit-for-purpose partnerships that can adequately address the implementation of resource-oriented sanitation and waste management systems)?
7.2. Clear division of responsibilities	To what extent are responsibilities clearly defined and allocated, in order to effectively address the implementation of resource-oriented sanitation and waste management systems?
7.3. Authority	To what extent are legitimate forms of power and authority present that enable long-term, integrated and sustainable approaches for implementing resource-oriented sanitation and waste management systems?
8.1. Affordability	To what extent are resource-oriented sanitation and waste management services available and affordable for all citizens, including the poorest?
8.2. Consumer willingness to pay	How is expenditure regarding resource-oriented sanitation and waste management systems perceived by relevant stakeholders?
8.3. Financial continuation	To what extent do financial arrangements support the long-term implementation of resource-oriented sanitation and waste management systems?
9.1. Policy instruments	To what extent are policy instruments effectively used and evaluated, in order to stimulate the desired behaviour and discourage undesired activities and choices in the city?
9.2. Statutory compliance	To what extent do stakeholders in the city respect agreements, objectives, regulations, and legislation?
9.3. Preparedness	To what extent is the city prepared for both gradual and sudden uncertain changes and events regarding resource-oriented sanitation and waste management systems?

Annex III

On the top, the predefined question for the indicator.is shown, further down and linked with this question, the Likert- type scoring describing each of the five levels (Daniel, 2019)

Condition 1: Awareness

Indicator 1.1: Community knowledge. ***What is the level of public knowledge in the community regarding resource recovery from organic waste streams*****?**

++	**Balanced awareness**	Nearly all members of the community are aware of and understand resource-oriented sanitation and waste management systems. Resource recovery is addressed at the local level. Local communities and stakeholders are familiar with or are involved in the implementation of resource recovery initiatives.
+	**Overestimation**	The community is knowledgeable and recognise the many opportunities of resource-oriented sanitation and waste management systems. Consequently, they often overestimate the benefits and trade-offs. Resource-oriented sanitation and waste management systems have been raised at the local political level and policies/plans may be co-developed together with local communities.
0	**Underestimation**	Most communities have a basic understanding of resource-oriented sanitation and waste management systems. However, the current opportunities, benefits, and trade-offs are often not fully known and underestimated. Future opportunities, benefits, and trade-offs are often unknown. Some awareness has been raised amongst or is being created by local stakeholders and communities.
-	**Fragmented knowledge**	Only a small part of the community recognizes resource-oriented sanitation and waste management systems. The most relevant stakeholders have limited understanding of resource-oriented sanitation and waste management systems. As a result, the issue is hardly or not addressed at the local governmental level.
--	**Ignorance**	The community, local stakeholders and decision-makers are unaware or ignore resource-oriented sanitation and waste management systems. This is even demonstrated by the absence of articles on the issue in local newspapers, on websites or local action groups addressing the issue.

Indicator 1.2: Local sense of urgency. ***To what extent do local stakeholders have a sense of urgency about resource recovery from organic waste streams?***

++	**Strong demand for action**	There is a general sense of importance regarding resource-oriented sanitation and waste management systems. There is continuous, active, public support and demand to undertake action and invest in innovative, ground-breaking solutions. This is evident since the issue receives much media attention and action plans are implemented.
+	**General sense of urgency**	There is an increasing understanding of the causes, impacts, scale, and urgency of resource-oriented sanitation and waste management systems. It leads to general sense of urgency of the need for long-term sustainable approaches. However, measures requiring considerable efforts, budget, or substantial change with sometimes uncertain results are often receiving only temporal support. Resource-oriented sanitation and waste management systems is a main theme in local elections.
0	**Moderate willingness for small changes**	There is growing public awareness and increasing worries regarding resource-oriented sanitation and waste management systems. However, the causes, impact, scale, and urgency are not widely known or acknowledged leading to the support for only incremental changes. It is a side topic in local elections.
-	**Raising of awareness by small groups**	A marginalized group (e.g. the most vulnerable, environmentalists, NGOs) express their concerns, but these are not widely recognised by the general public. Measures for implementing resource-oriented sanitation and waste management systems are not an item on the political agenda during elections.
--	**Resistance**	There is generally no sense of urgency and sometimes resistance to spending resources on issues regarding resource-oriented sanitation and waste management systems. It is not an item on the political agenda during elections, as is evident from the lack of (media) attention.

Indicator 1.3: Behavioural internalization. ***To what extent do local communities and stakeholders try to change their behaviour in order to implement resource-oriented sanitation and waste management systems?***

++	**Full internalization**	Because actors are fully aware of resource-oriented sanitation and waste management systems, their causes, impacts, scale, and urgency, there is integrated into long-term and joint strategy, practices, and policies. All actors are encouraged to participate. Presently, resource-oriented sanitation and waste management systems are integrated into everyday practices and policies.
+	**Moderate internalization**	Awareness has evolved into mobilization and action. There are various incentives for actors to change current practices and approaches regarding resource-oriented sanitation and waste management systems. Resource-oriented sanitation and waste management systems, however, is not yet fully integrated into clear strategy, practices, and policies.
0	**Exploration**	There is a growing awareness, often as a result of local, exploratory research regarding the causes and solutions of resource-oriented sanitation and waste management systems. There are only incremental changes in actions, policy and stakeholders' behaviour.
-	**Recognized as an external pressure**	Resource-oriented sanitation and waste management systems are partly recognised, mainly due to external pressure instead of intrinsic motivations. There is no support to investigate potential approaches to implementation or to proceed to action or changing practices.
--	**Unawareness**	There is unawareness of resource-oriented sanitation and waste management systems with hardly any understanding of necessity and benefits or how current practices impact resource-oriented sanitation and waste management systems, the city or future generations.

Condition: 2 Useful knowledge

Indicator 2.1: Information availability. ***How well is useful information regarding resource-oriented sanitation and waste management systems readily available in the local context****?*

++	**Comprehensive information is available**	Comprehensive and integrated documentation of resource recovery from waste can be found on local websites and policy papers. It is characterized by adequate information, integrated description of social, ecological and economic processes regarding resource-oriented sanitation and waste management systems, as well as goals and policies. Furthermore, progress reports on effective implementation can be found.
+	**Information enhancing integrated long-term thinking**	Strong effort is put in providing integrated information from various fragmented sources. Information gaps are identified and attempted to be bridged. This may be clear from extensive documentation on the long-term process. Also, citizen knowledge may be taken into account.
0	**Information fits demand but with limited exploratory research**	Information on resource-oriented sanitation and waste management systems is available. Knowledge on understanding or tackling resource-oriented sanitation and waste management systems is progressing and is produced in a structural way. Knowledge gaps are hardly identified due to lock-in into existing disciplines and policy. This is apparent from the quantity of factual information, but the causes, risks, and impacts of long-term processes are lagging behind.
-	**Information scarcity and limited quality**	Limited information is available which does not grasp the full extent of resource-oriented sanitation and waste management systems. In some cases, not all information is of sufficient quality to generate a comprehensive overview
--	**Lack of information**	No information on resource-oriented sanitation and waste management systems can be found. Or the scarce available information is of poor quality

Indicator 2.2: Information transparency. ***To what extent is information on resource-oriented sanitation and waste management systems accessible and understandable for interested stakeholders, including experts and non-experts?***

++	**Easy access to cohesive knowledge**	Information is easily accessible on open source information platforms. There are multiple ways of accessing and sharing information. Information is often provided by multiple sources and is understandable for non-experts.
+	**Sharing of partly cohesive knowledge**	All interested stakeholders can access information. Action has been taken to make knowledge increasingly understandable. Still, it is a time-consuming search through a maze of organizations, protocols, and databases to abstract cohesive knowledge and insights.
0	**Sharing of very technical knowledge**	There are protocols for accessing information; however, it is not readily available. Although the information is openly available, it is difficult to access and comprehend because it is very technical. Resource-oriented sanitation and waste management systems are reported on local websites and reports.
-	**Low sharing of fragmentized knowledge**	Information is sometimes shared with other stakeholders. However, information is inaccessible for most stakeholders. Furthermore, knowledge is often technical and difficult to understand for non-experts. Resource-oriented sanitation and waste management systems may be addressed on local websites.
--	**Not transparent and inaccessible knowledge**	Information is limitedly available, and sharing may be discouraged. The available information is difficult to understand. Resource-oriented sanitation and waste management systems are not addressed on local websites.

Indicator 2.3: Knowledge cohesion. ***To what extent is information about resource-oriented sanitation and waste management systems cohesive in terms of using, producing and sharing different kinds of information amongst different policy fields and stakeholders?***

++	**Implementation of cohesive knowledge**	Stakeholders are engaged in long-term and integrated strategies. Information can be found that is co-created knowledge and will contain multiple sources of information, multiple and mixed methods taking into account the socio-ecological and economic aspects of resource-oriented sanitation and waste management systems.
+	**Substantial cohesive knowledge**	Sectors cooperate in a multidisciplinary way, resulting in complete information regarding resource-oriented sanitation and waste management systems. Besides multiple actors, multiple methods are involved to support information. Too many stakeholders are involved, sometimes in an unbalanced way. Knowledge of effective implementation is often limited.
0	**Insufficient cohesion between sectors**	Data collection within sectors is consistent and is sustained in multiple projects for about two to three election periods. Knowledge of resource-oriented sanitation and waste management systems, however, is still fragmented. This becomes clear from different foci of the stakeholders as stated in their organization's strategies and goal setting.
-	**Low-cohesive knowledge within sectors**	Information that is found is sector-specific and information is inconsistent within and between sectors.
--	**Non-cohesive and contradicting knowledge**	A lack of data strongly limits the cohesion between sectors. Information that is found can even be contradictory.

Condition 3: Continuous learning

Indicator 3.1: Smart monitoring. ***To what extent is the monitoring of resource-oriented sanitation and waste management processes able to quickly recognize alarming situations, identify underlying trends and have predictive value?***

++	**Useful to predict future developments**	Monitoring system is adequate in recognizing alarming situations, identifying underlying processes and provides useful information for identifying future developments. Reports of monitoring will display discrepancies between fundamental beliefs and practices. The monitoring is changed to act upon these findings by altering the fundamental beliefs. Often regulatory frameworks are changed, new actors are introduced, new risk management approaches are used.
+	**Useful to recognize underlying processes**	The abundant monitoring provides a sufficient base for recognizing underlying trends, processes, and relationships. Reports of monitoring will display discrepancies between assumptions and real process dynamics. Acting upon these findings by altering the underlying assumptions characterizes this level of smart monitoring. Often also system boundaries are re-defined, new analysis approaches introduced, priorities are adjusted, and new aspects are being examined.
0	**Quick recognition of alarming situations**	The monitoring systems cover most relevant aspects. Alarming situations are identified and reported. This leads to improvement of current practices regarding the technical measures. There is only minor notification of societal and ecological effects.
-	**Reliable data but limited coverage**	Monitoring occurs; however, the monitoring system does not cover all facets of resource-oriented sanitation and waste management systems, with sometimes incomplete descriptions of the progress and processes of technical and policy measures. Monitoring is limited to singular effectiveness or efficiency criteria and cannot identify alarming situations.
--	**Irregular, poor quality or absent**	There is no system to monitor resource-oriented sanitation and waste management systems or monitoring is irregular.

Indicator 3.2: Evaluation. ***To what extent is current policy and implementation regarding sanitation, waste and natural resource management continuously assessed, evaluated and improved?***

++	**Exploring the fitness of the paradigm**	Frequent and high-quality evaluation procedures fully recognize long-term processes. Assumptions are continuously tested by research and monitoring. Evidence for this is found in sources (primarily online documents) that report on the learning process and progress. Uncertainties are explicitly communicated. Also, the current dominant perspective on governance and its guiding principles are questioned.
+	**Changing assumptions**	There is continuous evaluation, hence continuous improvements of technical and policy measures and implementation. Innovative evaluation criteria are used. This is evidenced by reports containing recommendations to review assumptions or explicitly indicating the innovative character of the approach.
0	**Improving routines**	The identified problems and solutions are evaluated based on conventional (technical) criteria. Current practices are improved. This becomes clear from the information of the used and existing criteria, the small changes recommended in reports and short-term character.
-	**Non-directional evaluation**	Evaluation is limited regarding both frequency and quality. Evaluation occurs sometimes, using inconsistent and even ad-hoc criteria. Also, the evaluation is not systematic. There is no policy on the performance of evaluations, only the evaluation(s) itself is reported.
--	**Insufficient evaluation**	There is no evaluation of technical or policy measures regarding resource-oriented sanitation and waste management systems. Otherwise, it is not documented.

Indicator 3.3: Cross-stakeholder learning. ***To what extent do stakeholders connected to resource-oriented sanitation and waste management have the opportunity to interact with each other and deliberately choose to learn from each other?***

++	**Putting cross-stakeholder learning into practice**	There is a recognition that resource-oriented sanitation and waste management systems are complex, and that cross-stakeholder learning is a precondition for adequate solutions and smooth implementation. This is evidenced by broad support for policy measures and implementation. Moreover, continuous cross-stakeholder learning programs are in place or may be institutionalized.
+	**Open for cross-stakeholder learning**	Stakeholder interaction is considered valuable and useful for improving policy and implementation. Various initiatives for cross-stakeholder learning have been deployed, yet the translation into practice appears difficult. The programs may not be structural, and the learning experience may not be registered and shared.
0	**Open for stakeholder interaction**	Stakeholders are open to interaction, though not much learning is going on due to the informative character of the interaction. Often, many stakeholders, that do not necessarily share interests or opinions, are involved in the decision-making process.
-	**Small coalitions of stakeholders with a shared interest**	Interaction occurs in small coalitions based on common interests. Opinions of those outside the coalition are generally withheld. Only information for the shared point of view is sought. This is evidenced by the finding of only one perspective regarding resource-oriented sanitation and waste management systems or few perspectives that are supported by means of circle-referencing
--	**Closed attitude towards cross-stakeholder learning**	There is no contact with other parties, contact may even be discouraged. This is apparent from the limited sharing of experience, knowledge, and skills. No information is shared outside the organisation and sector, nor is external information used

Condition 4: Stakeholder engagement process

Indicator 4.1: Stakeholder inclusiveness: ***To what extent are all relevant stakeholders able to join any decision-making process concerning resource-oriented sanitation and waste management systems? Are the engagement processes transparent and are stakeholders able to speak on behalf of their interest group?***

++	**Transparent involvement of committed partners**	All relevant stakeholders are actively involved. The decision-making process and the opportunities for stakeholder engagement are clear. It is characterized by local initiatives specifically focusing on water, sanitation, waste management, recycling and resource recovery among others with contractual arrangements, regular meetings, workshops, focus groups, citizen committees, surveys, etc.
+	**Timely, over-inclusive and active involvement**	Stakeholders are actively involved. It is still unclear how decisions are made and who should be involved at each stage of the process. Often too many stakeholders are involved. Some attendants do not have the mandate to make arrangements. Stakeholder engagement is abundantly done for often overlapping issues.
0	**Untimely consultation and low influence**	Stakeholders are mostly consulted or informed. Decisions are largely made before engaging stakeholders. The frequency and time-period of stakeholder engagement are limited. Engagements are mainly ad hoc consultations where stakeholders have low influence on the end result.
-	**Non-inclusive involvement**	Not all relevant stakeholders are informed and only sometimes consulted. Procedures for stakeholder participation are unclear. If involved, stakeholders have but little influence.
--	**Limited supply of information**	No relevant stakeholders are included, or their engagement is discouraged. Information cannot be found in the extant decision-making process. Many interests are unheard, and the incorporated representatives lack authority.

Indicator 4.2: Protection of core values. ***To what extent do stakeholders feel confident that their core values will not be harmed during their engagement in any decision-making process concerning resource-oriented sanitation and waste management systems?***

++	**Maximal protection of core values**	Stakeholders are actively involved and have a large influence on the end result. There are clear exit possibilities and leading to more stakeholders more committed to the process. The participation opportunities and procedures of implementation are clear.
+	**Requisite for early commitment to output**	Stakeholders are actively involved and expected to commit themselves to early outcomes in the process. Hence relevant stakeholders may be missing in contractual arrangements as they do not want to commit themselves to decisions to which they have not yet contributed. At this point, involved stakeholders have influence on the end result and therefore the output serves multiple interests.
0	**Suboptimal protection of core values**	As stakeholders are consulted or actively engaged for only short periods, alternatives are insufficiently considered. The influence on end-result is limited. Decisions comply with the interests of the initiating party primarily. There are no clear exits in the engagement process.
-	**Non-inclusive and low influence on results**	The majority of stakeholders are engaged, but the level of engagement is low (informative or sometimes consultative). There is a low influence on the result which invokes resistance, for example on internet platforms and newspapers.
--	**Insufficient protection of core values**	Because stakeholders are hardly engaged or informed, core values are frequently being harmed. Implementation and actions may be contested in the form of boycotts, legal implementation obstructions and the invoking of anti-decision support. There may be distrust and an absence of participation.

Indicator 4.3: Progress and variety of options. To what extent do stakeholders have the prospect of gain during their active involvement in any decision-making process concerning resource-oriented sanitation and waste management systems?

++	**Active engagement with choice selection at the end of the cooperation**	There is an active engagement of all relevant stakeholders and clarity of participation procedure and realistic deadlines. The range of alternatives is fully explored, and selection of the best alternatives occurs at the end of the process. Reviews of stakeholder meetings provide the alternatives addressed. Stakeholders are engaged throughout the whole process as specified in contractual agreements.
+	**Active involvement with an abundant choice variety**	Stakeholders are actively involved and there is sufficient room for elaborating alternatives. Procedures, deadlines, and agreements are unclear. There are no or few specifications on deadlines in terms of dates. Due to inexperience with active stakeholder engagement, decisions are taken too early in the process leading to the exclusion of arguments and solutions. Hence, decisions may not be fully supported.
0	**Consultation or short active involvement**	There is a clear procedure for consultation or short active involvement of stakeholders, but the opportunities to consider all relevant alternatives are insufficient. Decisions are therefore still largely unilateral and solutions suboptimal. The suboptimal character of a solution can be observed from evaluations or differences in opinions.
-	**Rigid procedures limit the scope**	Informative and consultative approaches are applied, according to rigid procedures with low flexibility. The period of decision-making is short with a low level of stakeholder engagement. These unilateral decision-making processes may lead to slow and ineffective implementation. The latter can be observed from critique via public channels.
--	**Lack of procedures limit engagement and progress**	The lack of clear procedures hinders stakeholder engagement. This unilateral decision-making limit progress and effectiveness of both decision-making and implementation. It might result in conflicting situations. Often, much resistance can be found online, and implementation may be obstructed.

Condition 5: Policy and Management Ambitions

Indicator 5.1: Ambitious and realistic goals. ***To what extent are goals for resource-oriented sanitation and waste management systems ambitious and yet realistic (supported by realistic intermittent targets that adequately deal with uncertainties)?***

++	**Realistic and ambitious strategy**	The policy is based on modern and innovative assessment tools and policy objectives are ambitious. Support is provided by a comprehensive set of intermittent targets, which provide clear and flexible pathways. Assessment tools and scenarios analyses identify tipping points that may be found in policy documents.
+	**Long-term ambitious goals**	There is a long-term vision that incorporates uncertainty. However, it is not supported by a comprehensive set of short-term targets. Hence, achievements and realistic targets are difficult to measure or estimate. Visions are often found online as an organization's strategy. They often entail a description of resource-oriented sanitation and waste management systems and need for action.
0	**Confined realistic goals**	There is a confined vision of resource-oriented sanitation and waste management systems. Ambition is mostly focused on improving the current situation where unchanging conditions are assumed and risk and scenario analyses are lacking.
-	**Short-term goals**	Actions and goals mention sustainability objectives. Actions and goals are "quick fixes" mainly, not adhering to a long-term vision or sustainable solutions. Uncertainties and risks are largely unknown.
--	**Short-term, conflicting goals**	Goals consider only contemporary waste and resource challenges, are short-sighted and lack sustainability objectives. Goals are arbitrary and sometimes conflicting, and the character of policy is predominantly reactive.

Indicator 5.2: Discourse embedding. ***To what extent are ambitions regarding resource-oriented sanitation and waste management systems interwoven in the historical, cultural, normative and political context of the city?***

++	**Embedding of sustainable implementations**	Local context is used smartly to accelerate policy implementation. Innovations are subdivided into suitable phases that are more acceptable and effectively enable sustainable practices. Effective policy implementation is enabled by a general consensus that long-term integrated policy is needed to address resource-oriented sanitation and waste management systems.
+	**Consensus for sustainable actions**	There is a consensus that resource recovery from waste is required, but substantial effort is necessary as there is little experience in implementing resource-oriented sanitation and waste management systems in a long-term integrated approach. Furthermore, the decision-making periods are long as trust relations with new unconventional partners need to be built.
0	**Low sense of urgency embedded in policy**	The current policy fits the local context. Resource-oriented sanitation and waste management systems are increasingly identified, framed and interwoven into local discourse, but the disregard of uncertainty prevents a sense of urgency that is necessary to adopt adequate measures towards resource recovery from waste. Decision making often results in very compromised small short-term policy changes.
-	**Persistent reluctance and poor embedding**	Actors feel reluctant to execute current policy as it conflicts with their norms and values. Policy hardly takes the local context and existing discourses into account. And the policy does not correspond with societal demands. This may lead to distrust between actors, inefficient use of resources and ineffective overall implementation.
--	**policy mismatch**	The cultural, historical and political context is largely ignored, leading to difficult policy implementation. Actors may not understand the scope, moral or to whom it applies or how to implement it hence leading to total confusion.

Indicator 5.3: Policy cohesion. ***To what extent are policies relevant for resource-oriented sanitation and waste management systems and coherent across geographic, administrative, sectoral boundaries and government levels?***

++	**Cohesive synergetic policies**	Policies are coherent and comprehensive within and between sectors. There is an overarching vision resulting in smooth cooperation. Goals are jointly formulated, evaluated and revised to adapt to new challenges in waste and resource management smoothly. This is evidenced by thematic instead of sectoral approaches. Many inter-sectoral meetings, interdisciplinary reports, and cohesiveness in goals and strategies are formulated.
+	**Overlapping comprehensive policies**	There is cross-boundary coordination between policy fields to address resource-oriented sanitation and waste management systems. Policies are cohesive but have not yet resulted in broad multi-sectoral actions. Efforts to harmonize different sectors are evident by employee functions or assignments and protocols.
0	**Fragmented policies**	The policy is fragmented and based on sector's specific scope and opportunities for co-benefits are hardly explored. However, effort may be made to balance the resource allocation between sectors.
-	**Opposing sectoral policies**	Overall policy on sanitation, waste and natural resource management is characterized by fragmentation and imbalance between sectors. The majority of resources are spent on the dominant policy field and overlaps between sectors lead to inefficient use of resources.
--	**Incompatible policies**	Policies between and within sectors are strongly fragmented and conflicting. This is evidenced by contradicting objectives and the squandering use of resources.

Condition 6: Agents of change

Indicator 6.1: Entrepreneurial agents. ***To what extent are the entrepreneurial agents of change able to gain access to resources, seek and seize opportunities and have an influence on decision-making regarding resource-oriented sanitation and waste management?***

++	**Long-term support for entrepreneurship**	There is recognition of the need for continuous innovation, hence applied research is enabled that explores future risk management and supports strategy formulation. The experiments yield increased benefits and new insights. This is recognized by other actors, thereby providing access to new resources. Continuous experimentation is secured by long-term and reliable resource allocation.
+	**Tentative experimental entrepreneurship**	There is a growing understanding of resource-oriented sanitation and waste management systems' uncertainty, complexity, and need for innovative approaches that entail a certain level of risk. Tentative experimental projects set in but are paid by conventional resources. Projects are small-scale pilots.
0	**Conventional and risk-averse entrepreneurship**	Entrepreneurial agents of change are better able to seize low-risk opportunities. Therefore, opportunities for innovative approaches and synergies are hardly pursued. Small changes can be observed.
-	**Room for short-sighted entrepreneurship**	Agents of change struggle to gain access to resources to address sanitation, waste and natural resource management challenges. Windows of opportunity to identify and to act upon perceived risks are limited. Opportunities to address stakeholders with potential access to resources are rarely seized.
--	**Insufficient entrepreneurship**	Ignorance for risk and threats leads to ineffective rigid governance and a lack of opportunity for entrepreneurial agents to enable improvements. Moreover, distrust by other actors and potential investors further decrease access to resources.

Indicator 6.2: Collaborative agents. ***To what extent are stakeholders enabled to engage, collaborate with and connect business, government and civil society actors to implement resource-oriented sanitation and waste management systems?***

++	**Agents of change enhance wide-spread synergetic collaboration**	There is an on-going build-up of productive and synergetic collaborations. Facilitators may even be administered to coordinate this through mediation and authority. There is a conception of the ideal collaboration composition.
+	**Agents of change can push for collaboration between new stakeholders**	There is an understanding that implementing resource-oriented sanitation and waste management systems requires long-term and integrated solutions. Hence, wide-spread collaborations between a variety of stakeholders and sectors are being established. New collaborations with unconventional actors, result, more and more, in valuable new insights and effective networks
0	**Agents are enabled to enhance conventional collaboration**	Traditional coalitions are preserved to maintain the status quo. There is trust within these coalitions. There is limited space to create new collaborations. If new collaboration occurs solutions are still mostly sectoral and short- to mid-term.
-	**Insufficient opportunities for collaborative agents**	There is an insufficient opportunity for agents of change to go beyond conventional collaboration. The current collaborations are deemed sufficient to deal with resource-oriented sanitation and waste management systems whereas the vision is limited to ad hoc command and control approaches.
--	**Lack of collaborative agents**	Collaboration is discouraged, because of a strong hierarchical structure. There is distrust between stakeholders and the willingness and thereby opportunities for collaborative agents are largely lacking.

Indicator 6.3: Visionary agents. ***To what extent are visionary actors in the city able to effectively push forward and manage long-term integrated strategies for resource-oriented sanitation and waste management systems?***

++	**Long-term vision supported by short-term targets**	Visionary agents of change in different positions and with different backgrounds actively and successfully promote a sustainable and tong-term vision regarding resource-oriented sanitation and waste management systems, that is communicated clearly. Short-term targets fit long-term visions. There are interests and employment in trend analysis.
+	**Long-term vision with flawed communication**	There is a clear long-term, integrated and sustainable-oriented vision. There is still some discrepancy between short-term targets and implementation strategies and the long-term vision from visionary agents of change. This means that agents are not always clear in their formulation regarding the effect and impact of envisioned strategies.
0	**Defence of status quo**	The visions of the existing agents of change are limited to promoting the business as usual. They do not oppose nor promote long-term, integrative thinking. Interest or employment in trend analysis is limited.
-	**Unilateral and short-term vision**	There is a unilateral vision regarding resource-oriented sanitation and waste management systems, which considers a limited group of actors. The vision often has a short-term focus, with a maximum of 3 to 4 years.
--	**Deficient sustainability vision and short-term focus**	There is a lack of visionary agents that promote change towards a long-term, sustainable vision regarding resource-oriented sanitation and waste management systems. Diverging the expectations and objectives of stakeholders is the result. This may be evidenced by indecisiveness or even conflicts. Long-term and integrative initiatives may also be blocked.

Condition 7: Multi-level network potential

Indicator 7.1: Room to manoeuvre. ***To what extent do actors have the freedom and opportunity to develop a variety of innovative approaches and fit-for-purpose partnerships that can adequately address the implementation of resource-oriented sanitation and waste management systems)?***

++	**Freedom to develop innovative solutions**	There is a common and accepted long-term vision for developing resource-oriented sanitation and waste management systems. Within the boundaries of this vision, actors are given the freedom to develop novel and diverse approaches and partnerships, resulting in continuous improvements and exploration. These partnerships are most likely institutionalized.
+	**Redundancy to address uncertainty**	There is a recognition that a high degree of freedom is necessary to deal with complex situations in the form of experiments and looking for new unconventional collaborations. There is a dynamic mix of cooperative partnerships and a redundant set of diverging alternative solutions. A clear overall vision to steer research is however lacking.
0	**Limited room for innovation and collaboration**	Actors are given the means to perform predefined tasks for dealing with problems that are framed with a narrow, short-term and technical-oriented scope. There is limited room to deviate. Solutions are sought in own sectoral field and expertise.
-	**Limited autonomy**	Only a few actors receive some degree of freedom, there are limited opportunities to develop alternatives, and there is hardly any opportunity to form partnerships with unconventional actors.
--	**Strictly imposed obligations**	The actions of stakeholders are strictly controlled and there are rigid short-term targets. Freedom to form new partnerships is strongly limited as actor-network composition is fixed and small. There are no resources made available for exploring alternatives that might be more effective or efficient whereas many actors that are affected by resource-oriented sanitation and waste management systems do not have a voice.

Indicator 7.2: Clear division of responsibilities. ***To what extent are responsibilities clearly defined and allocated, to effectively address the implementation of resource-oriented sanitation and waste management systems?***

++	**Dynamic, fit-for-purpose cooperation**	There are many synergetic cooperation within the urban stakeholders that can provide solutions for resource-oriented sanitation and waste management systems. The roles and responsibilities are clearly divided amongst actors. These cooperation are dynamic and result in fit-for-purpose problem solving necessary to solve complex, multi-level and unknown challenges.
+	**Innovative cooperative strategies**	Actors recognize that knowledge and experience are scattered within the local network. Therefore, extra effort is made to bundle the scattered expertise and to reach fit-for-purpose division of clear roles and responsibilities. New cooperation compositions are explored.
0	**Inflexible division of responsibilities**	Responsibilities are divided over a limited set of conventional actors. Opportunities for new cooperation and more effective division of responsibilities are not seized or even recognized. Sometimes conventional actors get more tasks to deal with new sanitation, waste, and resource management challenges.
-	**Barriers for effective cooperation**	Authorities are fragmentized or they lack interest. Moreover, miscommunication and lack of trust are causes that block effective sanitation, waste and natural resource governance.
--	**Unclear division of responsibilities**	There is an unclear division of responsibilities and often the relationships are over-hierarchical. Everybody expects someone else to make the required effort and trust is hardly found.

Indicator 7.3: Authority. ***To what extent are legitimate forms of power and authority present that enable long-term, integrated and sustainable approaches for implementing resource-oriented sanitation and waste management systems?***

++	**Strong well-embedded authority**	Long-term, integrated approaches regarding resource-oriented sanitation and waste management systems are well embedded in policy and regulatory authorities. Authoritative figures receive much support both politically and by society. Their opinions and statements also receive much media attention.
+	**Stirring authority**	There is recognition of the need for long-term and integrated approaches by both the public and the political arena. Sustainability approaches regarding resource-oriented sanitation and waste management systems are now implemented as declarations of intent and sustainability principles in policy and regulation. Legitimate authorities are assigned to coordinate long-term integrated policy and implementation.
0	**Restricted authority**	Resource-oriented sanitation and waste management systems is addressed as long as the status quo is not questioned. Long-term policy visions are limited, and new policy mainly needs to fit into existing fragmentized structure. This means small (technical) changes are occurring.
-	**Unfruitful attempts**	Resource-oriented sanitation and waste management systems are put forward by individuals or groups of actors, but there is only little interest which is also fragile due to poor embedding of sustainability principles in current policy mechanisms, interests, and budget allocation. The challenge may have been mentioned in reviews or reports but left unaddressed.
--	**Powerlessness**	The addressing of resource-oriented sanitation and waste management systems is regularly overruled with contradicting and competing interests and so it is hardly included in policy, regulation or administrative principles.

Condition 8: Financial viability

Indicator 8.1: Affordability. ***To what extent are resource-oriented sanitation and waste management services available and affordable for all citizens, including the poorest?***

++	**Sanitation & waste management services and resources are affordable for all**	Programs and policies ensure resource-oriented sanitation and waste management services for everyone. This includes public infrastructure and private property protection. The solidarity principle is clearly percolated in policy and regulation
+	**Limited affordability of services**	Serious efforts are made to provide resource-oriented sanitation and waste management services for everyone, including vulnerable groups. There is often recognition that poor and marginalized groups are disproportionately affected by insufficient sanitation and waste management systems. This is increasingly addressed in policy and regulation
0	**Unaffordable services**	Basic resource-oriented sanitation and waste management services are affordable for the vast majority of the population, however poor people and marginalized communities have much difficulty to afford these services.
-	**Limited affordability of basic services**	A share of the population has serious difficulty to pay for basic sanitation and waste management services and essential resources such as neighbourhoods with low-income or marginalized groups. There is hardly any social safety net regarding these services and resources
--	**Unaffordable basic services**	Basic sanitation and waste management services and essential resources are not affordable or even available for a substantial part of the population. This may be due to inefficient or obsolete infrastructure, mismanagement or extreme poverty

Indicator 8.2: Willingness to pay. ***How is expenditure regarding resource-oriented sanitation and waste management systems perceived by relevant stakeholders?***

++	**Willingness to pay for resource-oriented sanitation and waste management systems**	Resource-oriented sanitation and waste management systems is fully comprehended by decision-makers. There is political and public support to allocate substantial financial resources. Also, expenditure for non-economic benefits is perceived as important. There is clear agreement on the use of financial principles, such as polluter-pays- and user-pays- or solidarity principle
+	**Willingness to pay for provisional sanitation and waste management services**	Due to growing worries about the sanitation and waste management crisis, there are windows of opportunity to increase funding. Financial principles, such as polluter-pays principle, may be introduced. Due to inexperience, implementation is often flawed. Focus groups decide on priority aspects regarding resource-oriented sanitation and waste management systems, but there is confusion regarding how to do actual implementation
0	**Willingness to pay for business as usual**	There is support for the allocation of resources for conventional tasks. There is limited awareness or worries regarding resource-oriented sanitation and waste management systems. Most actors are unwilling to financially support novel policies beyond the status quo. Generally, there is sufficient trust in local authorities
-	**Fragmented willingness to pay**	Willingness to pay for resource-oriented sanitation and waste management systems are fragmented and insufficient. The importance is perceived differently by each stakeholder. Generally, their estimates of the costs are substantially lower than the actual costs
--	**Mistrust and resistance to financial decisions**	There is a high level of mistrust in decision making of resource allocation. At this level financial decisions are based on prestige projects, projects that benefit small groups or specific interests. As expenditures often do not address the actual sanitation, waste and resource management challenges, there is a high degree of resistance regarding resource allocation

Indicator 8.3: Financial continuation. ***To what extent do financial arrangements support the long-term implementation of resource-oriented sanitation and waste management systems?***

++	**Long-term financial continuation**	There is secured continuous financial support for long-term policy, measures and research regarding resource-oriented sanitation and waste management systems. These costs are included into baseline funding. Generally, both economic and non-economic benefits are considered and explicitly mentioned
+	**Abundant financial support with limited continuation**	Abundant financial resources are made available for project-based endeavours that are often exploring new solutions but lack long-term resource allocation or institutionalized financial continuation. Hence, long-term implementation is uncertain
0	**Financial continuation for basic services**	Financial resources are available for singular projects regarding basic services of resource-oriented sanitation and waste management systems. The allocation of financial resources is based on past trends, current costs of maintenance and incremental path-dependent developments. Costs to deal with future sanitation, waste and resource management challenges are often not incorporated. Limited resources are assigned for unforeseen situations or calculated risks
-	**Inequitable financial resource allocation**	There are potential resources available to perform basic management tasks regarding resource-oriented sanitation and waste management systems, but they are difficult to access, are distributed rather randomly and lack continuity. No clear criteria can be found on the resource allocation. Resources allocation is ad hoc and considers only short-time horizons
--	**Lack of financial resources**	There are insufficient financial resources available to perform basic tasks regarding resource-oriented sanitation and waste management systems. Financing is irregular and unpredictable leading to poor policy continuation

Condition 9: Implementing capacity

Indicator 9.1: Policy instruments. ***To what extent are policy instruments effectively used and evaluated, to stimulate desired behaviour and discourage undesired activities and choices in the city?***

++	**Effective instruments enhance sustainable transformations**	There is much experience with the use of policy instruments. Monitoring results show that the current use of instruments proves to be effective in achieving sustainable behaviour. Continuous evaluation ensures flexibility and fit-for-purpose use of policy instruments
+	**Profound exploration of sustainability instruments**	Instruments to implement principles such as full cost-recovery and polluter-pays principle, serve as an incentive to internalize sustainable behaviour. The use of various instruments is explorative and therefore not yet optimized and efficient. The use of instruments is dynamic. There are a lot of simultaneous or successive changes and insights
0	**Fragmented instrumental use**	Policy fields or sectors often have similar goals, but instruments are not coherent and may even contradict. Overall instrumental effectiveness is low and temporary. There is sufficient monitoring and evaluation leading to knowledge and insights in how instruments work and actors are getting a more open attitude towards improvements
-	**Unknown impacts of policy instruments**	Instruments are being used without knowing or properly investigating their impacts on forehand. The set of instruments actually leads to imbalanced development and inefficiencies that are hardly addressed
--	**Instruments enhance unsustainable behaviour**	Policy instruments may enhance unwanted or even damaging behaviour that opposes sustainability principles. There is hardly any monitoring that can be used to evaluate the counterproductive effects of these policy instruments

Indicator 9.2: Statutory compliance. ***To what extent do stakeholders in the city respect agreements, objectives, regulations and legislation?***

++	**Good compliance to effective sustainable legislation**	Legislation is ambitious and its compliance is effective as there is much experience with developing and implementing sustainable policy. Short-term targets and long-term goals are well integrated. There is a good relationship among local authorities and stakeholders based on dialogues.
+	**Flexible compliance to ambitious explorations**	New ambitious policies, agreements and legislations are being explored in a "learning-by-doing" fashion. Most actors are willing to comply. Some targets may be unrealistic and requires flexibility
0	**Strict compliance to fragmentized legislation**	Legal regulations regarding resource-oriented sanitation and waste management systems are fragmented. However, there is strictly compliance to well-defined fragmentized policies, regulations and agreements. Flexibility, innovations and realization of ambitious goals are limited. Activity may be penalized multiple times by different regulations due to poor overall coordination
-	**Moderate compliance to incomplete legislation**	The division of responsibilities of executive and controlling tasks is unclear. Legislation is incomplete meaning that certain gaps can be misused. There is little trust in local authorities due to inconsistent enforcement typically signalled by unions or NGOs
--	**Poor compliance due to unclear legislation**	Legislation and responsibilities are unclear, incomplete or inaccessible leading to poor legal compliance by most actors. If legislation is present it enjoys poor legitimacy. Actors operate independently in small groups. Fraudulent activities may take place

Indicator 9.3: Preparedness. ***To what extent is the city prepared for both gradual and sudden uncertain changes and events regarding resource-oriented sanitation and waste management systems?***

++	**Comprehensive preparedness**	Long-term plans and policies are flexible and bundle different risks, impacts and worst-case scenarios. They are clearly communicated, co-created and regularly rehearsed by all relevant stakeholders. The required materials and staff are available on short-term notice in order to be able to respond adequately. Evaluations on the rehearsals or reviews on dealing with calamities are available
+	**Fragmented preparedness**	A wide range of threats is considered in action plans and policies. Sometimes over-abundantly as plans are proactive and follow the precautionary principle. Awareness of risks is high, but measures are scattered and non-cohesive. They may be independent or made independently by various actors. Allocation of resources, staff and training may therefore be ambiguous
0	**Low awareness of preparation strategies**	Based on past experiences, there are action plans and policies addressing resource-oriented sanitation and waste management systems. Actions and policies are clear but actual risks are often underestimated and the division of tasks is unclear. They are not sufficient to deal with all imminent calamities or gradually increasing pressures. Damage is almost always greater than is expected or prepared for
-	**Limited preparedness**	Action plans are responsive to recent calamities and ad hoc. Actual probabilities and impacts of risks are not well understood and incorporated into actions or policies. Reports can be found on how the sanitation, waste and natural resource management sectors deal with recent calamities
--	**Poor preparedness**	There are hardly any action plans or policies for dealing with (future) calamities, uncertainties and existing risks. The city is highly vulnerable

Annex IV

CATEGORIES	CONTRIBUTION	REFERENCE
Governance Capacity Framework	Studies that apply the GCF as a governance capacity assessment method	Brockhoff et al. 2019, Koop et al. 2017, Kim et al. 2018, Madonsela et al 2019, Schreurs et al. 2017, Šteflová et al 2018, Van Leeuwen et al. 2018
Waste Management and Sanitation in the LAC region	Wastewater governance challenges in Latin America and the Caribbean	Rodríguez et al. 2020
	Solid Waste Management	Hettiarachchi et al. 2018b, Kaza et al. 2018, UN Environment 2018
	Case studies of resource recovery from waste	Moya et al. 2019, Otoo & Dreschel 2018
	Biowaste treatment technologies	Lohri et al. 2017
	Water governance in the LAC region	Akhmouch et al. 2012
Colombian national strategies and policies	Solid waste Management, Sanitation Services, sludge management, subsidies for waste pickers	Decreto 1077 de 2015. República de Colombia 2015a
	Regulative basis to recover energy from waste	Official Journal of the Colombian Government 2015b
	Regulation for recovery from solid waste and legal basis for transforming the informal sector or waste pickers	Official Journal of the Colombian Government 2016
	Policy for Solid Waste Management	Departamento Nacional de Planeación 2016
	Review of national regulations of solid waste management	Ochoa 2018
	Strategy to Implement the Sustainable Development Goals	Departamento Nacional de Planeación 2018a
	Strategy of Circular Economy	Gobierno de la República de Colombia 2019
	Guidelines and goals for the environmental sector based on the National Development Plan	Muñoz et al 2015
	Assessment of the national sanitation services 2014-2017	Parra et al. 2018
	Green Growth Policy	Departamento Nacional de Planeación 2018b
Resource recovery in Colombia	Technical guidance for composting	Universidad Nacional de Colombia, no data
	Government Incentives for Energy from Waste	Alzate -Arias et al. 2018
Chía local strategies and policies	Solid Waste Management Plan	Alcaldía Muncipal de Chía 2016, Consultoría y Dirección de Proyectos SAS 2016a, 2016b, 2016c

	Sanitation and Discharge Management Plan	Sanchez 2015
	Spatial Plan	Municipio de Chia 2016
	Risk Management Plan	Consejo Municipal de Gestión de Riesgos de Desastres 2015
Resource recovery in Chía and Cundinamarca	Analysis of resource recovery alternatives from organic waste streams	Mosquera 2018
	Recovery of solid urban organic waste in Cajicá	Hettiarachchi et al 2018a
	Interviews – UC Project	Universidad el Bosque 2019
Grey literature	Suspension of the Spatial Plan in Chía	Bogotá 2019
	Creation of the Committee of Territorial Integration	Camará de Comercio de Bogotá 2017
	Waste pickers sector in Chía	Extrategia 2017
	Newspaper of the landfill of Bogotá City	Unidad Administrativa Especial De Servicios Públicos 2019
	Corruption in the wastewater treatment plan of Chía	Bogotá 2018, Rubiano 2018
	Pollution in the Bogotá River	Taborda 2019
	Public health emergencies and open landfills	Sarralde 2018
Others	Local Public Utility Competences	EMSERCHÍA 2019
	Chía Population trends	Alcaldía Municipal de Chía 2015

Annex V

Table 5. Categorization used in the selection of stakeholders for the interviews and number of interviewees per category. Interviewees were classified by stakeholder role, type and the stage of the waste service chain to which their work belonged (Daniel et al. 2019).

Category	Description	Stakeholders interviewed
Stakeholders as categorized by role		
Decision maker	Stakeholders that have explicit responsibility for polices or measures related to sanitation, waste management, circular economy, bioeconomy, water, energy, agriculture, and related sectors.	3
Implementer	Stakeholders responsible for implementing policies or measures/actions/initiatives.	10
Coordinator	Stakeholders that coordinate other actors for the implementation of policies or measures/actions/initiatives.	3
Expert	Stakeholders that provide research, knowledge and information.	3
Affected	Stakeholders who are beneficiaries or victims of policies or measures/actions/initiatives.	2
	Total	**21**
Stakeholders as categorized by type		
Regional public authority	Ensuring policy, regulatory support, the introduction of support measures, as well as technical and financial support at the regional level.	1
Local public authority	Ensuring policy, regulatory support, the introduction of support measures, as well as technical and financial support at the local level.	10
Private sector - large	Developing and investing in new sustainable businesses, business models, products and services based on circularity principles.	2
Private sector - SME	Developing and investing in new sustainable businesses, business models, products and services based on circularity principles.	6
Research & innovation institution	Cooperating with authorities, SMEs and industries in developing new solutions and scoping visions of regions, towns, communities.	1
NGO	Educating and raising awareness amongst the population, promoting sustainability innovations, including lobby groups and industry sectoral associations promoting or lobbying for specific regulations or policy decisions	0
Funders	Funders of measures/actions and/or related research	0
Citizens	General citizens and user groups.	1
	Total	**21**
Stakeholders as categorized by stage of waste service chain		

Category	Description	Stakeholders interviewed
Waste generation	Involved in the generation and containment of waste at the site	2
Emptying & transport	Involved in emptying, collection, and transport of waste	4
Treatment & processing	Engaged in the treatment and processing of waste and the production of resource recovery products	5
Disposal/End-use	Disposal of end-products, distribution and use of resource recovery products	1
Policy/Overarching	Other stakeholders not directly involved in activities in the waste service chain	9
	Total	**21**

Annex VI

Table 6. Example of the Excel Sheet used for the data analysis. This template shows just the three first categories, but the template had 27 categories in total according to the 27 GCF indicators.

CONDITIONS	CATEGORIES& INDICATORS	INFORMATION GOT FROM THE INTERVIEWS	QUOTES [CH001…CH021]	PERSONAL REFLEXIONS FROM THE FIELD	SUPPORTING DOCUMENTS	CHALLENGES RELATED TO THE GCF
1.AWARENESS	1.1. Community knowledge					
	1.2 Local sense of urgency					
	1.3 Behavioural internalization					